NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

NATIONAL TECHNICAL INFORMATION SERVICE

FISCAL YEAR 2012

BUDGET SUBMISSION TO CONGRESS

National Institute of Standards
and Technology

Department of Commerce
National Institute of Standards and Technology
BUDGET ESTIMATES, FISCAL YEAR 2012
CONGRESSIONAL SUBMISSION

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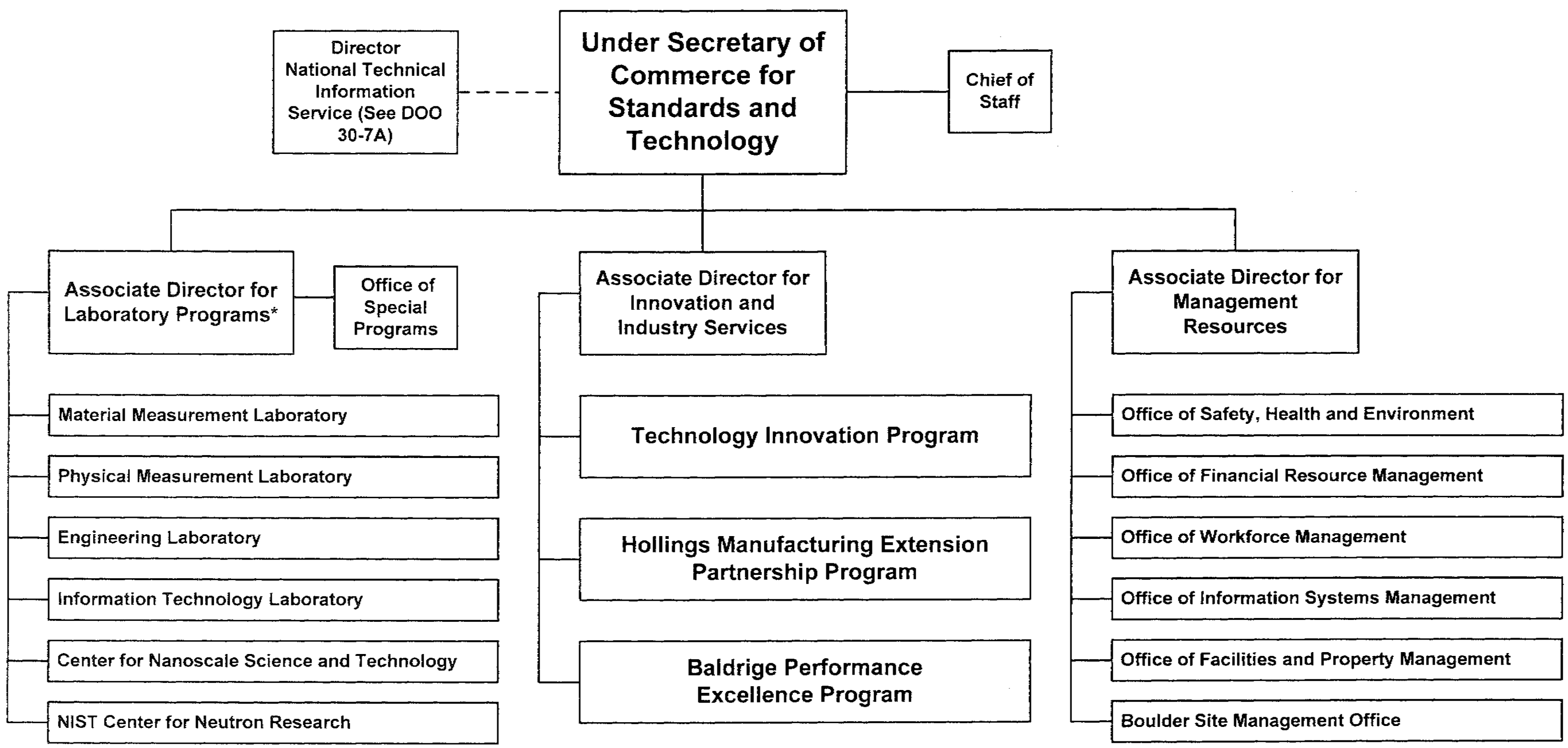
Exhibit 2

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



*The Associate Director for Laboratory Programs serves as the Principal Deputy for NIST.

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EXECUTIVE SUMMARY

General Statement

For FY 2012, NIST's discretionary appropriation is $1.001 billion, $144.5 million or 17 percent above the FY 2011 Continuing Resolution Annualized level. This request reflects the Administration's effort to continue support for basic scientific research as proposed in the President's Plan for Science and Innovation, which intends to double funding for NIST Laboratories over a ten year period. For our extramural programs, the request continues support for the Hollings Manufacturing Extension Partnership program (MEP) and Technology Innovation Program (TIP), and also provides for a new Advanced Manufacturing Technology Consortia program. The request proposes to reduce funding for the Baldrige Performance Excellence Program, with the goal of transitioning the program out of Federal funding.

Under NIST's discretionary request level, net program changes within the Scientific and Technology Research and Services (STRS) appropriation are a net increase of $167.9 million, including the redirection of administrative savings to laboratory programs and drop-outs of congressionally directed projects. Within the Industrial Technology Services (ITS) appropriation net program changes result in an increase of $33.0 million, and within the Construction of Research Facilities (CRF) appropriation net program change is a decrease of $41.6 million. Under CRF, NIST will drop-out $47.0 million in congressionally designated projects and discontinue the $20.0 million in funding for the congressionally directed competitive construction grants program. A program increase of $25.4 million is included for the renovation of Building 1 in Boulder, Colorado.

In addition to the discretionary request level, NIST also requests $100.0 million in mandatory appropriations for the Public Safety Innovation Fund, NIST's component of the Wireless Innovation Fund – Public Safety Innovation Fund as part of the President's Wireless Innovation and Infrastructure Initiative (WI3). This mandatory appropriation request will fund NIST's efforts in this area, with particular focus on working with industry and public safety organizations to develop new standards, technologies, and applications to advance public safety.

The Administration is pursuing an aggressive government-wide effort to curb non-essential administrative spending called the Administrative Efficiency Initiative. In order to be good stewards of taxpayer money, the Federal Government should continue to seek ways to improve the efficiency of programs without reducing their effectiveness. As such, the President directed each agency to analyze its administrative costs and identify savings where possible. After reviewing its administrative costs, NIST has identified $11,569,000 in administrative savings. NIST has targeted a number of areas to achieve these savings. Of these savings, $6,406,000 is tied to more effective acquisition processes for FY 2012. In the area of human capital and general administrative support, NIST expects to reduce its costs by $4,481,000 by keeping its administrative budgets relatively flat from FY 2011 to FY 2012. NIST identified savings of $364,000 in utilities and travel. An additional $318,000 in savings was identified through the Department's Working Capital Fund (see the Departmental Management Working Capital Fund section for more details.) Portions of the administrative savings are reinvested back into additional laboratory program initiatives that will benefit the economy and better support the Department's mission.

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

A constant flow of new technologies is the bedrock of a healthy, growing economy. New technologies contribute to the development of new products, higher productivity, new high-wage jobs, and an improved quality of life. The nations that create and make products based on these new technologies reap the economic benefits. Those that don't, lose market share and jobs, leading to a lower average standard of living.

The United States was the unrivaled leader of technological change for much of the last century. The reward was sustained prosperity for large portions of the post World War II era. As technology has become more sophisticated and other nations have invested heavily in R&D intensive industries and in science and technology education, the United States faces unprecedented challenges. It's dominance in critical areas of advanced technology is waning.

Part of this trend is due to manufacturing jobs that have steadily moved offshore. At first these jobs were in low-skilled areas where higher paid U.S. workers could not compete with larger, cheaper labor forces. Now, however, even in areas like computer and electronic products there are alarming signs of competitive weakness. From 1985 to 2000 the industry was one of the Nation's most productive with 144 percent growth in value added. From 2000 to 2007, however, value added by domestic computer and electronics manufacturers dropped by 21 percent. The U.S. still leads in global sales of semiconductors but its market share is declining, and other nations -- especially in Asia -- are now dominating semiconductor equipment manufacturing, wafer production, and other areas critical to the industry.

Reversing such trends requires a multi-pronged, long-term approach for fostering continuous innovation. What is required is a supportive environment that encourages U.S. companies to produce advanced technologies domestically. This supportive environment can be thought of as a technology-based or innovation ecosystem.[1] It includes a complex set of interdependent elements that establish the right conditions for industrial competitiveness and economic growth in a fast moving global economy.

It is in this context that NIST's proposed request for the President's FY 2012 Budget calls for increases in NIST's funding in high priority targeted areas, even in these times of fiscal constraint. Investment in NIST research, programs, services, and facilities is a direct investment in the Nation's future.

The National Institute of Standards and Technology (NIST) plays a central role in maintaining and strengthening the U.S. innovation ecosystem. In particular, NIST research and program activities enhance innovation and industrial competiveness by:

- creating critical research and development (R&D) infrastructure such as measurement tools and capabilities that enable new technologies to be reliably made and to prove their performance against more established products;

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[1]Tassey, Gregory, "Rationales and Mechanisms for revitalizing U.S. manufacturing R&D strategies," *Journal of Technology Transfer,* Jan. 29, 2010.

- coordinating development of standards, calibrations, and other services that improve productivity and efficiency while promoting interoperability for components made by different manufacturers;

- ensuring equity and faster acceptance of new technologies in the marketplace by providing the technical tools for buyers and sellers to confidently exchange complex technology-based products and services;

- partnering directly with industry, academia, and local, state, and other Federal government agencies to overcome specific technical and organizational barriers impeding progress in high priority areas;

- sharing best practices that help companies conserve energy, reduce waste, and make and use "green" products that promote sustainable approaches to manufacturing; and

- accelerating technology development and transfer by convening experts and participating in technical committees across an extremely wide range of fields—energy, environment, health care, manufacturing, construction, and information technology—to encourage interdisciplinary collaboration and map out strategies to reach transformational research goals.

Overarching Priorities: NIST Three-Year Programmatic Plan (FY 2012-2014)

With the aim of promoting U.S. innovation and industrial competitiveness, NIST has established three overarching priorities to guide and align investments in its programs:

1. Strengthen and focus NIST's Laboratories and facilities to ensure U.S. industrial competitiveness and enable technological innovation.
   - Enhance support of other Federal agencies in meeting U.S. Government needs for voluntary consensus standards.
   - Develop and deliver state-of-the-art measurement science and services.
   - Enhance the facilities and equipment that enable cutting-edge research and measurement service delivery.
   - Strengthen and maintain NIST's world-class user facilities to provide industry, academia, and Government with the infrastructure to support high-tech innovation.
   - Expand collaboration and partnerships to leverage NIST capabilities and advance innovation at regional and national levels.

2. Focus new NIST activities to address critical national priorities.
   - Driving continued innovation and technological advancement in manufacturing.
   - Improve energy efficiency and environmental stewardship.
   - Enable widespread adoption of innovations in information technology and ensure a secure cyberspace for the Nation's economic and security interests.
   - Ensure consumer health and safety.

3. Promote the stimulation and acceleration of technological innovation.
- Promote collective effort for the development of key enabling over-arching technology platforms and infrastructures.
- Improve alignment of research and development with generic industry needs.
- Provide an environment for maximizing the leverage on Federal investment through cost sharing.
- Compress the timescale of technological innovation providing platform technologies suitable for commercialization.
- Foster a robust U.S. innovation ecosystem through broad participation by industry, Federal government, universities, and states and local governments.

NIST research and programs are an essential component to the successful realization of these overarching priorities. 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 NIST Laboratories will continue to 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 measurements.

- **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 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.

NIST Realignment/Reorganization

NIST's FY 2012 request reflects Congressional approval of our realignment that reorganizes NIST's laboratory structure, transfers the Baldrige Performance Excellence Program (BPEP) from the Scientific and Technical Research Services (STRS) to the Industrial Technology Services (ITS) account, and creates a new Office of Special Programs. The approved reorganization will improve NIST's service delivery and improve accountability by streamlining how the responsibility to carry out NIST's mission is delegated throughout the organization.

NIST FY 2012 Budget Request

President's Plan for Science and Innovation

NIST Laboratories are part of the President's Plan for Science and Innovation that, consistent with the goals of the America COMPETES Reauthorization Act of 2010, doubles funding for basic research at key science agencies. The FY 2012 budget request continues the intent of the Administration to double the funding for NIST Laboratories and User Facilities. Specifically, the request supports NIST's two core programs that are critical to promoting American innovation and competitiveness:

- The **NIST Laboratories** directly support U.S. innovation and industrial competitiveness by developing new measurement instruments and facilities to address critical barriers to innovation; disseminating validated measurement methods and protocols; providing reference data, reference materials, and calibration services to ensure that industry-performed measurements are traceable to NIST standards; and developing testing protocols and supporting laboratory accreditation programs. The request includes a net program increase of $167.9 million for NIST Laboratories and User Facilities, including the redirection of administrative savings to laboratory programs and excluding congressionally directed projects.

- NIST's **Construction of Research Facilities** (CRF) appropriation supports projects for new buildings and the renovation and maintenance of current buildings and laboratories. A program increase of $25.4 million is included for the renovation of Building 1 in Boulder, Colorado.

NIST's FY 2012 request for these core programs total $763.5 million, an increase of $111.1 million or 17 percent from the FY 2011 Annualized Continuing Resolution level. This funding level keeps NIST on path to double its Laboratory research budget.

Hollings Manufacturing Extension Partnership (MEP)

The request also continues the Administration's commitment to increase funding for the Hollings Manufacturing Extension Partnership (MEP) program. Through public (Federal-state-local) and private sector partnerships, 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 request includes a program increase of $17.6 million for MEP.

Technology Innovation Program (TIP)

The TIP statute originated in the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Sciences (COMPETES) Act of 2007 (P.L. 110-69). The COMPETES Act was recently reauthorized as the America COMPETES Reauthorization Act of 2010 (P.L. 111-358). TIP was established to help U.S. businesses, institutions of higher education, and other organizations—such as national laboratories and nonprofit research institutes—to support, promote, and accelerate innovation in the United States through high-risk, high-reward research in areas of critical national need. Areas that TIP has supported include civil infrastructure, and manufacturing and biomanufacturing. TIP aims to speed the development of high-risk, transformative research targeting key societal challenges that are not adequately being addressed elsewhere. The request includes a program increase of $5.2 million for TIP.

Advanced Manufacturing Technology Consortia (AMTech) Program

The request includes $12.3 million for the Advanced Manufacturing Technology Consortia (AMTech) program, which provides grants to leverage existing consortia or establish critical new industry-led consortia. These consortia will develop road-maps of critical long-term industrial research needs as well as fund facilities, equipment and research at leading universities and government laboratories directed at meeting these needs. This program would be based on NIST's experience with the Nanoelectronics Research Initiative (NRI) partnership and would expand and improve on that model.

Baldrige Performance Excellence Program (BPEP)

The Baldrige Performance Excellence Program (BPEP) provides global leadership in the learning and sharing of successful strategies and performance practices, principles, and methodologies to strengthen U.S. organizations. The program promotes organizational excellence through education, outreach, and an annual Presidential awards program. The Baldrige Award is given to organizations in six categories: manufacturing, service, small business, health care, education, and nonprofit. BPEP works closely with its stakeholders to recognize and disseminate proven best practices for management and operation, leading to organizations that are more strategic, innovative, competitive, and effective. The request proposes a reduction of $2.1 million, continuing to provide $7.7 million for criteria development, best practices disseminations, and the award process. Additionally, the program will evaluate alternative sources of funding, with the goal of transitioning the Baldrige Performance Excellence Program out of Federal funding.

Public Safety Innovation Fund

The President's budget includes a request of $100.0 million in mandatory appropriations for the Public Safety Innovation Fund, NIST's component of the Wireless Innovation Fund, which will help spur the development of cutting-edge wireless technologies. As part of this initiative, NIST will work with industry and public safety organizations to conduct research and develop standards, technologies and applications to advance public safety communications. Core components of this program will include documenting public safety requirements and driving the adoption of those requirements into the appropriate standards; developing the capability for communications between currently deployed public safety narrow band systems and the future nationwide broadband network; and establishing a roadmap that addresses public safety's needs beyond what can be provided by the current generation of broadband technology and driving technological progress in that direction. NIST will accomplish these tasks through directed research, development, applications, and demonstration projects. Where appropriate, NIST will collaborate with other government research agencies and transfer funding if particular agencies are better suited to sponsor and oversee relevant research, development, or demonstration projects.

Detailed Summary of FY 2012 Budget Request

Discretionary Appropriations

NIST is requesting a total discretionary appropriation level of $1.001 billion, a 17 percent increase from the FY 2010 Enacted level. The request includes net program changes totaling $159.3 million from the FY 2010 Enacted level for the STRS, ITS, and CRF appropriations. The details of the request are provided below.

Scientific and Technology Research and Services

The request for the Scientific and Technical Research Services appropriation total $678.9 million, an increase of $173.5 million above the FY 2011 Continuing Resolution annualized level. 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 $178.5 million in program initiatives and request a decrease of $10.5 million in congressionally directed projects. The net program increase of $168.0 million includes the redirection of both administrative savings and congressionally directed projects to laboratory programs.

NIST will invest the $168.0 million in the following manner:

1. Ensuring a Secure and Robust Cyber Infrastructure ($43,442,000)

The request would provide improvements to cybersecurity in support of the Comprehensive National Cybersecurity Initiative (CNCI), the Federal Information Security Management Act (FISMA), and other national priorities. The Administration has declared the cyber infrastructure a strategic asset, and the President has established a set of high-priority initiatives in the *White House Cyberspace Policy Review*. NIST has a leading role in the Department of Commerce program of cybersecurity and privacy initiatives that support realizing the potential for e-commerce to foster innovation, bolster U.S. industrial competitiveness, and enhance our economic prosperity and security. The request also supports the Administration's National Strategy for Trusted Identities for Cyberspace (NSTIC) by providing $24.5 million to support an

NSTIC National Program Office to raise the level of trust associated with the identities of individuals, organizations, services, and devices involved in online transactions. The request would also support an expansion of the scope of the Comprehensive National Cybersecurity Initiative's (CNCI) Education Initiative from training the Federal workforce to a larger National education focus through the establishment of the National Initiative for Cybersecurity Education (NICE). Both the NSTIC and NICE initiatives are responsive to the recommendations in the *White House Cyberspace Policy Review.*

2. Interoperability Standards for Emerging Technologies ($22,835,000)

This initiative funds efforts to catalyze the development of standards and conformity assessment systems and associated architectural frameworks for emerging technologies that address national priorities such as Smart Grid, Healthcare Information Technology (Health IT) and Cloud Computing (CC).

This initiative supports the following goals and priorities:

- Providing the measurement tools and standards to enable innovation and enhance efficiency, a major objective outlined in the *U.S. Department of Commerce's Strategic Plan: FY 2011–2016.* This plan specifically directs NIST to develop interoperability standards for Smart Grid and Health IT so that industry has "confidence to invest in these new technologies by broadening the market and decreasing the limitations inherent in legacy systems".
- 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) 2007.
- Accelerating the deployment of electronic health records by providing expertise on Health IT implementations and the establishment of voluntary certification programs, and by performing pilot testing of standards and implementation specifications, as requested.
- Enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly set-up and made available with minimal management effort or service provider interaction.

3. Strengthening Measurement Services in Support of Industry Needs ($20,016,000)

The request would strengthen the national time and synchronization measurement system which underpins a substantial part of the national and global technology infrastructure, from telecommunications and information networks, to electric power distribution, to positioning and navigation systems such as GPS, to many crucial applications in national defense, intelligence, and homeland security. Funds will also be used to update and expand the electrical measurement infrastructure required to support the measurement needs of other Federal agencies, especially the Department of Defense (DoD) and Department of Energy (DoE), which rely upon NIST to provide the primary traceability path for precision measurements for defense and nuclear programs. The advances and capabilities developed by the proposed programs will also meet the ever increasing measurement demands of high-tech industries, such as aerospace, semiconductor, electronics, and test equipment manufacturers.

4. Advanced Materials for Industry ($14,242,000)

This request funds the effort to develop the measurement science, tools and standards necessary to enable greatly improved efficiency in the Nation's development and manufacture of new products and services based on innovative materials. The funds would enable NIST to extend its expertise in the development and use of materials modeling and simulation directed at manufacturing, and to create a national measurement and standards infrastructure that would substantially lower the cost of both design and manufacturing for industries seeking to realize the benefits of computer-based materials discovery and optimization.

5. Innovations for 21st Century U.S. Manufacturing: Faster, Smarter and Cleaner ($13,331,000)

This initiative funds the effort to develop the measurement science, tools and standards that will provide the infrastructure for manufacturing that is faster, more intelligent and more environmentally sustainable. 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. Funds requested also support efforts to develop advanced robotics technologies that allow the U.S. to retain manufacturing competitiveness, and respond rapidly to new products and changes in consumer demand, and funds programs that will promote sustainable operations and improve energy efficiency in both the manufacturing and construction sectors of the economy.

6. Measurement Science and Standards to Support Biomanufacturing ($9,526,000)

This initiative funds efforts to create the measurement and standards infrastructure necessary for efficient and effective manufacture and characterization of biologic drugs. Within the current manufacturing paradigm for the biotechnology industry, manufacturing costs are high, production efficiency is low, process understanding is limited, and manufacturing processes and product quality remain largely frozen. This NIST initiative will develop measurement methods, protocols, and standards for improved, real-time measurement of biologic products during manufacturing. NIST will work closely with industry, the Food and Drug Administration, and other standards organizations with the goal of developing metrology infrastructure to achieve greater process understanding, higher quality biologic products through continuous improvement of manufacturing processes, and agile biomanufacturing processes required for next generation products such as stem cells and personalized biotherapeutics.

7. Measurements to Support the Manufacture and Production of Nanotechnology-based Products ($28,256,000)

This initiative supports a number of projects and improvements that will enable industry to fully take advantage of recent innovations in nanotechnology. Economic recovery and economic growth are the important priorities for the Department of Commerce and the Administration. A strong economy hinges on revitalizing U.S. manufacturing by fostering innovation, commercializing new products, and creating new jobs. In the President's *Framework for Revitalizing American Manufacturing*, nanotechnology is called out as having the "promise to transform production processes and consumer products for everything from traditionally high-tech products like computers to less obvious sources of innovation and growth like sunscreen and paint." This initiative focuses on addressing four key areas that can enable significant innovations and breakthroughs in manufacturing through adoption and development of nanotechnology. The key areas are (1) recapitalization of the NIST Center for Nanoscale Science and Technology, (2) Nanomaterial Environmental, Health and Safety (Nano-EHS), (3) High-Volume Nanomanufacturing with Advanced Materials, and (4) Measurements to Enable the Manufacture of Advanced 3rd Generation Photovoltaics.

8. Measurements and Standards to Support Increased Energy Efficiency and Reduced Environmental Impact ($13,270,000)

Developing innovative energy technologies is an important component to reducing energy usage and greenhouse gas (GHG) emissions that can negatively impact the climate. But equally important is the ability to assess if these new technologies are truly reducing energy usage and GHG emissions, and for this capability, high-accuracy measurement techniques and standards are necessary. To address both of these issues, this request focuses on two high-priority areas: (1) net-zero energy, high-performance buildings and (2) greenhouse gas inventory measurements. The decision to focus specifically on net-zero energy buildings comes from the fact that buildings in the U.S. consume 72 percent of all electrical energy produce in this country. 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. However, to measure the impact of new energy technologies on mitigating the impact of greenhouse gas emissions, including those employed in net-zero energy buildings, one must also be able to accurately measure the greenhouse gas inventory with sufficient accuracy. The inability to quantify greenhouse gas inventories is a key issue that could also impede future international agreements on emissions reductions where demonstrated and robust methodologies are critical for verification. From an operational viewpoint, techniques for assess greenhouse gas inventories are currently in their infancy. The lack of robust and demonstrated methodologies tying inventories to increases in atmospheric GHG levels contributes significantly to reduced confidence by decision makers and the public alike in gauging the impact of human-made greenhouse gas emissions on the Earth's atmosphere and biosphere. Several quantification approaches are necessary that combine satellite and enhanced surface-network based observations. This initiative addresses the needs for a comprehensive surface-based observing and modeling effort.

9. Measurements and Standards to Support Advanced Infrastructure Delivery and Resilience ($10,571,000)

This request funds efforts to provide improvements to our physical infrastructure that will both increase the resilience of our building infrastructure to damage from earthquake, windstorms, and fire; and that will enable U.S. industry to improve productivity by transforming the implementation of construction and infrastructure projects, which represent nearly five percent of our Nation's GDP. 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. NIST also proposes to develop critical measurement science tools needed by U.S. industry for: (1) risk-based condition assessment of aging infrastructure systems; (2) determining the remaining service life—and guiding development and use—of sustainable infrastructure materials; and (3) for ensuring the disaster resilience of structures under extreme conditions (specifically, hurricanes, tornadoes, and other windstorms). Funds will also be used to help improve infrastructure implementation for engineering, construction, manufacturing and research organizations by addressing the eroding productivity demonstrated on many construction projects. Funds would support efforts to help improve construction productivity through integrated and automated processes using advanced technology.

10. Postdoctoral Research Associateship Program ($2,979,000)

The Administration continues to be committed to strengthening science, technology, engineering, and mathematics (STEM) education. The NIST postdoctoral program is an important part of NIST's efforts to support industry through advancing measurement, standards, and technology, and represents a highly cost-effective means of technology transfer to and from NIST of the latest measurement sciences and technology. Incoming associates bring the most recent advances in university research to NIST, while actively contributing to NIST projects that address national priorities. The program increases technology transfer from NIST to industry, academia, and other government agencies, contributing to the employment pool of highly-qualified scientists and engineers for these sectors. The request will increase the number of postdoctoral research opportunities at NIST.

11. Non-recurring Congressionally Directed Projects: (-$10,500,000)

NIST will not recur amounts provided previously for congressionally directed projects.

Industrial Technology Services

The Industrial Technology Services (ITS) request totals $237.6 million, a $33.4 million increase above the FY 2011 Continuing Resolution Annualized level. The request funds MEP at $142.6 million, an increase of $17.9 million above the FY 2011 Continuing Resolution annualized level (a $17.6 million increase above the FY 2012 base). TIP is funded at $75 million, an increase of $5.1 million above the FY 2011 Continuing Resolution annualized level (an increase of $5.2 million from the FY 2012 base). The Baldrige Performance Excellence Program (BPEP) is transferred to this appropriation account from STRS and is funded at $7.7 million, a decrease of $1.9 million from the FY 2011 Continuing Resolution annualized level (a decrease of $2.1 million from the FY 2012 base). A new Advanced Manufacturing Technology Consortia (AMTech) Program is funded at $12.3 million.

Additional details of the ITS request are provided below:

1. Technology Innovation Program (+$5,186,000)

TIP is designed to fund high-risk, high-reward R&D projects that address critical national needs and societal challenges in any area that is important to the Nation but is not being addressed by others. TIP has the agility to make targeted, high impact investments that are within NIST's areas of technical competence and are not being addressed by other mission-oriented agencies or programs. 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 Administration guidance, the TIP Advisory Board, science advisory bodies, collaborations with other Federal agencies, national or state science policy reports, academic reports and organizations, industry roadmaps and the public. The $5.2 million increase will enhance TIP's capability to fund additional projects in new areas of critical national need while funding remaining mortgage commitments from previous competitions. In FY 2012, TIP is planning to hold a competition for funding in one or more areas of critical national needs that include topic areas in: Advanced Robotics and Intelligent Automation, Energy, Healthcare, Water, Civil Infrastructure Technologies, and Manufacturing. 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 has held two competitions in the area of Civil Infrastructure and two competitions in the area of Manufacturing, and intends to hold a competitive funding opportunity that expands upon these areas in FY 2011. In FY 2012, TIP plans to further expand the Manufacturing topic and introduce new investment areas as well to meet additional and changing areas of critical national need.

2. Advanced Manufacturing Technology (AMTech) Consortia Program (+$12,306,000)

This initiative provides grants to leverage existing consortia or establish critical new industry-led consortia. These consortia will develop road-maps of critical long-term industrial research needs, and fund facilities, equipment and research at leading universities and government laboratories directed at meeting these needs. Since these consortia will be composed of private industry, government laboratories, and universities as well as regional governments and private sector financiers, the members will span the innovation lifecycle from idea to discovery, invention, and ultimately commercialization. The partnerships supported by this initiative will leverage the unique capabilities of each partner and depend critically on the open dissemination and sharing of methods and results. Through the advanced planning and road mapping, this initiative will increase the productivity of all research institutions that participate in this effort. By convening the key players across the innovation lifecycle, this initiative will eliminate critical barriers to innovation, increase the efficiency of domestic innovation efforts and collapse the timescale to deliver new products and services based on scientific and technological advance. This strategy has the potential to drive economic growth, enhance competitiveness and spur job creation in high-value sectors. This program would be based on NIST's experience with the Nanoelectronics Research Initiative (NRI) partnership and would expand and improve on that model.

3. Hollings Manufacturing Extension Partnership Program (+$17,649,000)

MEP's mission is to act as a strategic advisor to promote business growth and connect manufacturers to public and private resources essential for increased competitiveness and profitability. In doing so, MEP supports the mission of NIST and the Department of Commerce, of promoting U.S. innovation and industrial competitiveness. MEP Centers know their communities and understand their local manufacturing industries. Across the country, they serve as trusted advisors to their manufacturing clients and help them navigate economic and business challenges, capitalize on opportunities and develop pathways leading to profitable growth. Services provided by MEP are grounded in technology- related activities, sustainability, efficiencies through continuous improvement, the integration of supply chains, and increasing the technical and problem-solving skills of the workforce. The funds requested for MEP in FY 2012 will expand the MEP program in support of the Administration's policy initiatives for reinventing domestic manufacturing to create jobs and better respond to future challenges and opportunities.

4. Baldrige Performance Excellence Program (-$2,117,000)

The Baldrige Performance Excellence Program (BPEP) provides global leadership in the learning and sharing of successful strategies and performance practices, principles, and methodologies to strengthen U.S. organizations. The program promotes organizational excellence through education, outreach, and an annual Presidential awards program. The Baldrige Award is given to organizations in six categories: manufacturing, service, small business, health care, education, and nonprofit. BPEP works closely with these organizations to recognize and disseminate proven best practices for management and operation, leading to organizations that are more strategic, innovative, competitive, and effective. The request includes $7.7 million for criteria development, best practices disseminations, and the award process. Additionally, the BPEP will evaluate alternative sources of funding, consistent with the Administration's goal of transitioning the program out of Federal funding.

Construction of Research Facilities

This appropriation supports the construction of new facilities and the renovation and maintenance of NIST's current buildings and laboratories to comply with scientific and engineering requirements and to keep pace with Federal, State, and local health and safety regulations. The Construction of Research Facilities (CRF) request totals $84.6 million and includes one initiative for the phased renovations of NIST facilities at Boulder, Colorado. The renovation project will substantially improve temperature, vibration, humidity, air cleanliness, and overall building performance, as well as help NIST to meet energy reduction and environmental goals. The Boulder Building 1 Renovation initiative request of $25.4 million will allow NIST to continue with the interior renovations for Building 1.

1. Boulder Laboratories Building 1 Renovation (+$25,381,000)

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 and FY 2011. Specific work in FY 2012 will include the completed interior renovations of Wing 5 and a portion of Wing 6. The remaining interior wing renovations will be completed with future funding requests. 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. Non-recurring Congressionally Directed Projects: (-$67,000,000)

NIST will not recur amounts provided previously for congressionally directed projects.

Department of Commerce High Priority Performance Goal (HPPG): Sustainable Manufacturing and Building Practices

Sustainability has become a critical economic consideration for manufacturers due to environmental and societal challenges and opportunities. MEP is working to help U.S. manufacturers gain a competitive edge by reducing environmental and energy cost factors and enabling growth by developing new environmentally-focused materials, products and processes to gain entry into new markets. As part of this effort, MEP is engaged in expanding its capacity to support additional Economy, Energy and Environment (E3) (www.e3.gov) efforts.

Currently, NIST is on target in meeting its goal of raising the number of firms adopting sustainable manufacturing process through the MEP by 250 by the end of FY 2011. During FY 2012, MEP will continue efforts to help companies reduce waste and develop economically and environmentally sustainable practices and products.

Mandatory Appropriations Budget Authority

Public Safety Innovation Fund (+ $100,000,000).

The President's budget includes a request of $100.0 million in mandatory appropriations for the Public Safety Innovation Fund, NIST's component of the Wireless Innovation Fund, which will help spur the development of cutting-edge wireless technologies. As part of this initiative, NIST will work with industry and public safety organizations to conduct research and develop standards, technologies and applications to advance public safety communications. Core components of this program will include documenting public safety requirements and driving the adoption of those requirements into the appropriate standards; developing the capability for communications between currently deployed public safety narrow band systems and the future nationwide broadband network; and establishing a roadmap that addresses public safety's needs beyond what can be provided by the current generation of broadband technology and driving technological progress in that direction. NIST will accomplish these tasks through directed research, development, applications, and demonstration projects. Where appropriate, NIST will collaborate with other government research agencies and transfer funding if particular agencies are better suited to sponsor and oversee relevant research, development, or demonstration projects.

Resources

The following is a comparison of NIST's FY 2012 level with its FY 2011 annualized Continuing Resolution level and related data on employment.

Appropriation	(Dollar amounts in millions) FY 2011 Annualized Continuing Resolution*		FY 2012 Request		Increase (or Decrease) from FY 2011 Continuing Resolution	
	FTE	Amount	FTE	Amount	FTE	Amount
Scientific and Technical Research and Services	2,072	505.4	2,421	678.9	349	173.5
Industrial Technology Services	210	204.2	199	237.6	(11)	33.4
Construction of Research Facilities	119	147.0	119	84.6	0	(62.4)
Working Capital Fund	741	0	755	0	14	0
TOTAL DISCRETIONARY	**3,142**	**856.6**	**3,494**	**1,001.1**	**352**	**144.5**
MANDATORY						
Public Safety Innovation Fund	0	0	7	100.0	7	100.0
TOTAL RESOURCES	**3,142**	**856.6**	**3,501**	**1,101.1**	**359**	**244.5**

*Amount and FTE are adjusted from the Annualized Continuing Resolution levels for the Baldrige Performance Excellence Program, which transfers from the STRS to ITS appropriation.

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: the need for traceability of measurements to national standards; the need for work that cannot or will not be addressed by the private sector; work supported by legislation that authorizes or mandates certain services; work that would result in an unavoidable conflict of interest if carried out by the private sector or regulatory agencies; and requests by the private sector for NIST action or services. NIST's reimbursable program is estimated to be $184.2 million in FY 2011 and $176.3 million in FY 2012.

Department of Commerce E-Gov Benefits

The Department of Commerce, along with its operating units, supports and is an active participant in the Government-wide e-Government initiatives and lines of business. Each initiative or line of business is managed by another Federal agency, such as the General Services Administration, and were implemented in part to avoid redundancy and duplication of government-wide activities such as rulemaking, human resource servicing, financial management, grants management, etc. The e-government initiatives and lines of business play a key role in Commerce's enterprise architecture, particularly for Department-wide administrative systems. These initiatives and lines of business promote internal Commerce efficiency in acquisition and other administrative activities. Commerce external customers benefit from a single source for grant postings, grant application submission and applying for Commerce benefit programs. Commerce e-government participation provides better services to the citizen, promotes transparency, and actively supports our stakeholders in the business community.

APP / Exhibit 3A Format

FY 2012 Annual Performance Plan

National Institute of Standards and Technology/ National Technical Information Service

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FY 2012 Annual Performance Plan

Section A1. 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 provide U.S. manufacturers with access to technologies, resources, and industry experts to strengthen the competitiveness of our Nation's domestic manufacturing base; 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 Performance Excellence Program (BPEP) to strengthen U.S. organizations by providing global leadership in the learning and sharing of successful strategies and performance practices, principles, and methodologies.

Section A2. DoC Strategic Themes, Goals and Objectives: Corresponding NIST Programs

DoC Theme: Economic Growth

DoC Strategic Goal: Innovation and Entrepreneurship

Performance Objective 3: Stimulate high growth business formation and entrepreneurship, through investments in high-risk high-reward technologies and removing impediments to accelerate technology commercialization (TIP, AMTech)

Technology Innovation Program (TIP):

As established by the America COMPETES Act in 2007 and reauthorized in 2010 (P.L. 111-358), TIP will offer cost-shared funding to U.S. small and medium sized businesses, institutes of higher education, national laboratories, and non-profit research organizations to accelerate innovation through high-risk, high reward research in areas of critical national need that align with the Administration's priorities. This research has the potential for yielding transformational results with far or wide-reaching implications, within NIST's areas of technical competence. TIP aims to speed the development of high-risk, transformative research targeted to key societal challenges that are not being addressed elsewhere. Program funds will support research that has scientific and technical merit, as well as strong potential for advancing the state-of-the-art and contributing to the U.S. science and technology knowledge base.

Advanced Manufacturing Technology Consortia (AMTech):

AMTech is new pilot program proposed in FY 2012. This initiative provides grants to leverage existing consortia or establish critical new industry-led consortia. These consortia will develop road-maps of critical long-term industrial research needs, fund facilities, equipment and research at leading universities and government laboratories directed at meeting these needs. Since these consortia will be composed of private industry, government laboratories, and universities as well as regional governments and private sector financiers, the members will span the innovation lifecycle from idea to discovery, invention, and manufacturability. This program's strategy will ultimately drive economic growth, enhance competitiveness and spur the creation of jobs in high value sectors.

DoC Strategic Goal: Innovation and Entrepreneurship

Performance Objective 5: Provide the measurement tools and standards to strengthen manufacturing enabling innovation and enhancing efficiency (NIST National Measurement and Standards Laboratories, NIST User Facilities)

NIST National Measurement and Standards Laboratories:

The NIST National Measurement and Standards Laboratories work at the frontiers of measurement science to ensure that the U.S. system of measurements is firmly grounded on a sound scientific and technical foundation. NIST promotes the use of measurements based on the international system of units (SI). The measurement science research at NIST is useful to all science and engineering disciplines. The NIST Laboratories directly support U.S. innovation and industrial competitiveness by developing new measurement instruments and facilities to address critical barriers to innovation; disseminating validated measurement methods and protocols; providing reference data, reference materials, and calibration services to ensure that industry-performed measurements are traceable to NIST standards; and developing testing protocols and supporting laboratory accreditation programs. NIST works actively with other metrology institutes from around the world to ensure that the global marketplace is supported with sound measurements and standards.

The NIST National Measurement and Standards Laboratories also support the development of written standards and specifications that define technical and performance requirements for goods and services. These standards—also known as documentary standards—are often developed collaboratively with the private sector through an open, consensus-based process. NIST scientists and engineers lend their expertise to these efforts in order to promote standards that are based on sound science and to ensure that the standards are supported by effective measurements and testing for conformity to the standards.

NIST User Facilities:

NIST has two User Facilities, the Center for Nanoscale Science and Technology (CNST) and the NIST Center for Neutron Research (NCNR).

The CNST is the only national nanocenter with a focus on commerce. Located in NIST's Advanced Measurement Laboratory Complex on the Gaithersburg, Maryland site, the CNST supports the development of nanotechnology from discovery to production through research on measurement and fabrication methods and technology. The CNST has a unique design that supports the U.S. nanotechnology enterprise through the readily available, shared-use NanoFab, as well as by providing opportunities for collaboration in multidisciplinary research on new nanoscale measurement instruments and methods. It also serves as a hub linking the international nanotechnology community to the comprehensive measurement expertise throughout NIST.

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.

DOC Strategic Goal: Market Development and Commercialization

Performance Objective 8: Provide services to improve the competitiveness of small and medium size firms in manufacturing and service industries (MEP)

Manufacturing Extension Partnership (MEP) Program:

Operating under the authority of 15 U.S.C. 278k, the Manufacturing Extension Partnership (MEP) is a Federal-state-industry partnership that provides small U.S. manufacturers with access to technologies, resources, and industry experts. Through a nationwide network of 60 manufacturing centers, linked to state, university, community college, and private sources of technology and expertise, MEP works directly with the local manufacturing community to strengthen the competitiveness of our Nation's domestic manufacturing base. Funding for the MEP Centers is a cost-sharing arrangement consisting of support from the Federal government, state and local government/entities, and fees charged to the manufacturing clients for services provided by the MEP Centers.

A strong domestic manufacturing base is essential to supporting our Nation's middle class, our national security, and our growing renewable energy economy. Now more than ever, strong manufacturing businesses are needed to create good jobs and help the U.S. economy regain its momentum. With Centers in every state and in Puerto Rico, MEP is uniquely positioned to connect manufacturers with the opportunities being made available through Federal and state governments to invest in environmentally sustainable manufacturing practices, develop innovative products, and diversify into new markets. MEP Centers know their communities and understand their local manufacturing industries. Across the country, they serve as trusted advisors to their manufacturing clients and help them navigate economic and business challenges, capitalize on opportunities that fit their business goals, and develop pathways leading to company growth.

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 U.S. manufacturing clients.

DoC Theme: Science and Information

DoC Strategic Goal: Generating and communicating new, cutting-edge scientific understanding of technical, economic, social and environmental systems

Performance Objective 13: Enhance scientific knowledge and provide information to stakeholders to improve innovation and technology, support economic growth, and improve public safety (SERI, SCMMR)

Strategic and Emerging Research Initiatives (SERI) Program:

The Strategic and Emerging Research Initiatives (SERI) program provides the NIST Director with the 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. SERI supports the Department of Commerce and NIST's mission of promoting U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology that drive technological change.

The primary activities being conducted with the program's resources are the development of new competencies necessary to develop and maintain knowledge related to measurement techniques to solve problems in selected national need areas. The SERI program gives NIST the flexibility to respond quickly to developing capabilities to solve new measurement problems for emerging national needs. Examples of recent national need areas that had related measurement and standards competencies addressed through SERI include Smart Grid, physical infrastructure, advanced manufacturing, and reduction of greenhouse gas emissions. SERI allows NIST to develop these measurement and standards competencies more quickly, which enables emerging problems to be addressed much more efficiently and effectively, leading to even greater economic benefits.

Safety, Capacity, Maintenance and Major Repairs (SCMMR) Program:

The program funds 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 current and future measurement and research needs for the Nation.

State-of-the-art facilities are essential to the capabilities of NIST's laboratories. NIST measurement capabilities must be maintained at the highest levels of precision and accuracy to meet the increasingly stringent needs of their users. Also, facilities must be compliant with various health and safety regulations. Other major considerations for facilities are to increase the capacity of facilities, to improve access for people with disabilities, and to safeguard the utility infrastructure of existing buildings.

NIST prioritizes its efforts to improve and upgrade its facilities so as to address its highest priority safety, capacity, maintenance, and major repair projects. If major facilities-related emergency situations arise, previously planned facilities work is reprioritized as appropriate.

DoC Strategic Goal: Generating and communicating new, cutting-edge scientific understanding of technical, economic, social and environmental systems

Performance Objective 14: Improve understanding of the US economy, society and environment by providing timely, relevant, trusted and accurate data, standards and services enabling entities to make informed decisions (BPEP)

Baldrige Performance Excellence Program (BPEP):

NIST's Baldrige Performance Excellence Program (BPEP) provides global leadership in the learning and sharing of successful strategies and performance practices, principles, and methodologies to strengthen U.S. organizations. The program promotes organizational excellence through education, outreach, and an annual Presidential awards program. The Baldrige Award is given to organizations in six categories: manufacturing, service, small business, health care, education, and nonprofit. BPEP works closely with these organizations to recognize and disseminate proven best practices for management and operation, leading to organizations that are more strategic, innovative, competitive, and effective. BPEP also takes advantage of more than 20 years' worth of learnings from Baldrige Award recipients to identify strategies and practices that are most likely to strengthen the performance and competitiveness of U.S. industry and other organizations.

DoC Theme: Worforce Excellence

DoC Strategic Goal: Develop and support a diverse, highly qualified workforce with the right skills in the right job to carry out the mission

Performance Objective 25: Recruit, develop and retain a high-performing, diverse workforce with the critical skills necessary for mission success including growing the next generation of scientists and engineers (Postdoctoral Research Associateship Program)

Postdoctoral Research Associateship Program:

NIST supports a nationally competitive Postdoctoral Research Associateships Program. 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 NIST 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 knowledge 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. The program increases technology transfer from NIST to industry, academia, and other government agencies, contributing to the employment pool of highly qualified scientists and engineers for these sectors. 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 postdoctoral program ensures a continuing infusion of postdoctoral associates who bring to NIST the benefits of the latest academic research.

Section A3. NIST Priorities / Management Challenges

With the aim of promoting U.S. innovation and industrial competitiveness, NIST has established three overarching priorities to guide and align investments in its programs:

1. Strengthen and focus NIST's Laboratories and facilities to ensure U.S. industrial competitiveness and enable technological innovation.
   - Enhance support of other Federal agencies in meeting U.S. Government needs for voluntary consensus standards.
   - Develop and deliver state-of-the-art measurement science and services.
   - Enhance the facilities and equipment that enable cutting-edge research and measurement service delivery.
   - Strengthen and maintain NIST's world-class user facilities to provide industry, academia, and Government with the infrastructure to support high-tech innovation.
   - Expand collaboration and partnerships to leverage NIST capabilities and advance innovation at regional and national levels.

2. Focus new NIST activities to address critical national priorities.
   - Driving continued innovation and technological advancement in manufacturing.
   - Improve energy efficiency and environmental stewardship.
   - Enable widespread adoption of innovations in information technology and ensure a secure cyberspace for the Nation's economic and security interests.
   - Ensure consumer health and safety.

3. Promote the stimulation and acceleration of technological innovation.
   - Promote collective effort for the development of key enabling generic technology platforms and infrastructures.
   - Improve alignment of research and development with generic industry needs.
   - Provide an environment for maximizing the leverage on federal investment through cost sharing.
   - Compress the timescale of technological innovation providing platform technologies suitable for commercialization.
   - Foster a robust U.S. innovation ecosystem through broad participation by industry, federal government, universities, and states and local governments.

DoC High Priority Performance Goal (HPPG): Sustainable Manufacturing and Building Practices

Sustainability has become a critical economic consideration for manufacturers due to environmental and societal challenges and opportunities. MEP is working to strategically re-position U.S. manufacturing in part by helping companies gain a competitive edge by reducing environmental and energy cost factors and enabling growth by developing new environmentally-focused materials, products and processes to gain entry into new markets. As part of this effort, MEP is engaged in expanding the capacity of the existing and partner resources to support additional Economy, Energy and Environment (E3) (www.e3.gov).

Currently, NIST is on target in meeting its goal of raising the number of firms adopting sustainable manufacturing process through the MEP by 250 by the end of 2011. During FY 2012, MEP will continue efforts to help companies reduce waste and develop economically and environmentally sustainable practices and products.

Section A4. NIST Targets and Performance Summary

NIST Performance Objective 5: Provide the measurement tools and standards to strengthen manufacturing enabling innovation and enhancing efficiency.

Measure 1A: Qualitative assessment and review of technical quality and merit using peer review	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Target	FY 2012 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 2010 assessment of the Building and Fire Research Laboratory, the Manufacturing Engineering Laboratory, the Materials Science and Engineering Laboratory and the NIST Center for Neutron Research. Overall, these assessments continue to attest to NIST's high quality programs, relevance of work to the measurement and standards needs, and impressive technical merit. In FY 2011, the NRC is conducting an assessment of the Information Technology Laboratory, the Center for Nanoscale Science and Technology, 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 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Target*	FY 2011 Target	FY 2012 Target
	>1.1	>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 2010 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 a large group of peer scientific and technical organizations. Internal controls include verification and review by NIST Information Services Office and the NIST Program Coordination 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 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Target	FY 2012 Target
	1,272	1,271	1,463	1,243	1,350	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. The decrease in the number of technical publications in FY 2010 may have been caused by multiple factors, including the increased workload accrued by the NIST scientific staff due to the Recovery Act responsibilities which negatively impacted time available for research as well as other issues beyond NIST control, such as the rate at which NIST publications are reviewed and published by the journals.

Comments on Changes to Targets: NIST estimates that the impact of the new and expanded programs funded under the requested increase for the NIST labs in FY 2012 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): $178.5 Million 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 Office.	Output Only	None

Measure 1D: Standard Reference Materials sold	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Target	FY 2012 Target
	32,614	33,373	29,769	31,667	31,000	31,000

Description: Standard Reference Materials (SRM) are the definitive artifact-based 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 requested increase for the NIST labs in FY 2012. The targets for FY 2011 and FY 2012 are based on the restoration of key SRMs to inventory.

Relevant Program Change(s): $178.5 Million 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 Measurement Services Division	Ongoing	NIST Measurement Services Division	Data represents direct and verifiable counts. Internal controls include verification and review by the NIST Material Measurement Laboratory.	Data provide information on output levels only.	None

Measure 1E: NIST-maintained datasets downloaded	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Target	FY 2012 Target
Original Methodology	130M	195.5M	226M	NA*	NA*	NA*
Revised Methodology	34.7M	23.7M	34.2M	25.0M	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 targets for FY 2011 and FY 2012 continue 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 requested increase for the NIST labs in FY 2012.

Relevant Program Change(s): $178.5 Million 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 Measurement Services Division	Ongoing	NIST Measurement Services Division	Data represents direct and verifiable counts. Internal controls include verification and review by the NIST Material Measurement Laboratory.	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 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Target	FY 2012 Target
	27,489	25,944	18,609	17,697	9,700	14,000

Description: NIST calibrations are the definitive service-based source of measurement traceability in the United States. 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 lower FY 2011 and FY 2012 targets reflect a new requirement that a signed Memorandum of Understanding with other Federal agencies be in place prior to performing calibration tests which is expected to significantly continue to delay the start and completion of these tests. These reduced targets are also based on the observed trend of fewer calibration tests performed in FY 2010 as a result of the economic downturn and reduced funding for the military. 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 requested increase for FY 2012 is expected to increase in the outyears.

Relevant Program Change(s): $178.5 Million 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 Measurement Services Division	Ongoing	NIST Measurement Services Division	Data represents direct and verifiable counts. Internal controls include verification and review by the NIST Physical Measurement Laboratory.	Data provide information on output levels only.	None

NIST Performance Objective 8: Provide services to improve the competitiveness of small and medium size firms in manufacturing and service industries.

Measure 2A: Number of clients served by MEP Centers receiving Federal funding	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Actual**	**FY 2010 Actual**	**FY 2011 Target**	**FY 2012 Target**
	28,004	31,961	32,926	34,299	30,000	34,000

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

Relevant Program Change(s): $17.649 M	**Title:** Hollings Manufacturing Extension Partnership	**Exhibit 13 Page no:** NIST- 255

Measure 2B: Increased sales attributed to MEP Centers receiving Federal funding ($ in Billions)	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Actual[1]**	**FY 2010 Target[2]**	**FY 2011 Target**	**FY 2012 Target**
	$5.6	$3.61	$3.5	$2.5	$2.0	$3.3
Measure 2C: Capital investment attributed to MEP Centers receiving Federal funding ($ in Billions)	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Actual[1]**	**FY 2010 Target[2]**	**FY 2011 Target**	**FY 2012 Target**
	$2.19	$1.71	$1.9	$1.0	$1.1	$1.8
Measure 2D: Cost savings attributed to MEP Centers receiving Federal funding ($ in Billions)	**FY 2007 Actual**	**FY 2008 Actual**	**FY 2009 Actaul[1]**	**FY 2010 Target[2]**	**FY 2011 Target**	**FY 2012 Target**
	$1.44	$1.41	$1.3	$1.2	$1.1	$1.7

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] Actuals are reported for the funding tied to the fiscal year. Due to the lag time associated with collecting and analyzing this data, the "actual" data reported for this measure in the FY 2010 DoC Performance and Accountability Report (PAR) was an estimate based on three-quarters of actual and one-quarter of estimated client impacts. This data reflects a full year of actual client impacts and is an update to the PAR.

[2] The FY 2010 actual will be available in January 2012 due to the lag time associated with collecting and analyzing the Hollings MEP client survey data six months after the services are delivered. These targets were based on an FY 2010 client target of 29,000.

Comments on Changes to Targets: The FY 2011 and FY 2012 targets are based on updated funding levels of $124.7M and $142.6M (including adjustments to base) respectively for MEP. While MEPs next generation services place greater emphasis on business growth activities, manufacturing clients are operating in survival mode with intense focus on cost cutting and simply retaining their current business. Due to current economic conditions, impacts are expected to remain steady.

Relevant Program Change(s): $17.649 Million	**Title:** Hollings Manufacturing Extension Partnership	**Exhibit 13 Page no:** NIST- 255

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 Objective 3: Stimulate high growth business formation and entrepreneurship, through investments in high-risk high-reward technologies and removing impediments to accelerate technology commercialization.

Measure 3A: Cumulative number of TIP projects funded	FY 2009 Actual	FY 2010 Actual	FY 2011 Target	FY 2012 Target
	9	29	38	60

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: The FY 2010 data and the FY 2011 and FY 2012 targets assume a total obligation funding level of $77.3M in FY 2010, $104.5M in FY 2011, and $78.8M in FY 2012. These obligation levels include budget authority of $69.9M; $69.9M, and $75.0, plus the addition of estimated carryover and prior year recoveries.

Relevant Program Change(s): $5.186M	Title: Technology Innovation Program (TIP)	Exhibit 13 Page no: NIST- 239

Validation and Verification (See table below for Objective 3)

Measure 3B: Cumulative number of publications	FY 2009 Target	FY 2010 Target	FY 2011 Target	FY 2012 Target
	24 in FY 2012	60 in FY 2013	105 in FY 2014	114 in FY 2015

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 cumulative number of publications is expected to be as follows: 24 in FY 2012, 60 in FY 2013, 105 in FY 2014, and 114 in FY 2015.

Comments on Changes to Targets: The FY 2011 and FY 2012 targets have been updated to reflect the actual information known from the 9 new projects begun in FY 2011 which affect the respective outyear performance targets.

Relevant Program Change(s): $5.186M	Title: Technology Innovation Program (TIP)	Exhibit 13 Page no: NIST- 239

Validation and Verification (See table below for Objective 3)

Measure 3C: Cumulative Number of patent applications	FY 2009 Target	FY 2010 Target	FY 2011 Target	FY 2012 Target
	12 in FY 2012	30 in FY 2013	35 in FY 2014	38 in FY 2015

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 cumulative number of patent applications is expected to be as follows: 12 in FY 2012, 30 in FY 2013, 35 in FY 2014, and 38 in FY 2015.

Comments on Changes to Targets: The FY 2011 and FY 2012 targets have been updated to reflect the actual information known from the 9 new projects begun in FY 2011 which affect the respective outyear performance targets.

Relevant Program Change(s): $5.186M	**Title:** Technology Innovation Program (TIP)	**Exhibit 13 Page no:** NIST- 239

Validation and Verification (See table below for Objective 3)

Measure 3D: Cumulative number of projects generating continued R&D	FY 2009 Target	FY 2010 Target	FY 2011 Target	FY 2012 Target
	4 in FY 2012	10 in FY 2013	18 in FY 2014	19 in FY 2015

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 cumulative number of projects generating continued R&D is expected to be as follows: 4 in FY 2012, 10 in FY 2013, 18 in FY 2014, and 19 in FY 2015.

Comments on Changes to Targets: The FY 2011 and FY 2012 targets have been updated to reflect the actual information known from the 9 new projects begun in FY 2011 which affect the respective outyear performance targets.

Relevant Program Change(s): $5.186M	**Title:** Technology Innovation Program (TIP)	**Exhibit 13 Page no:** NIST- 239

Validation and Verification (See table below for Objective 3)

Measure 3E: Cumulative number of projects with technologies under adoption	FY 2009 Target	FY 2010 Target	FY 2011 Target	FY 2012 Target
	2 in FY2012	5 in FY 2013	9 in FY 2014	10 in FY 2015

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 cumulative number of projects with technologies under adoption is expected to be as follows: 2 in FY 2012, 5 in FY 2013, 9 in FY 2014, and 10 in FY 2015

Comments on Changes to Targets: The FY 2011 and FY 2012 targets have been updated to reflect the actual information known from the 9 new projects begun in FY 2011 which affect the respective outyear performance targets.

Relevant Program Change(s): $5.186M	Title: Technology Innovation Program (TIP)	Exhibit 13 Page no: NIST- 239

Validation and Verification for Objective 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.

Section A.5 NIST FY 2012 Proposed Program Changes

Discretionary Appropriations

	Accompanying GPRA		Base	Increase/Decrease		Page of Exhibit 13
Program Change:	**APP Page no.**	**Performance Measure no.**	**Amount ($000)**	**FTE**	**Amount ($000)**	**Non-GPRA Measures and Targets**
Interoperability Standards for Emerging Technologies	NIST-31	1C,D,E,F	11,202	69	22,835	NIST-108
Ensuring a Secure and Robust Cyber Infrastructure	NIST-31	1C,D,E,F	28,900	67	43,442	NIST-97
Innovations for 21st Century Manufacturing: Faster, Smarter, Cleaner	NIST-31	1C,D,E,F	5,619	18	13,331	NIST-148
Measurement Science and Standards to Support Biomanufacturing	NIST-31	1C,D,E,F	5,800	18	9,526	NIST-159
Strengthening Measurement Services in Support of Industry Needs	NIST-31	1C,D,E,F	13,284	37	20,016	NIST-126
Measurements to Support the Manufacture and Production of Nanotechnology-based products	NIST-31	1C,D,E,F	13,852	58	28,256	NIST-165

Measurements and Standards to Support Increased Energy Efficiency and Reduced Environmental Impact	NIST-31	1C,D,E,F	18,265	23	13,270	NIST-180
Postdoctoral Research Associateship Program	NIST-31	1C,D,E,F	11,448	17	2,979	NIST-202
Advanced Material for Industry	NIST-31	1C,D,E,F	2,000	23	14,242	NIST-138
Measurements to Support Advanced Infrastructure Delivery and Resilience	NIST-31	1C,D,E,F	5,475	19	10,571	NIST-192
AMTech	N/A	N/A	0	1	12,306	NIST-249
Technology Innovation Program (TIP)	NIST-37	3 A,B,C,D,E	69,787	0	5,186	NIST-239
Hollings Manufacturing Extension Partnership Program (MEP)	NIST-35	2 A,B,C,D	124,967	2	17,649	NIST-255
Total			310,599	352	213,609	

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 (NTIS)

NTIS Performance Objective 13: Enhance scientific knowledge and provide information to stakeholders to improve innovation, technology, support economic growth and improve public safety.

Description of Performance Objective:

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 2012

NTIS' priority is to contribute successfully to the Department of Commerce's strategic goal of generating and communicating new, cutting-edge scientific, technical, economic, social and environmental systems. 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

NTIS Performance Objective 13: Enhance scientific knowledge and provide information to stakeholders to improve innovation, technology, support economic growth and improve public safety.

Measure 1A: Number of Updated Items Available (Annual)	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Target	FY 2012 Target
	744,322	813,775	893,138	969,473	825,000	875,000

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 2012 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 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Target	FY 2012 Target
	32,027,113	32,267,167	49,430,840	50,333,206	52,800,000	54,800,000

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 2012 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 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Target	FY 2012 Target
	98%	96%	98%	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 2012 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	$65.5M	0	$0	N/A

NIST/NTIS Discretionary Resource Requirements Table *

NIST Resource Requirements (obligations in M)

DoC Goal: Innovation and Entrepreneurship								
	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Annualized CR Level	FY 2012 Base	Increase/ Decrease	FY 2012 Request
Objective 3: TIP (ITS)	$93.4	$54.5	$50.2	$77.2	$104.5	$73.6	$5.2	$78.8
Objective. 3: AMTech (ITS)						0	$12.3	$12.3
Objective 5: Labs (STRS & majority of Reimbursable)	$523.5	$529.7	$543.4	$576.9	$603.5	$594.8	$150.6	$745.4
Objective 5: User Facilities (STRS)	$67.0	$70.5	$74.5	$72.9	$77.4	$74.9	$14.4	$89.3
Recovery Act Funds (ARRA)			$42.6	$116.4	$13.6			
Total Goal Funds ($M)	$683.9	$654.7	$710.7	$843.4	$799.0	$743.3	$182.5	$925.8

DoC Goal: Market Development and Commercialization								
	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Annualized CR Level	FY 2012 Base	Increase/ Decrease	FY 2012 Request
Objective 8: MEP (ITS Approp)	$107.3	$91.2	$112.6	$126.8	$125.9	$125.2	$17.6	$142.8
Total Goal Funds ($M)	$107.3	$91.2	$112.6	$126.8	$125.9	$125.2	$17.6	$142.8

DoC Goal: Generating and communicating new, cutting-edge scientific understanding of technical, economic, and social and environmental systems

	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Annualized CR Level	FY 2012 Base	Increase/ Decrease	FY 2012 Request
Objective 13: Seri (STRS)	$0.0	$1.9	$8.8	$9.2	$10.6	$9.8	$0.0	$9.8
Objective 13: SCMMR (CRF)	$51.5	$138.3	$161.7	$169.8	$181.0	$126.2	($41.6)	$84.6
Objective 14: BPEP (ITS)	$10.2	$8.4	$13.0	$10.8	$10.1	$10.4	($2.2)	$8.2
Recovery Act Funds (ARRA)			$71.9	$349.4				
Total Goal Funds ($M)	$61.7	$148.6	$255.4	$539.2	$201.7	$146.4	($43.8)	$102.6

DoC Goal: Develop and support a diverse, highly qualified workforce with the right skills in the right job to carryout the mission

	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Annualized CR Level	FY 2012 Base	Increase/ Decrease	FY 2012 Request
Objective 25: Postdocs (STRS)	$10.1	$10.6	$10.9	$10.7	$11.5	$11.3	$3.0	$14.3
Recovery Act Funds (ARRA)			$10.6	$9.8				
Total Goal Funds ($M)	$10.1	$10.6	$21.5	$20.5	$11.5	$11.3	$3.0	$14.3

Total NIST	$863.0	$905.1	$1,100.2	$1,529.9	$1,138.1	$1,026.2	$159.3	$1,185.5

NTIS Resource Requirements (obligations in M)

DoC Goal: Generating and communicating new, cutting-edge scientific understanding of technical, economic, and social and environmental systems.

	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Annualized CR Level	FY 2012 Base	Increase/ Decrease	FY 2012 Request
Objective 13: NTIS	$27.9	$22.5	$31.9	$46.0	$65.0	$65.5	$0.0	$65.5
Total Goal Funds ($M)	$27.9	$22.5	$31.9	$46.0	$65.0	$65.5	$0.0	$65.5

Grand Total (NIST & NTIS)	FY 2007 Actual	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Annualized CR Level	FY 2012 Base	Increase/ Decrease	FY 2012 Request
Total Funding ($M)	$890.9	$927.6	$1,132.1	$1,575.8	$1,203.1	$1,091.7	$159.2	$1,250.9
Direct	$694.1	$733.1	$926.2	$1,358.9	$949.9	$849.8	$150.5	$1,000.3
Reimbursable	$196.8	$194.4	$205.9	$216.8	$253.2	$241.8	$8.8	$250.6
IT Funding	$78.2	$85.7	$97.7	$97.7	$96.3	$98.4	$0.0	$98.4
Total FTE	2,891	2,934	3,000	3,120	3,292	3,292	352	3,644

*Dollars reflect obligations for all fund sources and excludes $100M Public Safety Innovation Fund (mandatory appropriation).

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
2011 Annualized CR Level	2,066	2,072	$510,373	$530,304	$515,000
less: Reorganization to ITS					(9,627)
less: Unobligated balance from prior year	0	0	0	(18,931)	0
less: Transfer from COPS, DoJ	0	0	(1,500)	(1,500)	0
less: Transfer from EAC	0	0	(3,500)	(3,500)	0
2012 Adjustments to base:					
plus: Restoration of 2011 deobligation offset	0	0	1,000	0	1,000
plus: Restoration of 2011 adjustments to base	0	0	7,779	7,779	7,779
plus: Uncontrollable cost changes	0	0	(2,177)	(2,177)	(2,177)
less: Estimated recoveries, 2012	0	0	(1,000)	0	(1,000)
2012 Base Request	2,066	2,072	510,975	511,975	510,975
plus: 2012 Program changes	467	349	180,885	180,885	189,719
less: Administrative savings			(11,251)	(11,251)	(11,251)
less: Dropout of Congressionally directed projects			(10,500)	(10,500)	(10,500)
plus: Transfer from EAC			3,250	3,250	0
2012 Estimate	2,533	2,421	673,359	674,359	678,943

		2010 Actual		2011 Annualized CR Level		2012 Base		2012 Estimate		Increase/ (Decrease) Over 2012 Base	
Comparison by activity/subactivity:		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Measurement science, services, and programs											
Laboratory programs	Pos./Approp	1,958	$460,616	1,958	$460,616	1,958	$465,453	2,369	$630,220	411	$164,767
	FTE/Obl.	1,915	636,395	1,964	481,440	1,964	466,313	2,271	625,648	307	159,335
Baldrige performance excellence program	Pos./Approp	51	9,627		1/		1/		1/		
	FTE/Obl.	48	9,906		1/		1/		1/		
Corporate services	Pos./Approp	52	18,880	52	18,880	52	19,510	52	19,510	0	0
	FTE/Obl.	49	22,106	52	19,822	52	19,613	52	19,613	0	0
Standards coordination and special programs	Pos./Approp	56	25,877	56	25,877	56	26,012	112	29,213	56	3,201
	FTE/Obl.	52	29,311	56	29,042	56	26,049	98	29,098	42	3,049
TOTALS	Pos./Approp	2,117	515,000	2,066	505,373	2,066	510,975	2,533	678,943	467	167,968
	FTE/Obl.	2,064	697,718 2/	2,072	530,304	2,072	511,975	2,421	674,359	349	162,384

Comparison by activity/subactivity:	2010 Actual Per-sonnel	2010 Actual Amount	2011 Annualized CR Level Per-sonnel	2011 Annualized CR Level Amount	2012 Base Per-sonnel	2012 Base Amount	2012 Estimate Per-sonnel	2012 Estimate Amount	Increase/ (Decrease) Over 2012 Base Per-sonnel	Increase/ (Decrease) Over 2012 Base Amount
Adjustments for:										
Recoveries		(9,273)		(1,000)		(1,000)		(1,000)		0
Refunds		(49)		0		0		0		0
Unobligated balance, start of year		(191,907) [3/]		(18,931)		0		0		0
Unobligated balance, end of year		18,931		0		0		0		0
Unobligated balance, expired account		3,137		0		0		0		0
Budget Authority		518,557		510,373		510,975		673,359		162,384
Financing from transfers:										
Transfers to other accounts		1,443		0		0		8,834		8,834
Transfer from Community Oriented Policing Services, DoJ		(1,500)		(1,500)		0		0		0
Transfer from Election Assistance Commission		(3,500)		(3,500)		0		(3,250)		(3,250)
Reorganization				9,627						
Appropriation		515,000		515,000		510,975		678,943		167,968

1/ Starting in FY 2011, Baldrige Performance Excellence Program has become part of ITS, rather than STRS.

2/ Includes the American Recovery and Reinvestment Act carryover of $174,044K.

3/ Includes the American Recovery and Reinvestment Act carryover 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)

	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
Total Obligations	$709,093 [1/]	$531,131 [6/]	$511,975	$674,359	$162,384
Offsetting collections from:					
Federal funds	(2,262) [2/]	0	0	0	0
Non-Federal sources	0	0	0	0	0
Total offsetting collections	(2,262)	0	0	0	0
Adjustments for:					
Recoveries and refunds	(9,322)	(1,000)	(1,000)	(1,000)	0
Unobligated balance, start of year	(201,847) [3/]	(19,758) [4/]	0	0	0
Unobligated balance, end of year	19,758 [4/]	0	0	0	0
Unobligated balance, expired	3,137	0	0	0	0
Budget Authority	518,557	510,373	510,975	673,359	162,384
Financing:					
Transfer to other accounts	1,443	0	0	8,834	8,834
Transfer from other accounts	(5,000) [5/]	(5,000) [5/]	0	(3,250) [5/]	(3,250)
Reorganization to ITS		9,627			
Appropriation	515,000	515,000	510,975	678,943	167,968

[1/] Includes $174,044K carryover from ARRA appropriation and $11,375K ARRA reimbursable.

[2/] Additional $2,000K from DoE for Smart Grid funding and a $261.5K from NTIA for convert box.

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

[4/] Includes $18,931K carryover from regular STRS and $827K carryover from ARRA reimbursable (no year).

[5/] $3,500K from EAC and $1,500K from COPS, DoJ in FY 2010 and FY 2011. $3,250K from EAC in FY 2012.

[6/] Includes $827K carryover from ARRA reimbursable (no year).

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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:		
Restoration of FY 2011 adjustments to base	0	$7,779

In FY 2011, NIST's STRS adjustments to base increase of $7,779,000 was not applied. This adjustment restores the increase in FY 2012.

Restoration of FY 2011 deobligation offset	0	1,000

In FY 2011, 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 2012.

Subtotal, FY 2012 adjustments	0	8,779
Financing:		
Recoveries of prior year deobligations	0	(1,000)

NIST's FY 2012 STRS budget authority is reduced by the estimated level of prior year deobligations in FY 2012.

Other Changes:

Personnel benefits		$882
Civil Service Retirement System (CSRS)	($237)	
Federal Employees' Retirement System (FERS)	396	
Thrift Savings Plan (TSP)	5	
Federal Insurance Contribution Act (FICA) - OASDI	(169)	
Health Insurance	941	
Employees' Compensation Fund	(54)	

Civil Service Retirement System (-$237,000) – 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 11.8 percent in FY 2011 to 10.2 percent in FY 2012. The contribution rate will remain at 7.0 percent in FY 2012.

Payroll subject to retirement systems ($211,415,322)	
Cost of CSRS contributions in FY 2012 ($211,415,322 x .102 x .07)	$1,509,505
Cost of CSRS contributions in FY 2011 ($211,415,322 x .118 x .07)	1,746,291
Total adjustment to base	(236,786)

Federal Employees' Retirement System ($396,000) – 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 88.2 percent in FY 2011 to 89.8 percent in FY 2012. The contribution rate increased from 11.2 percent to 11.7 percent in FY 2011.

Payroll subject to retirement systems ($211,415,322)	
Basic benefit cost in FY 2012 ($211,415,322 x .898 x .117)	$22,212,562
Basic benefit cost in FY 2011 ($211,415,322 x .882 x .117)	21,816,793
Total adjustment to base	395,769

Thrift Savings Plan ($5,000) – The cost of agency contributions to the TSP will also rise as FERS participation increases. The contribution rate will decrease from 4.64 to 4.56 percent in FY 2012.

Thrift plan cost in FY 2012 ($211,415,322 x .898 x .0456)	$8,657,204
Thrift plan cost in FY 2011 ($211,415,322 x .882 x .0464)	8,652,130
Total adjustment to base	5,074

Federal Insurance Contributions Act (FICA) - OASDI (-$169,000) – As the percentage of payroll covered by FERS rises, the cost of OASDI contributions will increase. However, in FY 2012, the maximum salary subject to OASDI tax will decrease from $114,975 in FY 2011 to $110,175 in FY 2012. The OASDI tax rate will remain at 6.2 percent in FY 2012.

FERS payroll subject to FICA tax in 2012 ($211,415,322 x .898 x .873 x .062)	$10,275,873
FERS payroll subject to FICA tax in 2011 ($211,415,322 x .882 x .903 x .062)	10,439,615
Increase (FY 2011-FY 2012)	(163,742)
OTP payroll subject to FICA tax in FY 2012 ($6,641,678 x .898 x .873 x .062)	322,820
OTP payroll subject to FICA tax in FY 2011 ($6,641,678 x .882 x .903 x .062)	327,964
Increase (FY 2011-FY 2012)	(5,144)
Total adjustment to base	(168,886)

Health insurance ($941,000) – Effective January 2010, NIST's contribution to Federal employees' health insurance premiums increased by 6.9 percent. Applied against the FY 2011 estimate of $13,637,000, the additional amount required is $940,953.

Employees' Compensation Fund (-$54,000) – The Employees' Compensation Fund bill for the year ending June 30, 2010 is a net $56,000 lower than for the year ending June 30, 2009. The STRS share of this decrease is $-54,000.

Travel and transportation of persons	0	324

The General Services Administration (GSA) decreased the mileage rate from 55.0 cents to 50.0 cents, a 9 percent decrease. This percentage was applied to the FY 2011 estimate of $9,000 to arrive at a decrease of $810. In addition, the GSA standard per diem rate of 6.4% for destinations within the Continental United States (CONUS) was applied to the FY 2011 estimate of $5,084,000 for an increase of $325,376.

Rental Payments to GSA	0	1

GSA rates are projected to increase 1.7 percent in FY 2012. This percentage was applied to the FY 2011 estimate of $37,000 to arrive at an increase of $629.

Communications, utilities, and miscellaneous charges	0	(5,649)

Electricity rate decrease	(2,701)
Natural Gas rate decrease	(2,949)
HCHB Electricity	1

The electricity ATB amount was derived using a year to year comparison of the cost per kilowatt hour. In analyzing the 12 months ended March 2010 and 2009, the per kilowatt hour rate decreased 17.9 percent (from 11.5 cents to .94 cents) for Gaithersburg, Maryland; decreased 17.9 percent (from 36.9 cents to 30.3 cents) for Kauai, Hawaii; decreased 1.5 percent (from 6.7 cents to 6.6 cents) for Boulder, Colorado; and increased 5.3 percent (from 8.6 cents to 9.1 cents) for Ft. Collins, Colorado for a net decrease of $2,701,000.

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 2010 and 2009, the per therm rate decreased 36.0 percent (from 1.329 to .851) and decreased 1.73 percent (from 7.370 to 5.637) for Gaithersburg and Boulder respectively resulting in a net decrease of $2,949,000.

The average increase for HCHB PEPCO electricity is projected to be 33%. This percentage was applied to the 2011 electricity estimate of $3,000 for an increase of $990.

Other Services	0	429

Working Capital Fund (Departmental Management)	$606
Working Capital Fund (Departmental Management) Administrative Savings	(318)
Commerce Business Systems (CBS)	139
National Archives and Records Administration (NARA) storage costs	2

Working Capital Fund (Departmental Management) ($606,000) – An additional $606,000 is required to fund cost increases in the Departmental Management Working Capital Fund.

Working Capital Fund (Departmental Management) Administrative Savings (-$318,000) – Administrative Savings of $318,000 are realized reducing the Working Capital Fund (Departmental Management) adjustment to base.

Commerce Business Systems (CBS) ($139,000) – An increase of $139,000 is required in FY 2012 consistent with the CBS Capital Asset Plan.

National Archives and Records Administration (NARA) storage costs ($2,000) - NARA estimates reflect an increase of $2,000 in FY 2012 for records storage and maintenance costs.

Supplies and Materials		0	188
Scientific journal subscriptions	$119		
Helium	69		

Scientific journal subscriptions ($119,000) - This adjustment to base addresses the FY 2009 to FY 2010 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 7.3 percent deflator results in an increase of $118,552 when applied to the FY 2011 estimate of $1,624,000.

Helium ($69,000) – 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 2010 and 2009, the per liter rate increased 21.7 percent (from 6.900 to 8.401) resulting in an increase of $68,572 when applied to the FY 2011 estimate of $316,000.

General pricing level adjustment	0	1,648

This request applies the OMB economic assumption of 1.2 percent for FY 2012 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 $14,532; rental payments to others $11,700 communications, utilities, and miscellaneous charges $41,964; printing and reproduction $4,704; other services $755,428; supplies and materials $261,852; and equipment $557,160.

Subtotal, Other changes	0	(2,177)
Total adjustments to base	0	5,602

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APPROPRIATION ACCOUNT: SCIENTIFIC AND TECHNICAL RESEARCH AND SERVICES

BUDGET ACTIVITY: MEASUREMENT SCIENCE, SERVICES, AND PROGRAMS

The NIST request for the Scientific and Technical Research Services appropriation's Measurement Science, Services, and Programs totals $678.9 million and 2,421 FTE, an increase of $163.9 million above the FY 2010 enacted level. This increase includes $5.6 million in inflationary adjustments. 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 net total of $178.5 million in program initiatives, which includes the redirection of administrative savings to laboratory programs and excludes congressionally directed projects.

BASE JUSTIFICATION FOR FY 2012:

Measurement Science, Services, and Programs Overview

NIST's FY 2012 Base Justification reflects the approval by the Administration and the Congress of our realignment that reorganizes the NIST laboratory structure, transfers the Baldrige Performance Excellence Program (BPEP) from the Scientific and Technical Research Services (STRS) to the Industrial Technology Services (ITS) appropriations, and creates a new Office of Special Programs. The approved reorganization will improve NIST's service delivery and improve accountability by streamlining how the responsibility to carry out NIST's mission is delegated throughout the organization.

The NIST Measurement Science, Services, and Programs work at the frontiers of measurement science to ensure that the U.S. system of measurements is firmly grounded on a sound scientific and technical foundation. NIST promotes the use of measurements based on the international system of units (SI). The measurement science research at NIST is useful to all science and engineering disciplines. The NIST Laboratories directly support U.S. innovation and industrial competitiveness by developing new measurement instruments and facilities to address critical barriers to innovation; disseminating validated measurement methods and protocols; providing reference data, reference materials, and calibration services to ensure that industry-performed measurements are traceable to NIST standards; and developing testing protocols and supporting laboratory accreditation programs. NIST works actively with other metrology institutes from around the world to ensure that the global marketplace is supported with sound measurements and standards.

The NIST Laboratories also support the development of written standards and specifications that define technical and performance requirements for goods and services. These standards—also known as documentary standards—are often developed collaboratively with the private sector through an open, consensus-based process. NIST scientists and engineers lend their expertise to these efforts in order to promote standards that are based on sound science and to ensure that the standards are supported by effective measurements and testing for conformity to the standards.

Primary areas being researched with the program's base resources include the following:

- maintaining and disseminating national measurement standards;
- developing new measurement technologies and ways to tie needed measurements to fundamental national standards;

- developing, maintaining, and improving existing measurement science, services, references, and standards; and
- pursuing basic and applied research in measurement areas within NIST's mission.

The work performed by the NIST Laboratories affects many aspects of daily life in the U.S. Examples include:

- providing the measurement science and standards needed for technologies that address rising energy costs, scarcity of fossil fuels, and environmental impacts of energy consumption;
- ensuring that the national infrastructure of measurement methods, standards, data, and data technologies is sufficient to help U.S. industry develop, evaluate, and implement sustainable business practices in areas such as chemicals, materials, processes, manufacturing methods, and products;
- enabling U.S. industries to innovate and compete in global trade by providing the ability to measure and precisely control production processes using measurements traceable to internationally recognized standards;
- establishing measurements and standards that are necessary for fundamental business services and communications; and
- providing the measurement assurance behind sensitive detection systems for homeland security, such as for detecting chemical, biological, explosive, and radiological weapons.

The work of the NIST Laboratories has had short and long-term impacts throughout our Nation. For example, every year over $4.6 trillion in U.S. wholesale and retail trade is measured against standards that are ultimately traceable to NIST.

The Measurement Science, Services, and Programs budget is organized into three subactivities under the Scientific and Technical Research and Services (STRS) appropriation account.

- The Laboratory Programs subactivity ($630.2 million, 2,271 FTE) includes two user facilities (NIST Center for Neutron Research and Center for Nanoscale Science and Technology), two measurement laboratories (Physical Measurement Laboratory, and Material Measurement Laboratory) and two technology laboratories (Engineering Laboratory and Information Technology Laboratory). It also includes the Strategic and Emerging Research Initiative (SERI), Innovations in Measurement Science (IMS), and the Postdoctoral Research Associateship Program.

- The Corporate Services subactivity ($19.5 million, 52 FTE) contains Computer Support, Business Systems, and Research Support Services in support of NIST's Laboratories.

- The Standards Coordination and Special Programs subactivity ($29.2 million, 98 FTE) manages the organization's programs and resources to meet specific mission objectives. Current activities include management of the Office of Law Enforcement Standards and NIST's responsibilities related to Smart Grid, Greenhouse Gases, and National Security Standards, among others.

Significant Adjustments-to-Base (ATBs):

NIST requests a net increase of 0 FTE and $5.6 million to fund adjustments to current programs for Measurement Science, Services, and Programs. The increase will provide inflationary increases for non-labor activities, including service contracts and utilities.

ADMINISTRATIVE COST SAVINGS:

The Administration is pursuing an aggressive government-wide effort to curb non-essential administrative spending called the Administrative Efficiency Initiative. In order to be good stewards of taxpayer money the Federal Government should continue to seek ways to improve the efficiency of programs without reducing their effectiveness. As such, the President directed each agency to analyze its administrative costs and identify savings where possible. After reviewing its administrative costs, NIST has identified $11,569,000 in administrative savings. NIST has targeted a number of areas to achieve these savings. Of these savings, $6,406,000 is tied to more efficient acquisition processes for FY 2012. In the area of human capital and general administrative support, NIST expects to reduce its costs by $4,481,000 by keeping its administrative budgets relatively flat from FY 2011 to FY 2012. NIST identified savings of $364,000 in utilities and travel. An additional $318,000 in savings was identified through the Department's Working Capital Fund (see the Departmental Management Working Capital Fund section for more details.) Portions of the administrative savings are reinvested back into additional laboratory program initiatives that will benefit the economy and better support the Department's mission.

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

Activity: Measurement science, services, and programs
Subactivity: Laboratory programs

		2010 Actual		2011 Annualized CR Level		2012 Base		2012 Estimate		Increase/ (Decrease) over 2012Base	
Line Item		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Strategic and emerging	Pos./Approp	34	$9,264	34	$9,763	34	$9,823	34	$9,823	0	0
research initiative fund	FTE/Obl.	33	68,439	33	10,640	33	9,823	33	9,823	0	0
Physical measurement laboratory	Pos./Approp	488	123,203	488	122,704	488	124,192	556	149,577	68	$25,385
	FTE/Obl.	461	164,023	492	122,949	492	124,416	542	146,701	50	22,285
Material measurement laboratory	Pos./Approp	423	98,540	423	98,540	423	99,783	511	136,050	88	36,267
	FTE/Obl.	394	110,877	427	99,515	427	99,962	492	132,479	65	32,517
Engineering laboratory	Pos./Approp	256	61,460	256	61,460	256	62,216	318	91,805	62	29,589
	FTE/Obl.	238	74,198	256	62,668	256	62,328	303	91,387	47	29,059
Information technology laboratory	Pos./Approp	342	67,206	342	67,206	342	68,032	475	124,168	133	56,136
	FTE/Obl.	326	88,063	346	83,696	346	68,143	446	126,227	100	58,084
NIST center for neutron research	Pos./Approp	166	41,593	166	41,593	166	42,026	166	42,026	0	0
	FTE/Obl.	155	49,672	165	41,894	165	42,193	165	42,193	0	0
Center for nanoscale science	Pos./Approp	81	28,121	81	28,121	81	27,710	118	42,121	37	14,411
and technology	FTE/Obl.	75	40,419	80	28,191	80	27,741	108	42,152	28	14,411
Innovations in measurement	Pos./Approp	74	20,199	74	20,199	74	20,382	74	20,382	0	0
science program	FTE/Obl.	68	20,236	73	20,343	73	20,404	73	20,404	0	0
Postdoctoral research associates	Pos./Approp	94	11,030	94	11,030	94	11,289	117	14,268	23	2,979
program	FTE/Obl.	165	20,468	92	11,544	92	11,303	109	14,282	17	2,979
Total	Pos./Approp	1,958	460,616	1,958	460,616	1,958	465,453	2,369	630,220	411	164,767
	FTE/Obl.	1,915	636,395	1,964	481,440	1,964	466,313	2,271	625,648	307	159,335

SUBACTIVITY: LABORATORY PROGRAMS

The objectives of the Laboratory Programs subactivity are to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology that drive technological change. NIST's Laboratories play a unique role in the Nation's scientific, industrial, and business communities. NIST anchors the national measurement and standards system that is the language of research and commerce. Maintaining the national standards of measurement is a role that the U.S. Constitution assigns to the Federal government to ensure fairness in the marketplace. 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.

NIST resources are devoted to meeting today's economic and societal challenges and to laying the foundation for future success. NIST activities help address a broad range of critical challenges for the Nation. Current Administration priority areas targeted by NIST include energy, environment, manufacturing, health care, physical infrastructure, and information technology. NIST also supports enacted legislation such as the America COMPETES Act, which outlines major roles for NIST in promoting national competitiveness and innovation, and the National Technology Transfer Advancement Act (NTTAA), which designates NIST as the coordinator for all Federal agencies using documentary standards.

NIST Laboratories support the following Department of Commerce strategic objectives:

- Provide the measurement tools and standards to strengthen manufacturing, enabling innovation and enhancing efficiency.
- Stimulate high growth business formation and entrepreneurship, through investments in high-risk high-reward technologies and removing impediments to accelerate technology commercialization.
- Promote and support the advancement of green and blue technologies and industries.
- Develop and influence international standards and policies to maximize the competitiveness of U.S. industry.
- Provide services to improve the competitiveness of small and medium size firms in manufacturing and service industries.
- Enhance scientific knowledge and provide information to stakeholders to improve innovation, support economic growth and improve public safety.
- Provide streamlined services and single point of contact assistance to customers through better interaction and communication utilizing CommerceConnect, partnerships, branding, and other means of stakeholder involvement.
- Provide a high level of customer service to our internal and external customers through effective and efficient Department functions with empowered employees.

The individual descriptions of the Budget Line Items under NIST's Laboratory Programs are described below.

1. NIST Center for Neutron Research (NCNR)

Program Description:

NIST safely and reliably operates a national user facility providing neutron-based measurement capabilities to U.S. researchers from industry, academia, NIST, and other government agencies in support of materials research, neutron imaging, chemical analysis, neutron standards, dosimetry, and radiation metrology. The NCNR, the Nation's premier neutron research facility, 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.

Examples of Accomplishments:

Research and Facility Performance:

- National Research Facility/Neutrons: Last year, 2,300 researchers directly benefited from access to NCNR capabilities, which accounts for over one-half of all neutron research done in the United States. Researchers from 39 States, Puerto Rico, and the District of Columbia are included in this total. These researchers also represent 142 U.S. universities, 46 U.S. corporations, and 32 U.S. government organizations and laboratories.

- High Impact Research: Research performed at the NCNR resulted in 350 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.

Priority Objectives for FY 2012:

- 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. As part of the NCNR Expansion Project, in FY 2012 the NCNR will continue the relocation of a number of existing neutron instruments and the installation of new instruments.

- Complète Facility Reliability Enhancements: Complete the installation of a number of reliability enhancements to the reactor plant including a secondary cooling pump system, an electrical substation to increase electrical capacity, and install a new cooling system for the reactor's thermal shield. These facility upgrades will ensure that the NCNR maintains its excellent record of reliable operations.

- 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 advanced materials for the auto industry to new nanocomposites for polymer-based solar cells to new materials and approaches for the efficient storage of energy.

- 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 pipelines, 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.

- Data Storage: Increasing the density of stored information. The advance of information technology requires a concomitant increase in the density of stored information. This required the development of new nanostructured magnetic materials. Neutrons allow researchers to develop a detailed understanding of the magnetism to develop these new data storage systems.

2. Center for Nanoscale Science and Technology (CNST)

Program Description:

In the few years since its inception, the CNST has become a major national resource for nanoscale science and the development of nanotechnology, and the only national nanocenter with a focus on commerce. 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 by providing a venue for highly collaborative, multidisciplinary research and direct access to state-of-the-art nanoscale measurement and fabrication tools. The continued development of nanotechnology is key to firmly establishing U.S. leadership in such diverse fields as energy, manufacturing, information technology, electronics, health, and biotechnology. In the case of energy, nanoscale phenomena lie at the heart of a great many energy production, storage, and transmission processes. Research aimed at optimizing the nanoscale structure of photovoltaic or thermoelectric 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 uniquely satisfy these demands. Offering many unique measurement capabilities, the CNST 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 takes place that advances the state-of-the-art of measurement and fabrication ("fab"). A critical component of the CNST, the NanoFab, offers open, convenient and economical access to expensive state-of-the-commercial-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. Having now completed its initial ramp up in staff, equipment, facilities, and processes, the CNST is continuing to expand its 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 2010, the CNST's third full year of operation, the number of researchers benefitting from access to the CNST totaled over 650, and continued to grow rapidly. These 650 researchers participating in CNST-supported projects were employed by 31 companies, 15 national laboratories, and 80 universities, including institutions in 31 states and the District of Columbia.

- Workshops: To assure that the CNST is always working on NIST's highest priority items, we co-organized a workshop on "Nano-Optics, Plasmonics and Advanced Materials" and participated actively in several workshops on such topics as photovoltaics and nanomanufacturing.

- Taking electronics beyond silicon: The CNST developed a beyond-state-of-the-art measurement system with unprecedented energy resolution and sub-atomic spatial resolution for determining the electronic properties of novel electronic materials, collaborating with scientists from Georgia Institute of Technology, Princeton University, University of Texas, Seoul National University, University of Regensburg, and others.

- Nanoscale imaging and fabrication: In collaboration with a leading U.S. nanotechnology company, the CNST developed a new source of ions that can greatly expand our capabilities in nanoscale microscopy and nanostructure creation, and enhance U.S. competitiveness in a $600 million industry.

Priority Objectives for FY 2012:

- Solar Energy/Photovoltaics (PV): Develop measurements essential to fully optimize existing PV technologies and to exploit emerging PV materials as identified by the NIST Workshop on Grand Challenges for Advanced Photovoltaic Technologies and Measurements. Specific measurements include the correlation of local photo-electric properties with grain boundaries, defects, chemical segregation, impurities, density variations, and voids with better than 50 nanometer spatial resolution.

- High-Throughput Measurement and Imaging: Develop a new technique using microscale optomechanics that produces an integrated, miniaturized system capable of measuring nanostructures with extraordinary sensitivity and speed, thereby enabling new types of process and quality control in nanomanufacturing – essential to the commercialization of a wide range of emerging nanotechnologies.

- Nanoscale Materials and Devices/Characterization: Create new ways to characterize the formation and activity of nanostructures to enable more efficient materials and process design, thereby enabling the U.S. to maintain leadership in aerospace technology and affecting a wide variety of applications in transportation, defense, energy, and agriculture.

- Battery technology: Develop methods to characterize the nanoscale physical and chemical processes which accompany the flow of charge in nanostructured Li-ion batteries, which are essential to widespread vehicle electrification and the integration into the electrical grid of solar, wind, and other non-polluting, but intermittent, energy resources. Use the experimental observations to develop physics-based models to describe the electrochemical behavior of these devices.

- Electronic data processing and storage: Using CNST-developed magnetic imaging technology, work with collaborators from three major electronics corporations and others from 15 academic and government laboratories to probe the magnetic structure of novel magnetic storage media, sensors, and logic devices, helping the U.S. stay competitive in a $7 billion industry.

- Efficiency of energy usage: In partnership with two major U.S. corporations, develop methods for measuring the properties of nanostructured thermoelectrics, in support of the development of high-efficiency thermoelectrics for waste heat recovery to improve the energy efficiency in both large and small scale applications.

- Solar-thermal energy conversion: Develop measurement techniques for characterizing nanoparticle dynamics and correlating these properties with thermodynamic properties of nanofluids used in high efficiency heat exchangers, in support of the development of high-efficiency solar-thermal energy conversion.

- Future electronic paradigms: In support of an industry-wide call for new ways to represent bits for faster, more energy efficient data processing, develop theoretical methods to elucidate the transport of electronic spin in nanoscale devices, working with over 30 collaborators at eight U.S. and five international universities.

- New Generation of Nanotechnologists: Help educate a new generation of nanotechnologists by providing hundreds of 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 nanometer scale. Through two-year-long postdoctoral appointments and visiting fellowships available to scientists from academia, industry, and government laboratories, provide in depth, post-graduate training in nanotechnology for more than 50 researchers.

3. Physical Measurement Laboratory (PML)

Program Description:

The PML develops and disseminates the national standards of length, mass, force and shock, acceleration, time and frequency, electricity, temperature, humidity, pressure and vacuum, liquid and gas flow, and electromagnetic, optical, microwave, acoustic, ultrasonic, and ionizing radiation. Its activities range from fundamental measurement research through provision of measurement services, standards, and data.

PML applies its measurement capabilities to problems of national significance through collaborations with industry, universities, professional and standards setting organizations, and other agencies of government. It supports the research community in such areas as communication, defense, electronics, energy, environment, health, lighting, manufacturing, microelectronics, radiation, remote sensing, space, and transportation. PML establishes spectroscopic methods and standards for infrared, visible, ultraviolet, x-ray, and gamma-ray radiation; investigates the structure and dynamics of atoms, molecules, and biomolecules; develops the electrical, thermal, dimensional, mechanical, and physical metrology for measuring the properties of precision measurement devices and exploratory semiconductor, quantum electronic, nanoelectronic, bioelectronic, biooptical, optoelectronic, and quantum information devices and systems; and examines the thermophysical and interfacial properties of streams of flowing fluids, fluid mixtures, and solids. It develops and disseminates national standards by means of calibrations, measurement quality assurance, standard reference materials, technology transfer, education/training, and a comprehensive weights and measurement program to promote uniformity and accuracy at the international, Federal, state, and local levels. It generates, evaluates, and compiles atomic, molecular, optical, ionizing radiation, electronic, and electromagnetic data in response to national needs; measures and improves accuracy of the fundamental physical constants; and develops and operates major radiation sources for measurement science and metrology.

NIST's base activities within PML 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. The Internet service alone provides official time to the public over three billion times daily.

- Medical Radiation and Imaging Technology: NIST calibrations underlie the safety and efficacy of diagnostic procedures (such as mammography) and therapeutic procedures (such as for cancer treatment). Well in excess of 22 million therapeutic radiation procedures[1] and nearly 37 million x-ray mammograms[2] annually are traced to NIST standards. NIST researchers have a robust program in a broad range of medical imaging technologies.

- Electrical and Electronics Metrology: Electronics is highly dependent on measurements enabled by NIST programs. The U.S. electronics and electrical equipment industries (including computer, communications, semiconductor component and equipment manufacturing) employed almost 3 million people at the end of 2007,[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. NIST supports the electronics industry in many ways in its drive to develop ever smaller and more functional semiconductor products. The accuracy of every electricity revenue meter in the U.S. relies on standards provided by NIST.

- Electric Power Distribution: NIST is leading the Nation's efforts to formulate the Smart Grid framework, which will accelerate the development of standards essential for the implementation of Smart Grid technologies in the U.S. electric power system. NIST works with the Department of Energy, Federal Energy Regulatory Commission, and key industry stakeholders to make U.S. electric power distribution more robust and reliable, better balance sources and loads, and accommodate new technologies that advance strategic goals to reduce carbon emissions.

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

- Mechanical and Dimensional Metrology: NIST leads the development of new measurement standards to support U.S. manufacturing and harmonize the U.S. with international standards, removing impediments to U.S. competitiveness. NIST activities in this area promote lower costs for U.S. manufacturers, assure quality and interchangeability of parts, and achieve acoustical standards for the safety of workers in noisy environments.

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[1] *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 over 1.5 million newly diagnosed cancers in the United States in 2010. 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.*

[2] *All mammograms performed in the United States must be traceable to NIST standards. As of August 1, 2010, nearly 39 million mammograms were being performed annually. See http://www.fda.gov/cdrh/mammography/scorecard-statistics.html.*

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

- Fluid Dynamics: NIST maintains, improves, and disseminates the national measurement standards for gas flow, liquid flow, air speed, pressure, temperature, and humidity. Such measurements underlie process chemistry and manufacturing, equitable commerce in natural gas and liquid fuels, wind turbine performance, aircraft altimeter accuracy, and atmospheric monitoring.

- 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 aids the law-enforcement community with performance standards for body armor and bullet forensics.

- Weights and Measures: NIST promotes uniformity in U.S. weights and measures laws, regulations, and standards to achieve equity between buyers and sellers in the marketplace nationwide and internationally. This enhances consumer confidence, enables U.S. businesses to compete fairly at home and abroad, and strengthens the U.S. economy. NIST works with state and local officials and business, industry, and consumer groups, to achieve these goals.

Examples of Accomplishments:

- Smart Grid Interoperability: NIST published the first roadmap to assess and guide the development of Smart Grid interoperability standards, and worked aggressively to coordinate the broad standards development community to prioritize and address key gaps. With NIST guidance, the standards that emerge will work in unison to guide the development of interoperable Smart Grid devices.

- Time and Frequency: NIST built the world's most precise atomic clock, which was based on a single aluminum atom and more than twice as precise as any previous clock. It would neither gain nor lose one second in 3.7 billion years. Ultra-precise timekeeping enables continued improvements in GPS technology and fundamental scientific inquiry.

- Medical Imaging Technology: NIST developed improved measurement methods and materials, including the first standard "phantom" to mimic the human body for the calibration of magnetic resonance imaging (MRI) machines, and pioneering the use of quantum dots to illuminate cell interiors. NIST advances are helping make medical imaging more accurate and consistent, and giving doctors new tools to visualize the body's internal structures, diagnose diseases, plan medical treatment, and measure the efficacy of therapies.

- Quantum Information and Communication: NIST made practical advances in the nascent field of quantum computing, demonstrating the first "universal" programmable quantum processor, which could one day be coupled together to perform practical computations, and the first quantum "dimmer switch," which could eventually store and transport information in future quantum computers. NIST also produced the world's most efficient single photon detector, which is able to count individual particles of light traveling through fiber optic cables with roughly 99 percent efficiency—a tool needed to ensure the accuracy of quantum computations and the integrity of secure quantum communications.

Priority Objectives for FY 2012:

- Dimensional Metrology: In support of the National Nanotechnology Initiative, develop a new class of fundamental, traceable nanoscale dimensional measurements for pitch, height, and width for features smaller than 20 nm in dimension with uncertainties at the atomic scale in direct support of nanoelectronics and nanotechnology manufacturing.

- Medical Imaging Technology: Develop a positron emission tomography – computed tomography (PET-CT) imaging testbed and user facility to determine the sources of error associated with medical imaging procedures and to measure the properties of potential imaging standards, biomimetic phantoms, and novel imaging agents.

- Electronics Technology: Advance solar energy technology by developing measurement methods that improve the understanding of the fundamental processes in which light generates electrical current in next-generation solar cells. Establish a world-class electronics reliability research center at NIST to ensure that next-generation and environmentally friendly devices perform predictably and reliably.

- Neutron Imaging: Apply and further develop expertise in neutron imaging to provide real-time diagnostics of lithium dynamics in next-generation lithium-ion batteries, being developed for advanced vehicle technologies. This will provide the U.S. battery industry with means to better engineer innovative technologies in support of a clean energy future.

- Optical Technology: Improve satellite and ground-based measurement methods for determining CO_2 emissions. Help develop new field able techniques for atmospheric monitoring using innovative laser spectroscopy, correlated with independent measurements of CO_2 mass flow rate.

- Public Health and Safety: Further develop NIST's state-of-the-art gamma ray spectrometer for application in verifying nuclear non-proliferation. This ultra-precise technology can distinguish between naturally occurring and weapons-related isotopes, quickly and non-destructively during cargo inspections.

4. Material Measurement Laboratory (MML)

Program Description:

The MML serves as the national reference laboratory for measurements in the chemical, biological, and material sciences through activities ranging from fundamental and applied research on the composition, structure, and properties of industrial, biological, and environmental materials and processes, to the development and dissemination of certified reference materials, critically evaluated data, and other programs to enable assurance of measurement quality.

MML serves a very broad range of industry sectors ranging from transportation to biotechnology by conducting research, and providing its output in the form of measurement services and measurement quality assurance tools to address problems of national importance such as: greenhouse gas measurements; renewable energy; the Nation's aging infrastructure; environmental quality; food safety and nutrition; forensics and homeland security; healthcare measurements; and manufacturing ranging from advanced materials to photovoltaics to biologic drugs.

Specifically, MML conducts research in:

- Analytical Chemistry to provide the measurement science for reference methods and Standard Reference Materials to support traceability and comparability of chemical measurements both within the U.S. and globally;
- Biochemical Science to provide biochemically- and biologically- based measurement methods, data, reference materials, and predictive models to advance innovation and support the commercialization of biotechnology-based discoveries;
- Ceramics to provide measurement science and provide measurement methods, reference materials, Standard Reference Data, and software tools pertaining to the structure, properties, and performance of advanced inorganic and hybrid materials and structures in support of technology development by U.S. industry;
- Chemical and Biochemical Reference Data to provide measurement science and computational approaches for Reference Data, protocols, and databases to support the identification of chemical and biochemical species and for the determination, estimation, and prediction of chemical and physical properties and reactivities for mixtures and for species such as small molecules, aerosols, proteins, nanoparticles and biomolecules to support accurate identification of species and to support prediction of success for design and commercialization of materials with desired characteristics;
- Surface and Microanalysis Science to provide measurement science and development of methods for provision of reference materials and reference data to support quantitative chemical characterization and imaging at high spatial resolution, ranging from atomic to macroscopic length scales, on systems and processes to support traceability of these measurements nationally and internationally;
- Materials Reliability to provide measurement methods, Standard Reference Materials and data to enable the prediction of the reliability of materials, in applications ranging from bridges to biology in support of assessing and improving the safety of physical infrastructures in the US as well as the innovation, evaluation of the reliability (in varied environments), and commercialization of a wide range of material components including biomaterials;
- Metallurgy to provide the measurement methods, Standard References Materials, and Reference Data for the measurement and prediction of performance and reliability of metallic materials that support innovation and lowering of costs of metals producers and users by enabling informed predictions of the performance, manufacturability, and long-term reliability of materials;
- Polymers for the measurement science to provide the measurement methods, reference materials and data in support of the determination of the physical/chemical/functional properties, and structure, and processing of polymers and complex fluids to advance the manufacture and use of these "soft" materials (polymers and complex fluids in industry);
- Process Measurements to develop standards, reference data, models, and sensing technologies to support the improvement and monitoring of industrial processes and for addressing measurement problems for applications in biomanufacturing, health care, and industrial processes;
- Thermal Properties and Science to provide critically-evaluated thermophysical property data on a wide range of gases, liquids, and solids (including mixtures and supercritical fluids) to support the availability of critical reliable data for development, design, and manufacture of

wide-ranging materials such as alternative/sustainable fuels, explosives, refrigerants, cryocooler and power cycle fluids.

MML is also responsible for coordinating the NIST-wide Standard Reference Materials and Standard Reference Data Programs. NIST SRMs, SRD and calibrations 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.

Example Activities (by Program Area):

Research and measurement service delivery focus on industry and government priorities, as described below:

- **Advanced Electronics:** MML develops nanoscale dimensional metrology, nanoscale chemical and mechanical measurements, functional property measurements, reference materials, reference data, and predictive models to support the manufacture of advanced electronics, including next-generation semiconductor devices, magnetic materials and devices for low-noise sensors and next generation computer logic, and flexible organic electronic devices; as well as tests and standards to ensure the safe and reliable long-term use of these products.
- **Advanced Materials:** MML develops measurement science, standards, data, and associated instrumentation and software tools to support the Nation's use of advanced materials. New, advanced materials define the state of technology in manufactured products, and MML works to provide tools for accurate measurement of the composition, structure, and properties of advanced materials and structures that enable the efficient manufacture of products ranging from nanoscale next-generation microelectronics to large scale energy efficient automobiles. MML outputs enable low cost and reliable manufacture and use of advanced materials—polymers, metals, and ceramics, and hybrids—at scales from atoms to bridges.
- **BioPharmaceutical Manufacturing:** The primary focus of MML's activities is the development of the measurement science and standards to support manufacturing and regulatory approval of biologic drugs. NIST has been asked by both FDA and the industry to apply its unique combination of expertise in the physical, chemical, and the biological measurement sciences to: 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 for biopharmaceuticals in general.
- **The Environment:** MML develops and disseminates the standards that underpin national efforts to assess and protect our soil, atmosphere, and marine and aquatic environments. These include measurement methods, certified reference materials, reference data, and measurement quality assurance programs that support environmental contaminant measurement and/or monitoring programs, computational models, and technology to improve the reliability and comparability of measurements and /or assessments of environmental quality and climate; measurements and reference materials for assessing the safety, toxicity and environmental impact of engineered nanomaterials; and an advanced specimen banking program for safe-keeping of biotic materials to enable future retrospective analyses for establishing time and spatial trends for contaminants in the environment and for health research and monitoring.
- **Food Safety and Nutrition:** MML develops and disseminates analytical methods and reference materials that underpin measurements made in food and water – preventing contaminated food and water from entering supply streams, improving the reliability of

nutrition information provided on product labels, and allowing consumers to make well-informed dietary choices.

- **Healthcare:** MML develops the underpinning measurement science, reference methods, certified reference materials, and reference data needed to increase the accuracy, comparability, and efficacy of measurements used in medical diagnostics and advanced therapeutics. For more than 25 years NIST has maintained standards for electrolytes, small organic biomarkers (such as cholesterol, creatinine and glucose), non-peptide hormones, drugs of abuse and toxic metals. NIST is now developing the measurement science base to underpin the provision of critically needed methods and standards to support: measurement of protein and nucleic acid health status markers in serum, urine, and tissue (clinical genetics/genomics, viral detection, circulating protein markers); the development of next generation diagnostics (personalized medicine); and the development of novel therapeutics (cell-based regenerative medicine). MML also provides the underpinning measurement science and standards to support the development of advanced dental materials, tissue engineering scaffolds, nanoparticle-based therapies for cancer early detection and treatment, the preservation of protein therapeutics, and to ensure the safety and reliability of implanted medical devices.
- **Physical Infrastructure:** MML develops measurement methods and standards, including non-destructive evaluation techniques, for assessing the health of aging physical infrastructure components, and for gauging its resilience to extreme environmental conditions. These include reference materials and standards for assessing material strength and hardness, standards for fuel pipeline safety, methods to assess the performance of plastic pipes for water and gas, and methods to test and predict the heath of critical connections and join-ends in bridges and buildings.
- **Renewable Energy:** MML develops and disseminates measurement methods, reference materials and data that support the development, manufacture and quality control of renewable energy sources and devices including biofuels, next generation photovoltaics, energy storage and heat-harvesting thermoelectric devices; and develops measurement techniques that support the manufacture of energy-efficient vehicles from lightweight materials.
- **Security, Safety, and Forensics:** MML generates and disseminates measurements, standards and data that support national security. These include advanced instrumentation and reference materials that enable the accurate and reliable detection of chemical, biological, radiological, nuclear and explosive threats; standards and reference materials that support DNA-based human identity testing for forensics and biometrics; and measurement methods to ensure the reliability of soft body armor.

Selected Examples of Future Outputs by Program Area:

Advanced Electronics: In support of the U.S. semi-conductor and electronics industry and the users of advanced electronic materials in a number of industries, MML will develop and disseminate:

- measurement methods, instruments and reference materials needed by the U.S. semiconductor industry to produce the nanoscale structures, and to employ the novel materials, inherent to the manufacture of next-generation microelectronic devices. These include dimensional metrologies to ensure the quality of manufactured structures and films, precise chemical imaging and depth profiling techniques to gauge the reliability of emerging materials deposition and doping routes for manufacturing multi-layered devices and interconnects, and measurements and models to determine mechanical integrity, and to predict the lifetime and reliability of device components;

- measurement methods and instrumentation needed to accelerate the commercialization of devices based on emerging electronic materials, including organic electronics and semiconductor nanowires, by enabling industry to determine the source of materials performance variations that hinder reliable manufacture of innovative products such as flexible displays; and

- measurement science underpinning ultrasensitive magnetic sensor technologies for healthcare and military applications, and measurement techniques that support the manufacture of reliable microelectromechanical systems by mapping strain and stress in devices at the nanoscale.

Advanced materials: For effective innovation, manufacture, and use of high priority advanced materials in a range of industry sectors, MML will develop and disseminate:

- measurement methods and instruments capable of determining the composition and structure of materials with the unprecedented resolution and accuracy needed by industry to advance the development and manufacture products including semiconductors, engineered nanomaterials and catalysts. New tools include novel microscopy and spectroscopic methods to image materials at the atomic and molecular scales, and the establishment of a suite of NIST-developed synchrotron spectroscopy instrumentation at the world's premiere synchrotron imaging user facility, NSLS-II (Brookhaven National Laboratory);

- new methods and instrumentation for measuring the mechanical and thermal properties of materials with nano-scale and finer spatial and energy resolution. These include the first SI-traceable platform for nanoindentation measurements (used ubiquitously by industry), and next-generation nanocalorimetry for in-situ measurements of chemical reactions and materials transformation processes at the nanoscale; and

- new reference materials and data needed by industry to calibrate nanoscale measurements and to gauge the properties and quality of nanomaterials and other advanced materials. These include precision reference cantilevers for calibration of nanoscale friction measurements, X-ray diffraction standard reference material for nanocrystallite size, ultrapure reference materials needed to gauge the performance and potential NanoEHS risks of single wall carbon nanotubes, and databases of critically evaluated crystal structure and phase equilibrium data.

Biopharmaceutical Manufacturing: Improved measurement methods and technologies along with supporting standards will be developed to positively impact the biopharmaceutical manufacturing industry and improve the ability of FDA to regulate "generic biologics". MML will develop:

- new methods and standards for protein aggregate measurements;

- new *in vitro* methods and models for measurement of human immune system response;

- a Stable Isotope Protein Labeling User Facility to support high resolution protein structural characterizations;

- reference methods, data, and standards to support the characterization of glycan components on biologic drugs; and

- reference data (molecular signatures) for predicting the efficiency and efficacy of production cell performance in the manufacture of biologic drugs.

The Environment: MML will develop and disseminate:

- measurement methods, data, and reference materials to allow precise measurements of key greenhouse gases, including carbon dioxide, methane, and reactive species;

- Standard Reference Data for next generation of refrigeration fluids that are more environmentally benign;

- reference materials, data, and measurement methods to enable sound scientific assessment of the state of aquatic and soil environments when impacted by contaminants attributed to chemical releases from industrial activities, including hydrocarbons in marine environments, heavy metals in soil;

- measurement methods, reference materials, reference data, and documentary standards to enable the assessment and management of risk to the environment of engineered nanomaterials and products containing engineered nanomaterials, with a focus on industry-relevant species, such as titanium dioxide and carbon nanotubes; and

- measurement methods, data, and reference materials to allow precise measurements of the optical properties of environmental aerosols for use in predicting atmospheric forcing.

Food Safety and Nutrition: In this area, reference measurement methods and reference materials or data will be developed and disseminated for underpinning measurements made for determining:

- the isotopic ratio of 87Sr/86Sr in food to support the identification of counterfeit food products or for customs investigations of food origin;

- folate species, vitamin B12, vitamin B6, and vitamin D metabolites to support human nutrition assessment studies being conducted by the CDC and NIH; and

- Indicators of food spoilage in selected systems.

Healthcare: The measurement science base will be developed to expand the NIST healthcare standards program to include reference methods, Standard Reference Materials, and/or measurement quality assurance programs to support increased accuracy and comparability for:

- blood protein health status marker detection (such as those used for detection of heart attack, kidney function, and prostate cancer);

- genetics analysis to support therapy decisions (such as those used for colon and breast tumor treatment decisions) and genetics-based diagnostics (such as those used for detection of Huntington's Disease and Fragile X Syndrome);

- viral load measurements (cytomegalovirus for immunocompromised patients);

- DNA mutations and RNA expression measurements as biomarkers for early detection of breast, colon, lung, and prostate cancer; and

- systematic studies, quantitative imaging methods, and models for tracking and predicting stem cell fate.

Physical Infrastructure: MML will expand its measurement science base in a number of areas critical to maintenance and assessment of our Nation's physical industry. MML will develop, validate, and disseminate:

- measurement techniques that will establish the safety of gusset plate connections in fracture-critical bridges, and that support the establishment of standards for non-destructive bridge condition assessments, in collaboration with the FHWA Turner-Fairbank Research Center;

- measurements and computational models of connections in bridges to predict their resilience to extreme conditions like fire and impact, and detect hidden flaws due to corrosion; and

- test methods and standards to qualify steels used in fuel pipelines, and measurements that foster the repurposing of pipelines for alternative fuels like hydrogen; and develop measurements to evaluate next generation plastic water pipelines used for household delivery and nuclear plant cooling.

Renewable Energy: To keep abreast of current measurement needs of U.S. industry as they design, manufacture, and deploy renewable energy resources, MML will develop and disseminate:

- measurement methods, documentary standards, and reference materials to accelerate the commercialization of inexpensive solar devices that incorporate thin-film semiconductors, 3D and nanostructured materials, and organic photovoltaics. These include cutting-edge methods and instrumentation needed by the budding U.S. solar industry to benchmark and report material performance, to establish structure-processing relationships and design principles for reliable manufacturing, and to determine failure mechanisms that threaten long-term reliability;

- measurement methods and reference materials to accelerate the industrial development of energy harvesting and energy storage devices. These include instrumentation and reference materials needed by the U.S. automotive industry to test the performance of thermoelectric devices that recover waste-heat, and measurements that enable industry to establish structure-property principles for the manufacture of reliable and high-energy density batteries and fuel cells needed to store energy from often intermittent renewable energy sources; and

- measurement methods, data, and reference materials that mitigate our Nation's dependence on petroleum fuels. These include the production of data and reference materials that enable reliable manufacturing and quality control of biofuels and that foster international standards on biofuels properties; and instrumentation needed by industry to accurately assess the performance of sorbent materials for carbon capture and sequestration.

Security, Safety, and Forensics: In this area, MML will develop and deploy:

- measurement methods, reference materials, and data to ensure that the Nation has reliable and effective detection capabilities for Chemical, Biological, Explosive, and Nuclear threat materials, including augmentation of the explosives property database;

- reference materials and methods of DNA profiling for consistent genetic typing within the forensics community; and

- measurements and methods for evaluating the performance of next generation body armor that incorporates materials for stab and puncture protection.

5. Engineering Laboratory (EL)

Program Description:

The EL promotes the development and dissemination of advanced manufacturing and construction technologies, guidelines, and services to the U.S. manufacturing and construction industries through activities including measurement science research, performance metrics, tools and methodologies for engineering applications, and critical technical contributions to standards and codes development. The Laboratory carries out mission related activities in fire prevention and control; national earthquake hazards reduction; national windstorm impact reduction; national construction safety teams; building materials and structures; engineering and manufacturing materials, products, processes, equipment, technical data, and standards; manufacturing enterprise integration; collaborative manufacturing research pilot grants; and manufacturing fellowships. It also carries out other mission related engineering research as may be necessary, including systems integration and engineering, intelligent systems and control, robotics and automation, cyber-physical systems, sustainability and energy efficiency, economic analysis and life cycle assessment, productivity measurement, and safety and environmental performance. The Laboratory's measurement science research includes the development of performance metrics, measurement and testing methods, predictive tools, protocols, technical data, and reference materials and artifacts; the conduct of intercomparison studies and calibrations; the evaluation of technologies, systems, and practices; and the development of the technical basis for standards, codes, and practices—in many instances via testbeds, consortia, standards and codes development organizations, and/or other partnerships with industry and academia. The Engineering Laboratory carries out its mission through high-leverage, high-impact infrastructural measurement science research and services to promote U.S. manufacturing and construction innovation and industry competitiveness; enhance productivity and sustainability of manufacturing and construction activities; and improve building and fire safety.

- Measurement Science for Intelligent and Integrated Manufacturing: To develop performance metrics, measurement methods, and standards that drive innovation in manufacturing robotics, automation, and process equipment and control systems; and develop fundamental measurements, standards, and tools to enable the transition from manufacturing practices based on human experience towards scientific-based modeling, decision making, and production. This goal enables manufacturers to meet market and societal demands for reduction in time to market through shorter product development cycles and increased flexibility and speed of manufacturing, higher quality and better performance of customized products, increased productivity and reduced costs, and improved safety and security.

- Measurement Science for Sustainable Manufacturing: To define, develop, and enable an open standards-based information infrastructure and content models for sustainable manufacturing; develop standards for functional and material flow models of closed-loop supply chains; collect, harmonize, and document metrics and best practices for sustainable manufacturing; and disseminate critical sustainability information among suppliers, customers, and regulatory agencies. This goal helps move manufacturing toward a future where it has a zero net impact on the environment.

- Measurement Science for Model-based Engineering Enterprise: To develop the measurement science infrastructure required for transitioning the manufacturing industry to a model-based engineering environment; develop three-dimensional product lifecycle models and manufacturing process models; develop standards and methods for product manufacturing information; and develop open standards infrastructure for lifecycle systems engineering that will permit development, planning, integration, compatibility, teaming, control, and management across a worldwide network of diverse processes and software applications covering production facilities, supplier inventories, supply production schedules, and shipment tracking information. This goal enables manufacturing innovation and productivity growth through improved production and supply chain efficiencies and responsiveness.

- 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. 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. 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. 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. 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. 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.

Examples of Accomplishments:

- Intelligent and Integrated Manufacturing: Established first ever national standards committee, in collaboration with industry, academia and other government agencies, to address the needs of the emerging new manufacturing industry utilizing additive material processes for fabricating complex parts layer by layer. Identified key performance metrics to characterize and improve metal-based additive manufacturing processes. NIST's participation as experts in machine and process characterization will enable speedy development of a much needed set of standards in this area leading to rapid improvements in precision and productivity associated with this technology.

- Sustainable Manufacturing: Developed a comprehensive analysis of existing standards and directives related to sustainable manufacturing. This NIST-developed web accessible tool will allow diverse stakeholders – software vendors, industry end users, industrial consortia, academia, and government agencies – to understand and apply standards for products, processes and services and to comply with applicable regulations.

- Model-Based Engineering Enterprise: Developed a new international standard, with industry collaboration, for the exchange of product manufacturing information (PMI) including geometric dimensioning and tolerancing. NIST's leadership in this area produced a standard that addresses critical industry priorities to exchange PMI data for design analysis, cost analysis, production operations, and quality assurance. This new standard will give manufacturing software developers the capability to directly import critical design data required to support advanced manufacturing functions including numerical control machining and automated inspection.

- Net-Zero Energy, High-Performance Buildings: Completed a multi-year international collaborative research project on cost-effective commissioning of low-energy building systems under the auspices of the International Energy Agency. The results established a technical basis for measuring the effectiveness and persistence of energy benefits of commissioning and developed new knowledge that can be incorporated into industry best practice standards and guidelines.

- Advancing Infrastructure Delivery: Developed the standard practice ASTM E2691 on Construction Job Productivity Measurement, covering task- and project-level metrics. This standard provides the foundation for determining productivity of construction work processes, discrete tasks and aggregate levels, and a framework for evaluating the benefits of promising automation and integration technologies in construction.

- Innovative Fire Protection: Completed an in-depth study on fire behavior and defensive actions taken in a community during a wildland-urban interface (WUI) fire to better understand and how best to prevent or fight WUI fires. The study examined in detail the events during the October 21-22, 2007 "Witch Fire" north of San Diego. The data collection tracked the fire's approach from the wildlands, the effects of the fire in the community, and defensive actions taken by owners and first responders. The report documented the construction characteristics of the destroyed homes and the wildland and residential vegetation damage immediately after the fire, and the study found that two-thirds of all the homes destroyed were ignited either directly or indirectly by embers.

- Disaster-Resilient Structures and Communities: Seventeen major and far-reaching building and fire code changes were approved recently by the International Code Council (ICC) for the 2012 edition of the I-Codes based on recommendations from NIST's investigation of the collapses of New York City's World Trade Center (WTC) towers and WTC 7 on Sept. 11, 2001. The new code changes include important safety improvements to the existing requirements for elevators in tall buildings used during an emergency by occupants evacuating and firefighters entering, and provisions to ensure that emergency radio communications will effectively serve emergency responders throughout their local communities. The newly adopted code changes are the second set adopted in the past two years by the ICC based on recommendations from the NIST WTC investigation. Twenty-three additional changes were approved and incorporated into the 2009 edition of the I-Codes.

Priority Objectives for FY 2012:

- Intelligent and Integrated Manufacturing: Develop standards-based software modules and application program interfaces for integration of wireless sensor networks for use in monitoring manufacturing processes and equipment in factory floor environments. NIST research will enable cost effective monitoring, control, prognostics, and maintenance planning of next generation agile manufacturing systems.

- Sustainable Manufacturing: Develop advanced representations for incorporating information and metrics about sustainability factors into product models 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 enabling competitive manufacturing in global markets.

- Model-Based Engineering Enterprise: Complete the development of a new draft international standard to support manufacturing enterprise data exchange in partnership with industry. NIST research and standards activities will support critical industry priorities for seamless data exchange for design, analysis, product support, and long term data archiving, thus enabling small and medium size companies to benefit from the availability of low-cost software applications made possible by open standards for manufacturing enterprise data exchange.

- Net-Zero Energy, High-Performance Buildings: Develop a commissioning tool for residential and light commercial air-conditioning and heat pump systems to guide the installer in setting proper refrigerant charge both in the cooling and heating modes as well as verify the overall health of the system. Verifying proper installation will significantly reduce the estimated 95 percent of systems that fail a health check and operate at less than 80 percent of their as-designed efficiency.

- Advancing Infrastructure Delivery: Develop a standard for classifying bridge elements and improving construction process, covering highway, railroad, and pedestrian bridges, issued by ASTM International. This standard, when added to ASTM UNIFORMAT II, will provide a consistent and searchable framework for recording construction, operating, and maintenance costs. Using this standard for classifying costs on an elemental basis early in the design process will contribute to substantial design, construction, and operational savings.

- Sustainable Infrastructure Materials: Complete, and introduce into the standardization process, a draft standard on concrete rheometer calibration protocol, which makes use of a combination of new NIST standard reference materials and computational models. This standard will give the concrete industry the measurement science-based tools needed to optimize concrete mix design for ease of placement and to make more wide-spread and effective use of new materials like self-consolidating concrete.

- Innovative Fire Protection: Complete development of, and introduce into the consensus standardization process, a test method for estimating the toxic potency of smoke from burning building and furnishing products (chairs, electrical cables, etc.). Smoke inhalation kills more people than burn injuries, and knowing how long it takes for a fire to become life-threatening enables cost-effective design of building fire control systems and evacuation systems.

- Disaster-Resilient Structures and Communities: Publish guidelines, developed in collaboration with industry, for vulnerability assessment of new and existing buildings for disproportionate collapse potential. The vulnerability assessment will identify building weaknesses and recommend mitigation strategies to reduce such weaknesses, incorporating both rapid and comprehensive evaluation procedures.

6. Information Technology Laboratory (ITL)

Program Description:

The ITL develops and disseminates standards, measurements, and testing for interoperability, security, usability, and reliability of information systems, including cybersecurity standards and guidelines for Federal agencies and U.S. industry, supporting these and measurement science at NIST through fundamental and applied research in computer science, mathematics and statistics.

ITL enables the future of the Nation's measurement and standards infrastructure for information technology by accelerating the development and deployment of information and communication systems that are interoperable, secure, usable, and reliable; advancing measurement science through innovations in mathematics, statistics, and computer science; and conducting research to develop the measurements and standards infrastructure for emerging information technologies and applications. We accomplish these goals through collaborative partnerships with our customers and stakeholders in industry, government, academia, and consortia. Based on input from these customers and stakeholders, we have focused our research and development agenda on several broad program areas: cloud computing; complex systems; cyber and network security; enabling scientific discovery; health information technology; identity management systems; information discovery, use and sharing; pervasive information technologies; quantum information; trustworthy information systems; virtual measurement systems and voting systems standards and research.

- Cloud Computing: Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. NIST's role in cloud computing is to promote the effective and secure use of the technology within government and industry by providing technical guidance and promoting standards.

- Measurement Science for Complex Information Systems: Complex Systems are composed of large interrelated, interacting entities which taken together, exhibit a macroscopic behavior which is not predictable by examination of the individual entities. The Complex Systems Program seeks to understand the fundamental science of these systems and develop rigorous descriptions (analytic, statistical, or semantic) that enable prediction and control of their behavior. Initially focused on the Internet and Grid Computing, this Program will facilitate predictability and reliability in these areas and other complex systems such as biotechnology, nanotechnology, semiconductors, and complex engineering.

- Cyber and Network Security: Cyber and network security is focused on ensuring three security objectives of information technology systems: confidentiality, integrity, and availability. The Cyber and Network Security Program addresses NIST's statutory responsibilities in the domain and the near- and long-term scientific issues in some of the building blocks of IT and network security - cryptography, security testing and evaluation, access control, internetworking services and protocols (Domain Name System, Border Gateway Protocol, IPv6, Wi-Max, etc.), security metrics, vulnerability analysis, security automation, and security properties. These efforts will provide a more scientific foundation for cybersecurity, while maintaining a focus on near-term security issues in emerging technologies.

- Enabling Scientific Discovery: Modern scientific research has become more and more dependent on mathematical, statistical, and computational tools for enabling discovery. The Enabling Scientific Discovery Program promotes the use of these tools to dramatically advance our ability to predict the behavior of a broad range of complex scientific and engineering systems and enhance our ability to explore fundamental scientific processes. This Program focuses on interdisciplinary scientific projects that involve novel computational statistics and the development of simulation methods and software. These efforts will have a foundational impact on scientific discovery throughout U.S. industry, government, and academia.

- Health Information Technology: NIST's laboratories are contributing to the healthcare industry by providing its standards, measurement science and testing expertise. NIST collaborates with major standards development organizations, professional societies and the public sector in fostering secure, interoperable, usable, standards-based solutions for the exchange of health information. NIST focuses on advancing healthcare information standards that are complete and testable and by providing the necessary conformance tests, interoperability tools and techniques where appropriate. These activities, when integrated into standards, software and certification processes, raise the quality of the clinical outcomes, lower cost of health IT implementation, and foster adoption of healthcare systems.

- Identity Management Systems: Identity management systems are responsible for the creation, use, and termination of electronic identities which are routinely used to access logical and physical resources, and have become a ubiquitous part of our national infrastructure. The Identity Management Systems Program is pursuing the development of common models and metrics for identity management, critical standards, and interoperability of electronic identities. These efforts will improve the quality, usability, and consistency of identity management systems while protecting privacy.

- Information Discovery, Use, and Sharing: Society is awash in data – our ability to amass data has outpaced our ability to use it. Extracting knowledge, information, and relationships from this data is one of the greatest challenges faced by the scientists in the twenty-first century. The data can be as diverse as biological research data, medical images, automated newswire, speech, or video. The Information Discovery, Use, and Sharing Program fosters innovation throughout the information life cycle by developing the measurement infrastructure to enhance knowledge discovery, information exchange, and information usability. The Program enables novel computational approaches to data collection and analysis to be combined with improved interoperability techniques to effectively extract needed information from the wealth of available data.

- Pervasive Information Technologies: Pervasive information technology is the trend towards increasingly ubiquitous connected computing sensors, devices, and networks that monitor and respond transparently to human needs. The Pervasive Information Technologies Program facilitates the creation of standards for sensor communication, networking interoperability, and sensor information security. The Program enables the use of pervasive information technologies to enhance personal and professional productivity and quality of life.

- Quantum Information Program: Quantum science and engineering has the potential to revolutionize 21st century technology in much the same way that lasers, electronics, and computing did in the 20th century. The aim of the ITL Quantum Information Program is to understand the potential for quantum-based technology to transform computing and communications, and to develop the measurement and standards infrastructure necessary to exploit this potential. The principal goals of the ITL Quantum Information Program are:

  - To understand the potential (both opportunities and risks) for quantum information to revolutionize information science.
  - To develop theory, methods, architectures and algorithms to enable engineering and testing of quantum computing components and systems.
  - To demonstrate and test communication components, systems and protocols for the quantum era.

- Trustworthy Information Systems: A trustworthy system is one that performs as intended for a specific purpose, when needed, with operational resiliency and without unwanted side effects, behaviors, or exploitable vulnerabilities. The Trustworthy Information Systems (TIS) Program conducts research, development, and testing to improve the ability to model, build, test, measure, and assess information system trustworthiness through the development and application of new and innovative technologies, models, measurement methods, and tools. The aim of the TIS program is to reduce the risk and uncertainty associated with information systems that must be trusted, and to improve the ability to build in and evaluate trustworthiness in information applications and systems.

- Virtual Measurement Systems: A virtual measurement is a quantitative result and its uncertainty, obtained primarily by a nontrivial computer simulation or computer-assisted measurements. Examples of virtual measurements include computational models of physical systems and visualizations of the results. The Virtual Measurement Systems Program introduces metrology constructs - standard references, uncertainty characterization and propagation, and traceability - into scientific computation and computer-assisted measurement technologies. As with physical measurement systems, development of a virtual metrology infrastructure will result in predictive computing with quantified reliability. In turn, this will enable improved decision making contingent on virtual measurement systems.

- Voting Systems Standards and Research: The 2002 Help America Vote Act has given NIST a key role in helping to realize nationwide improvements in voting systems. To assist the Election Assistance Commission with the development of voluntary voting system guidelines, HAVA established the Technical Guidelines Development Committee (TGDC) and directs NIST to chair the TGDC. NIST research activities include:

    - security of computers, computer networks, and computer data storage used in voting systems;
    - methods to detect and prevent fraud;
    - protection of voter privacy; and
    - the role of human factors in the design and application of voting systems, including assistive technologies for individuals with disabilities (including blindness) and varying levels of literacy.

Examples of Accomplishments:

- Cloud Computing: NIST developed recommendations for securely configuring and using full virtualization technologies, which, by means of software, duplicate a computer's operating system and its applications on other machines. Because it helps maximize the use and flexibility of computing resources—multiple operating systems can run simultaneously on the same hardware—full virtualization is considered a key technology for cloud computing, but it introduces new issues for IT security. For cloud computing systems in particular, full virtualization can increase operational efficiency because it can optimize computer workloads and adjust the number of servers in use to match demand, thereby conserving energy and information technology resources.

- Measurement Science for Complex Information Systems: NIST investigated and evaluated modeling and analysis methods that can be applied to predict and understand macroscopic behavior and variations in user experience that may arise as engineers introduce changes in software components into a large information network, such as the Internet. Currently, system designers lack techniques to predict global behaviors that may arise in the Internet as a result of interactions among existing and altered software components. Hardware faults and unexpected usage patterns may also occur within the Internet. The ITL study aims to improve existing knowledge about a range of methods and tools that could be applied to understand and predict behavior in complex information systems.

- Cyber and Network Security: NIST completed a major initiative to enhance the stability and security of the Internet, in collaboration with the National Telecommunications and Information Administration. The completion marks full deployment of a security technology—Domain Name System Security Extensions (DNSSEC)—at the Internet's authoritative root zone. The Domain Name System (DNS) is akin to a global address book for the Internet. The authoritative root zone of the DNS is at the top level with links to addresses in lower-level books for individual countries (e.g., .us) and affinity groups (e.g., .edu). DNS data authenticity is essential to Internet use. For example, it helps to ensure that Internet users are not unknowingly redirected to bogus and malicious websites and will help protect Internet users against phishing and other types of cyber attacks. The DNS was not designed with strong security mechanisms. Technological advances have made it easier to exploit vulnerabilities in the DNS protocol, putting DNS data at risk. Deploying DNSSEC, which is a suite of Internet Engineering Task Force specifications for securing information provided by the DNS, mitigates these vulnerabilities. A main benefit of installing DNSSEC at the root zone is to facilitate greater DNSSEC deployment throughout the rest of the global DNS hierarchy.

- Enabling Scientific Discovery: NIST developed a novel computational statistics technique for specialized measurements of the effect of mechanical strain on superconductor properties, which is critical for applications in magnetics, power transmission, and electronics.

- Health Information Technology: NIST developed test tools and test procedures will be used by the Authorized Testing and Certification Bodies in testing complete Electronic Health Record (EHR) systems and/or EHR modules to ensure compliance with the meaningful use technical requirements and standards defined by the Office of the National Coordinator for Health Information Technology.

- Identity Management Systems: NIST established the Iris Exchange IREX program as a NIST-industry collaboration to encourage development of iris recognition algorithms operating on images conforming to the new ISO-IEC 19794-6 standard. NIST completed the first Iris Exchange project, IREX I, providing quantitative support to the new ISO-IEC 19794-6 standard by conducting the largest independently administered test of iris recognition technology to date. The test attracted 19 recognition technologies from ten different providers. The international standard, now under revision, defined three competing image formats and three compression methods: the IREX I test narrowed the field by determining which ones performed consistently at a high level. The IREX I tests also looked at technical factors affecting users. These include speed-accuracy tradeoffs, threshold calibration, storage requirements, image quality assessment, and the effects of iris size, eyelid occlusion and pupil dilation. The test result shows that forensic applications, where image quality is sometimes degraded, can benefit from slower but more powerful algorithms.

- Information Discovery, Use, and Sharing: NIST has developed a novel computational framework for quantifying and correlating geometric features within vascular smooth muscle cells. Innovative methods to segment cells beyond typical thresholding techniques were developed to identify clinically-relevant regions of interest. Geometric features are extracted within these regions to quantify the size, orientation, and distribution of fibers within protein channels. Methods to correlate features between protein channels were also developed. Applications of such a tool include automated methods for cell biologists to measure cell response and proliferation, leading to a greater understanding of complex biological systems. Our subcellular feature extraction work will play a role in understanding how mechanical forces regulate biochemical events within living cells and will lead to a better understanding of important biomedical issues such as blood vessel development, muscle contraction, and tumor formation.

- Pervasive Information Technologies: NIST developed a Statistical Path Loss Model for medical implant communication channels to characterize radio frequency (RF) path loss from wireless medical implants. The model was obtained using data from extensive computational simulations of four near surface and two deep tissue implants in a typical male human body. The team developed a novel quantitative visualization capability, running on platforms from desktops to immersive visualization environments, to perform 3D simulation, analysis and post-processing of the results. The path loss models obtained in this study have been adopted by the standards committee IEEE 802.15 Task Group 6 on body area networks.

- Quantum Information Program: Like classical computers, quantum computers must have a small set of basic instructions upon which all its complex computations are built. NIST researchers have shown that a certain class of highly desirable quantum operations cannot solely be relied upon for the practical implementation of quantum computers. In particular, it was proved that transversal encoded gate sets, which are ideal for error management, cannot be universal. This settles a long-standing conjecture in the theory of quantum computing which has important practical implications.

- Trustworthy Information Systems: NIST completed the first Static Analysis Tool Exposition (SATE), in collaboration with static analyzer equipment vendors, to improve the performance of these tools. Static analyzers try to find weaknesses in other programs that could be triggered accidentally or exploited by hackers. The number and subtlety of attacks from hackers on software is increasing. Because it is impossible to anticipate every combination of inputs a given piece of software might receive, static analyzers attempt to use mathematical and logical tools to rigorously predict the behavior of the program and examine it for weaknesses based on its code or set of instructions. The results of SATE help toolmakers assess and improve their products' ability to find security defects in other software.

- Virtual Measurement Systems: NIST Computational scientists, in collaboration with Indiana University, have achieved record levels of accuracy in the development of computational methods for the virtual measurement of fundamental properties of the three electron atom lithium (Li). Their recent results for the nonrelativistic energies for four excited states of the lithium atom represent the highest level of accuracy ever reached (less than 10-9 hartree) in atomic quantum computations with more than two electrons.

- Voting Systems Standards and Research: NIST is developing a set of key research findings related to Uniformed and Overseas Citizens Absentee Voting Act (UOCAVA) research: Information Systems Security Best Practices for UOCAVA-Supporting Systems; Security Best Practices for the Electronic Transmission of UOCAVA Election Materials and Accessibility and Usability Considerations for Remote Electronic UOCAVA Voting.

Priority Objectives for FY 2012:

- Cloud Computing: Develop Federal guidance to support the effective adoption of Cloud Computing, facilitate the development of Cloud Computing standards, particularly to address security, interoperability, and portability requirements, and model and analyze Complex Behaviors in the Cloud Computing environment.

- Measurement Science for Complex Information Systems: Develop and validate a cloud computing simulation model for Infrastructure as a Service (IaaS), conduct a sensitivity analysis to identify significant model parameters, design and conduct experiments to assess the influence of selected resource allocation algorithms on model behavior.

- Cyber and Network Security: Develop information security standards, measurements, and tools for systems and networks. Extend the reach of strong cybersecurity mechanisms to emerging lightweight platforms. Produce guidelines and automated tools needed to promote adoption of interoperable, secure technologies and infrastructures on a national level. ITL's primary

Cybersecurity research and standards development focus will be responsive to the President's Smart Grid, Healthcare IT, voting mandates, citizen facing authentication, cloud computing, national cybersecurity priorities and Executive initiatives. These activities will also support innovative classes of networked devices by establishing new foundational security mechanisms necessary to establish end-user trust.

- Enabling Scientific Discovery: Develop a suite of tools, techniques and numerical schemes for the advancement of standards and measurements research work at NIST: sophisticated simulation and modeling techniques for physical systems and novel statistical techniques for analysis, calibration and performance improvement. Enhance our scientific understanding of those issues that play a role in standards and measurement. Design, test and implement numerical algorithms for design and control of physical systems.

- Health Information Technology: Advance the interoperability, security, usability and adoption of health IT by collaborating with stakeholders to develop health information standards and technologies that are complete and testable and by providing the necessary conformance tests and tools. Accelerate development of key standards, measurements and technologies for emerging health IT priorities: clinical decision support; medical records discovery and sharing; retrieval and analysis of free-text healthcare data; integrated clinical environment and medical device interoperability; image quality; long-term preservation and management of electronic health records; and, wireless medical wearable sensors.

- Identity Management Systems: Facilitate implementation of the National Strategy for Trusted Identities in Cyberspace. Accelerate the development and adoption (by individuals and industry) of secure, efficient, easy-to-use, and interoperable identity solutions to access online services in a manner that promotes confidence, privacy, choice, and innovation. Build a focused strategy to support the development of international standards. NIST's primary focus will be toward providing the research and standards development needed for development of an online environment where individuals and organizations can complete online transactions with confidence, trusting the identities of each other and the identities within the infrastructure.

- Information Discovery, Use, and Sharing: Accelerate research, discovery, and innovation in critical national priorities such as the biosciences, manufacturing, and the intelligent use and sharing of multimodal information by addressing standards and measurement science issues that result from the automated and integrated analysis of large data sets. Develop measurement methods and tools to improve the state-of-the art and reliably quantify uncertainty in computational algorithms and information models for the automated discovery, access, manipulation, analysis, exchange, and archival of digital information. NIST research will result in reliable and robust products and systems for information discovery, use and sharing, impacting both national and commercial sectors.

- Pervasive Information Technologies: Develop measurement science, testing methodologies, modeling and performance evaluations of innovative access technologies focusing on body area networks (implant communications, body surface communication, interference analysis and co-existence, energy harvesting), interoperability of medical devices and smart autonomous sensors and environments.

- Quantum Information Program: Develop novel theoretical techniques to assess the true nature of the improvement in processing power obtainable through the use of quantum resources. Apply to the assessment of algorithms which may provide the basis for future quantum-resistant public key cryptography.

- Trustworthy Information Systems: Develop improved security and correctness measurement methods for software, including reference software for both static and dynamic measures and mathematically sound analysis measurement techniques for a few classes of weaknesses. Analyze the use of combinatorial methods for testing software in aerospace, smart phone, and other applications, in collaboration with CRADA and other research partners. This work includes analyzing effectiveness of test prioritization methods and access control policy testing. NIST will work with other government agencies, academia, and industry to transfer the use of these measurements into national infrastructure, commercial, and Federal government sectors.

- Virtual Measurement Systems: Research and develop metrology constructs – standard reference computations, uncertainty quantification, and traceability – into scientific computation and computer-assisted measurement technologies. This measurement infrastructure will result in predictive computing with quantified reliability. In turn, this will enable risk-informed decision-making for problems in which the results of computational models provide critical inputs.

- Voting Systems Standards and Research: Accelerate the development and adoption of advanced voting technologies through research and development of standards and test methods in security, reliability, usability, accessibility, and privacy of voting systems. Develop high-level guidelines, a risk management framework, and a common data format in support of voting standards for remote oversees and military voting. Develop methods for achieving auditability of voting systems that support both security and accessibility requirements. This will result in more trustworthy voting systems for Federal, state, and local elections in the U.S.

7. Strategic and Emerging Research Initiative (SERI)

Program Description:

The Strategic and Emerging Research Initiatives (SERI) program provides the NIST Director with the 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. SERI supports the Department of Commerce and NIST's mission of promoting U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology that drive technological change.

The primary activities being conducted with the program's base resources are the development of new competencies necessary to develop and maintain knowledge related to measurement techniques to solve problems in selected national need areas. The SERI program gives NIST the flexibility to respond quickly to developing capabilities to solve new measurement problems for emerging national needs. Examples of recent national need areas that had related measurement and standards competencies addressed through SERI include Smart Grid, physical infrastructure, advanced manufacturing, and reduction of greenhouse gas emissions. SERI allows NIST to develop these measurement and standards competencies more quickly, which enables emerging problems to be addressed much more efficiently and effectively, leading to even greater economic benefits.

Current Objectives and Examples of Accomplishments:

Greenhouse Gas Measurements

SERI funding is being utilized to support cross NIST efforts to develop and validate novel methodologies and procedures for remote measurement of greenhouse gas emissions. Specifically SERI funds have accomplished the following:

- Dense Networks - In collaboration with leading universities, NIST initiated a feasibility study of the performance of spatially-dense, surface observing networks for the greenhouse gases, carbon dioxide and methane, and the anthropogenic tracer, carbon monoxide, as a potential measurement methodology capable of identification and quantification of emission sources and sinks as a first step toward validation of greenhouse gas inventories locally and regionally.

- Microwave Standards – NIST scientist have recently completed the world's first free-field microwave brightness-temperature (T_B) measurements, with full measurement uncertainty analysis, on commercial microwave black-body calibration targets that are traceable to the International System of Units, and have demonstrated improved black-body target free-field reflectivity measurements on three candidate targets. These accomplishments are important steps towards realizing a full microwave emissivity measurement capability, essential to NIST's efforts to develop a full, SI-traceable T_B standard that will fill an important gap in microwave remote sensing instrument performance evaluation for use by both the airborne and satellite observing communities.

- Frequency Combs - IR Spectroscopic Source Development – Demonstrated an advanced dual frequency-comb spectrometer capable of simultaneously detecting the greenhouse gases carbon dioxide, methane, water vapor, associated atmospheric tracer gases, e.g., carbon monoxide, and many hydrocarbon pollutant gases. In addition significant advances toward combining dual frequency-comb spectroscopy with conventional laser spectroscopy as a basis for future measurement approaches useful for development of high accuracy spectral reference data have been made.

Methamphetamine Decontamination and Remediation Efforts

SERI funding was used to support NIST efforts to develop the measurements and standards necessary to support EPA's efforts to remediate homes and structures that were contaminated by illicit methamphetamine laboratories.

Major Accomplishments

- Evaluate current guidance on remediation from EPA, AIHA (American Industrial Hygiene Association) and selected states from perspectives of building science and indoor air quality, and recommend modifications to enhance current approaches to assessment and remediation.

- Determine key characteristics of buildings (i.e., building type, size and HVAC/ventilation system) being used as meth labs to support building assessment and remediation activities.

- Develop a building model using multizone airflow and contaminant transport simulation that can be used to analyze cooking and smoking source impacts on building contamination.

- Develop and critically evaluate NIST reference methamphetamine sampling and detection methodology.

- Evaluate sensitivity and specificity of selected colorimetric and immunoassay-based field test kits for methamphetamine.

- Screen existing household dust SRMs for the methamphetamine content and assign reference values. Such SRMs could serve as interim "accuracy control materials" for methamphetamine detection methods/instrumentation for the household environment.

- Evaluate current reliability and comparability of swipe analysis for methamphetamine by commercial testing laboratories by submitting swipes with known amounts of methamphetamine deposited.

Biomanufacturing

SERI Funding is being utilized to jump start NIST's ability to address inefficiencies and stimulate innovation in healthcare by addressing challenges associated with the development and manufacture of biologic drugs. To date SERI funding has been utilized to accomplish the following:

- Procured two types of instruments commonly used by the biopharmaceutical industry for characterizing protein particulates and developed competence in these measurements.

- Procured state-of-the-art ion trap mass spectrometer, developed liquid chromatographic and mass spectral expertise and new methodologies for characterizing glycosylation of therapeutic proteins, a post-translational modification found in ~3/4 of all protein products and a critical quality attribute that affects both product safety and efficacy.

- Completed procurement of an ARRA funded, ultra-high field 900 MHz Nuclear Magnetic Resonances (NMR) spectrometer. This NMR will be used to develop measurements and standards to support quantitative analysis of protein structure, function and post-translational modification that will support commercial development of protein biologics.

- Procured a SERI funded, state-of-the-art medium pressure chromatography system that will be used in conjunction with protein expression equipment/systems, rapid dialysis, and other purification equipment to increase the speed, reproducibly, and quality of in house protein (biologics) purification. This system is part of instrumentation being procured and two FTE positions being filled to establish a protein production and isotope labeling facility that will form a core capability to further development of standardized NMR and Neutron methods for analysis of protein (biologics) 3D structure.

- Procured a SERI funded, state-of-the-art temperature controlled Aqua spec infrared spectroscopy transmission cell, cell accessories, rapid scan capabilities and controlling software to upgrade our Bruker Optics Vertex 80 Fourier transform infrared spectrometer to measure and compare protein 2D and 3D structure using standardized methods to support biomanufacturing.

- Consulted with industry, FDA, other standards organizations, and biomedical community regarding the need for higher-order (3D) protein structure methods and standards to support protein biologics development and biomanufacturing.

- Established a simple phosphorus (31P) NMR based method for the detection of trace host cell protein enzyme contaminants in biologic samples that is based on the detection of dephosphorylation activity. This method has been used to detect and tentatively identify trace host cell protein contaminants in human protein biologic samples produced in transgenic plants.

- Collected and began culture and expansion of three cell lines from different biomanufacturers lines that represent different protein expression capabilities in order to characterize the performance of the lines and better understand the mechanisms that lead to more productive biomanufacturing processes.

Advanced Manufacturing

SERI funding is supporting expanded NIST work in the area of advanced manufacturing and robotics specifically targeting new work directed at developing the measurement tools to support the development of and validate robot safety standards and protocols. Specific efforts include:

- Develop infrastructure for evaluating advanced human/robot safety concepts via real/virtual testbeds. NIST will continue tests of safety sensors that detect and track humans, leading to development of test methods and characterization procedures for these sensing systems, as well as for the corresponding planning/replanning software onboard the robots. This will involve modeling and animating all components in the test bed, including the robot, vehicle, conveyors, sensors, and especially the safety system. Human avatars will also be included. The virtual sensors will be able to trigger events in the real world, and vice versa. This will provide a safe way of exploring human-robot interaction and will also provide a platform for developing communications protocols and interoperability requirements for sensors, manipulators, and safety components.

- Continue interactions on robot safety and human-robot collaboration with RIA and USCAR and expand interactions with industry. Develop a draft technical specification document (attachment to the ISO 10218-2 Standard) for Speed and Position Monitoring to support human robot interaction.

Nano-EHS

FY 2010 SERI funds were used to develop measurement tools relevant to the three most widely used ENMs in consumer and biomedical products—titanium dioxide and silver nanoparticles, and single-wall carbon nanotubes (SWCNT). Work focused on the development of methods to measure the structure (atomic to nanometer length scales) and chemistry (concentration and elemental composition) of ENMs. Specific accomplishments include:

- Release of titanium dioxide nanoparticle reference material and related measurement and dispersion protocols;

- Release of the first SWCNT reference materials, including raw soot, length-sorted populations, and "bucky paper," and development of two ISO technical specifications on SWCNT spectroscopy measurements;

- Identification of the parameters determining the stability of silver and gold nanoparticles in biological and environmental media;

- Development and demonstration of a technique to map structural and chemical changes in ENMs at atomic resolution using an ultra-high resolution electron microscope; and

- Identification of the effect of various processes, such as bio-accumulation and bio-adsorption, on the leaching of silver from consumer products in various environmental media.

Physical Infrastructure

SERI funding is supporting NIST efforts to accelerate work directed at assessing the condition of aging physical infrastructure and guide cost-effective strategies for its maintenance, repair, and replacement. Specifically NIST is developing advanced sensor technologies for high-resolution strain sensing, including microscale and full-field macroscale approaches that can be integrated with minimal impact into existing structures for real-time inspection and monitoring. These sensors, combined with NIST reference artifacts and calibration services, will provide a gold standard by which other inspection methodologies will be cross-compared. We envision a future user facility in which sensor manufacturers can perform calibration and validation testing of their products, increasing the portfolio of inspection tools available to the structural community.

8. Innovations in Measurement Science (IMS)

Program Description:

The Innovations in Measurement Science (IMS) Program provides funds to explore high-risk, leading-edge research concepts that anticipate future measurement and standards needs of industry and science. These funds are a principal mechanism for initiating the new programs and research directions necessary for NIST to keep pace with and respond quickly to the increasingly complex nature, and the shorter time frame, of technology development.

Since its inception in 1979, the IMS Program has: 1) funded over 100 research projects that have evolved into core activities within the NIST Laboratories, 2) formed the cutting edge of NIST's research programs, and 3) attracted some of the Nation's top scientific talent to NIST. Three NIST Nobel Prize winners in Physics (Dr. William Phillips, 1997, Dr. Eric Cornell, 2001, and Dr. Jan Hall, 2005) each conducted projects that were funded by the IMS Program. Other program achievements include the development of a cold-neutron small-angle scattering facility, a bold concept that ultimately led to the NIST Center for Neutron Research (NCNR), now a premier research program that attracts more than 2,000 affiliated researchers annually from industry, government, and academia.

One current research effort funded through the IMS program is addressing fundamental problems with the essential links between electrical and mechanical units from the International System of Units (SI). The calculable capacitor, a device that realizes the capacitance unit (farad) from the meter, was originally created 40 years ago after many years of research and has been used ever since. With the availability of new technologies, such as modern lasers and digital electronics, it is now possible to build the next generation of calculable capacitors with improved reliability, accessibility, and accuracy. In this project, NIST will use femtosecond laser frequency comb technology to create a new calculable capacitor that would, for the first time, realize an SI electrical unit based directly on an atomic clock. NIST's goal is for its new calculable capacitor to have measurement uncertainties roughly a factor of two lower than those of other calculable capacitors currently being developed around the world.

9. Postdoctoral Research Associateship Program

Program Description:

NIST supports a nationally competitive Postdoctoral Research Associateship Program. The NIST postdoctoral program recruits outstanding research scientists and engineers to work on NIST research projects, strengthens communications with university research, and provides a valuable mechanism for the transfer of research results from NIST to the scientific and engineering communities.

The NIST postdoctoral program is an important part of NIST's efforts to support industry through advancing measurement, standards, and technology, and represents a highly cost-effective means of technology transfer to and from NIST of the latest measurement sciences and technology. Incoming associates bring the most recent advances in university research to NIST, while actively contributing to NIST projects. The program increases technology transfer from NIST to industry, academia, and other government agencies, contributing to the employment pool of highly-qualified scientists and engineers for these sectors. 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 postdoctoral program ensures a continuing infusion of postdoctoral associates who bring to NIST the benefits of the latest academic research.

Examples of Accomplishments:

NIST postdoctoral associates carry out state-of-the-art research, which supports industry through advancing measurements, standards, and technology throughout the core programs of NIST. Each of the projects advances measurement and standards research areas in some way, but a few examples of areas of research by recent postdoctoral associates include such projects as:

- 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; and

- Investigation of the use of light-atom coupling in a Bose-Einstein condensate of charge-neutral atoms.

Priority Objectives for FY 2012:

The priority objectives for FY 2012 for the NIST postdoctoral program are to continue to recruit the best applicants for the program and to make best use of the available resources to bring on as many highly-qualified postdoctoral associates as possible. NIST scientists and engineers, acting as mentors/advisers for the program, are constantly refining and proposing new research areas in which to interest applicants. The program is a very flexible and responsive way to focus new NIST activities to address critical national priorities including those in energy, environment, information technology security, and physical infrastructure. Across all NIST laboratories, the program strongly supports the goals of the NIST Three Year Programmatic Plan. The postdoctoral program addresses NIST priorities to meet critical national needs, strengthening and focusing NIST's laboratories and research to ensure U.S. leadership in measurement science and standards in these areas.

PROGRAM CHANGES FOR FY 2012:

1. Ensuring a Secure and Robust Cyber Infrastructure (Base Funding: $28.9 million; Program Change: 67 FTE and + 43.442 million).

NIST requests an increase of $43.442 million and 67 FTE for a total of $ 72.342 million to improve the security and interoperability of our Nation's cyberspace infrastructure.

Proposed Actions: Advances in Cyberspace Infrastructure and Assurance ($43.442 million)

America relies on our digital infrastructure daily, and protecting this strategic asset is a national priority. The Administration is committed to advancing both the security of our informational infrastructure and the cutting-edge research and development necessary to meet the digital challenges of our time. NIST has a leading role in the Department of Commerce's cybersecurity and privacy initiatives, which contribute to the potential for ecommerce to foster innovation, bolster U.S. industrial competitiveness, and enhance our economic prosperity and security. NIST's efforts in this area support the recommendations of the Administration's Cyberspace Policy Review, as well as the Department's broad mandate of creating an environment that fosters business growth. Specifically, identity fraud and lack of consumer confidence in the security of business transactions in cyberspace could become a barrier to entrepreneurship, growth of innovation and development of high-growth businesses.

The request continues and expands existing efforts to improve the cybersecurity assurance posture of current and future information technologies and increase the trustworthiness of IT components such as claimed identities, data, hardware, and software for networks and devices. The current funding for cybersecurity research is insufficient to achieve the objectives of the Administration's recommendations that other Federal agencies and the general public are relying on NIST to accomplish. NIST will apply its security research standards expertise and proven ability for industry collaboration to enable organizations to improve the efficiency and effectiveness of their cybersecurity trusted credential practices and thereby work towards the Administration's goal of improving the security and interoperability of our Nation's cyberspace infrastructure.

Action 1: Scalable Cybersecurity for Emerging Technologies and Threats ($14.9 million)

The request would provide improvements to cybersecurity in support of the Comprehensive National Cybersecurity Initiative (CNCI), the Federal Information Security Management Act (FISMA), and other national priorities. The Administration has declared the cyber infrastructure a strategic asset, and the President has established a set of high-priority initiatives in the Cyberspace Policy Review. NIST will apply its security research and standards expertise to enable organizations to improve the efficiency and effectiveness of their cybersecurity practices. The request allows NIST to enable Federal agencies, industry, and others to significantly improve their cybersecurity posture. NIST will develop improved security techniques, support the creation of consensus security standards, increase the interoperability and usability of security technologies, and expedite the secure adoption of emerging information technologies. The request supports several targeted efforts to meet these objectives: cryptographic technologies and capabilities, multi-factor authentication for online use identity assurance, usability of security, security automation technologies, security measurement and modeling for dynamic large-scale systems, critical infrastructure testbed, cloud computing cybersecurity standards, and secure adoption of emerging virtual technologies.

Action 2: National Program Office for the National Strategy for Trusted Identities in Cyberspace (NSTIC) and NSTIC Grant Program ($24.5 million)

The request would support a National Program Office (NPO) within the Department of Commerce to coordinate Federal Activities needed to implement the Administration's National Strategy for Trusted Identities in Cyberspace (NSTIC), an initiative established in direct response to the recommendations of the *White House Cyberspace Policy Review* that will raise the level of trust associated with the identities of individuals, organizations, services, and devices involved in online transactions.

A crucial component of implementing the NSTIC is establishing an NPO to coordinate the execution of the national strategy. A white paper developed under the auspices of the Information & Communications Infrastructure Interagency Policy Committee (IPC) identified the following critical attributes of the NPO for the National Strategy for Trusted Identify in Cyberspace: the NPO must have the ability to meet its resource requirements and have dedicated staff at all times; the NPO must have cross-sector experience and relationships, and be able to work closely with non-Federal organizations, to include private sector entities, state, local, tribal, and territorial governments, and the international community; the NPO should maintain dedicated senior leadership; the NPO will work closely with EOP, the Federal CIO Council, the IPC, and other identified governing bodies to obtain appropriate guidance, expertise, and issue resolution; the NPO should be agile and be able to swiftly staff subject matter experts and update required skill mix; and the NPO should be multidisciplinary and maintain multiple perspectives. NIST will be responsible for day to day and overall operation of the NPO to include defining requirements, planning and tracking projects throughout their life-cycle, defining resources, ensuring effective Federal and non-Federal coordination and outreach, and providing a framework for implementing the national strategy. This request also supports pilots that will provide opportunities for incentivizing the private sector to provide leading roles in delivery of NSTIC solutions, enabling the private sector to work with state, local, and regional governments to improve acceptance of Identity Ecosystem components, and incentivizing cross-sector efforts. NIST will work with the private sector and Federal, state, and local partners to identify potential opportunities for pilots, and provide funding through grants or other funding vehicles. Of the $24.5M for NSTIC, $7.0 million will support a National Program Office and $17.5 will fund the pilot grants.

Action 3: National Initiative for Cybersecurity Education ($4.0 million)

The request supports the National Initiative for Cybersecurity Education (NICE), which expands the scope of the Comprehensive National Cybersecurity Initiative's (CNCI) Education Initiative from training the Federal workforce to a larger national education focus. NICE is responsive to the recommendations of the White House Cyberspace Policy Review. The initiative recognizes that cybersecurity is much more than technological solutions to technical problems; it is also highly dependent on educated users who are aware of and routinely employ sound practices when dealing with cyberspace. NICE will establish an operational, sustainable, and continually improving cybersecurity education program for public and private sectors focused on correct application of sound cyber practices. NIST will work with Federal, state, local, and regional governments to improve cybersecurity education. NIST will ensure coordination, cooperation, focus, public engagement, technology transfer, and sustainability of NICE. NIST will develop a cybersecurity education framework that addresses: national cybersecurity awareness; formal cybersecurity education; Federal cybersecurity workforce structure; and cybersecurity workforce training and professional development.

Statement of Need and Economic Benefits:

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 enabling more than $200 billion of e-commerce transactions in the U.S. alone for 2008, interconnected networks of computers are essential for 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. Many IT systems have a poorly implemented and maintained security configuration, hard-to-use security controls, and security postures that 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. Achieving cybersecurity in the context of today's extensively networked information systems remains an elusive goal. The proliferation of security technologies targeting single applications combined with users that are inadequately educated in cybersecurity best practices makes the protection of cyber identities a significant challenge.

The Nation's dependence on information technologies continues to deepen quickly, and cybersecurity efforts must expand accordingly to keep pace. Failure to increase investment in cybersecurity research and standards activities will delay progress in mitigating existing cybersecurity threats and leave the U.S. even more vulnerable to future threats. The result is a continued increase of loss of data (personal and non-personal) and further expansion in the gap between attackers' capabilities and defenders' ability to prevent attacks from succeeding and limit the impact of those attacks that do succeed, allowing much greater negative impacts to occur to U.S. organizations and individuals. Delays in conducting this work will also delay corresponding improvements in the efficiency of cybersecurity operations, thus wasting significant resources at a cost much higher than the cost to develop these improvements.

The Nation's ever-increasing reliance on the Internet for conducting transactions, providing services, and supporting national initiatives, such as smart grid and virtualization of energy management, is directly tied to the development of initiatives that strengthen the reliability and veracity of electronic commerce and authenticity of users, both individual and organizational. Through the funding of these initiatives, NIST can support the research and development that will improve the security, availability, and confidence of the Nation's cyberspace infrastructure. Failure to invest in research, the development of standards, and improvement of cybersecurity awareness outreach will continue to leave the Federal government service providers, consumers, and private service providers vulnerable to the ever-increasing cyber attacks that will ultimately result in damaging the national critical infrastructure.

Base Resource Assessment:

NIST collaborates with industry, consortia, and other Federal agencies to resolve critical cybersecurity issues for the Nation's cyber infrastructure. NIST's activities in support of cybersecurity cover the full range of the research lifecycle, from conducting fundamental research, such as improved techniques for measuring elements of security, to disseminating the results of that research in many forms. This includes the following:

- Developing and reviewing standards, and coordinating the development of large sets of standards.

- Writing guidelines on securing technologies for agencies and other organizations to follow.
- Developing tools, tests, and testbeds for evaluating cybersecurity technologies and the security of emerging information technologies.
- Establishing validation programs to confirm the proper implementation of standards in IT products and services.
- Conducting outreach to make the cybersecurity and IT communities aware of NIST activities and outputs.

NIST has a proven track record in the research and development of standards and guidance for data protection, security automation, identity management, and IT security. Critical to cybersecurity research is improving the protection of data and identity information and NIST has extensive expertise in the development of related standards. NIST has a leading role in the Department of Commerce program of cybersecurity and privacy initiatives that support realizing the potential for ecommerce to foster innovation, bolster U.S. industrial competitiveness, and enhance our economic prosperity and security. NIST is responsible for the development of Federal cryptographic standards for unclassified IT systems. The cornerstone cryptographic publication produced by NIST, *Federal Information Processing Standard 140-2, Security Requirements for Cryptographic Modules*, is globally recognized and used and sets the gold standard by which cryptographic module evaluations are conducted worldwide. NIST led the development of and authored standards in support of Homeland Presidential Directive 12, *Federal Information Processing Standard 201-2, Personal Identity Verification (PIV).* HSPD-12 mandated the use of secure identity credentials for all Federal government employees and certain contractors. To date, over three million FIPS 201-PIV credentials have been issued, with significant consequent adoption of the standard occurring at the state and local level to meet regional cybersecurity and identity management requirements, a testimonial that the NIST work in cybersecurity is addressing real national needs.

Schedule & Milestones:

Action 1: Scalable Cybersecurity for Emerging Technologies and Threats ($14.9 million)

- FY 2012-FY 2013: Develop and publish security management content with links to FISMA requirements.
- FY 2012-FY 2013: Facilitate development of and access to initial suites of cloud standards and reference implementations.
- FY 2012-FY 2014: Establish lower-end IT product assurance capabilities.
- FY 2012-FY 2014: Conduct research into the security and interoperability of cloud architectures, and establish best practice recommendations.
- FY 2012-FY 2016: Create security management and security event management automation protocols, specifications, and standards.
- FY 2012-FY 2016: Evaluate existing higher-end IT product assurance capabilities and rework them to better meet consumer needs.
- FY 2014-FY 2016: Facilitate development of and access to comprehensive suites of cloud standards and reference implementations.

Action 2: National Program Office for the National Strategy for Trusted Identities in Cyberspace (NSTIC) and NSTIC Grant Program ($24.5 million)

- FY 2012-FY 2013: Conduct research into existing identity management schemes and publish gap analysis and recommendations.
- FY 2012-FY 2013: Develop, in collaboration with stakeholders, a standards roadmap for credential issuers, relying parties, and services providers.

- FY 2012-FY 2014: Conduct RFI for pilots based on private sector input gathered from workshops, and develop proposal requests and selection criteria. The actual number of pilots conducted will be influenced by the focus areas of the pilot, the number of responses to request for proposals, the complexity of the responses, and lessons learned from preceding pilots. Pilots will be scalable, with a migration path to a large-scale deployment and implementation. Pilots will initially be conducted collaboratively between the Federal Government and private industry but ultimately should not require Federal Government operational support for sustainability. Pilots will be assessed for migration to a live system and/or provide lessons learned that will improve the adoption, security, resilience, usability, interoperability and other Identity Ecosystem objectives. Pilot duration will be defined to align with the Strategy goals and objectives. Some examples of what pilots could achieve include:
    - Enabling the user to have one credential that can be used by several service providers. Currently users have several passwords for each of the various online transactions they conduct. By using relying parties and other components that meet the Identity Ecosystem requirements, a user will no longer be required to maintain dozens of passwords, for both public and private use.
    - Promoting two-factor authentication at different risk levels. Different kinds of hard tokens have been developed in the marketplace and a pilot could explore areas to determine the right tokens for different types of users (e.g., online access to records or services where government employees, parties and beneficiaries and the general public all need different levels of access). Pilots that test different types of issuance, including some type of in person proofing, would be desirable.
    - Improving privacy and protection of data by demonstrating mechanisms that enable a user to authorize the secondary use or disclosure of personally identifiable information or limit collection of transactional information.
    - Creating model trust frameworks that improve interoperability and could help put relying parties (corporate and governmental) and users on equal footing in the marketplace.
    - Improving the security and interoperability of credentials through the use or creation of technology solutions based on private sector offerings that align with the goals and objectives of the Strategy.
    - Improving the resilience of data breach recovery through the use of digital credentials that are created through known and trusted processes used by the Identity Ecosystem.
- FY 2013-FY 2014: Develop metrics for determining if pilots will be migrated to a live system or provide publications for lessons learned to improve security, usability, interoperability, and other NSTIC Goals and Objectives.
- FY 2012-FY 2014: Conduct research and perform needs assessment for usability of identity credentials. Publish findings and recommendations.
- FY 2014-FY 2016: Enable the user to have one credential that can be used by several service providers. Create options for multi-factor authentication to eliminate the need of multiple passwords. Create standards for multi-factor authentication mechanisms.
- FY 2014-FY 2016: Create security and privacy enhancing mechanisms that enable a user to authorize the secondary use or disclosure of personally identifiable information (PII) and limit the collection and retention of PII to that which is minimally necessary to conduct transactions.
- FY 2013-FY 2016: Establish metrics for measuring the effectiveness of digital credentials.
- FY 2012-FY 2014: Develop outreach program for consumers, relying parties, and service providers and build from the National Initiative for Cybersecurity Education.

Action 3: National Initiative for Cybersecurity Education ($4 million)

- FY 2011-FY 2012: Develop, in collaboration with USG and industry partners, a strategic plan to guide future NICE activities.
- FY 2011-FY 2012: Deploy a web-based portal as a tool for community engagement as a mechanism for transparent open communications and community input, including best practices.
- FY 2011-FY 2012: Identify overlaps, gaps, and points of mutual support and leverage in current cybersecurity education; communicate findings from the evaluation; and encourage innovative approaches to address issues.
- FY 2011-FY 2012: Develop and implement a comprehensive communications plan to ensure consistency and accuracy of the message(s) that NICE provides in all activities.
- FY 2011-FY 2013: Identify cyber-risks, in collaboration with USG and industry partners and determine where effective cybersecurity education, training, and awareness will have the most impact.
- FY 2012-FY 2016: Develop, report, and track measurements and metrics assessing effectiveness of cybersecurity education, training, and awareness, in collaboration with USG and industry partners.
- FY 2011-FY 2016: Connect NICE activities with other related national initiatives and programs such as Science, Technology, Engineering, and Mathematics (STEM) education, Scholarships for Service, and the National Centers of Academic Excellence in IA Education (CAE/IAE) and CAE-Research (CAE-R) programs.
- FY 2012-FY 2016: Develop cybersecurity education, training, and awareness business cases that promote U.S. competitiveness in the global marketplace, by strengthening and safeguarding the Nation's cybersecurity infrastructure; keep America competitive with cutting-edge science and technology and an unrivaled cybersecurity information base; and ensure sustainable economic opportunities.

Deliverables:

Action 1: Scalable Cybersecurity for Emerging Technologies and Threats ($14.9 million)

- Specifications and standards for security management automation, product assurance, and cloud computing security and interoperability
- Guidelines on secure implementation of information technologies such as cloud computing, and guides on sound practices for using cybersecurity technologies (for example, security automation technologies)
- Validation programs for IT product assurance
- Conferences and workshops on security automation and product assurance
- Web presence that provides global sharing of cloud computing security and interoperability standards and reference implementations

Action 2: National Program Office for the National Strategy for Trusted Identities in Cyberspace (NSTIC) and NSTIC Grant Program ($24.5 million)

- Gap analysis on availability of existing identity management schemes and recommendations
- Improved security and interoperability of identity credentials
- Pilot demonstrations
- Conferences and workshops
- Guidelines on metrics for determining if pilots will be migrated to a live system
- Publications on pilots and lessons learned
- Needs Assessment
- Improved privacy and protection of data
- Trust frameworks

- Improved data breach recovery
- Conference and workshops
- Web presence that provides global sharing of information, recommendations, and potential reference implementations

Action 3: National Initiative for Cybersecurity Education ($4.0 million)

- Cybersecurity Education Strategic Plan
- Business Cases
- Web-based Cybersecurity Education Portal
    - o Cybersecurity Education Reporting Tools
    - o Cybersecurity Education Feedback Tools
- Conferences and workshops on cybersecurity education

Performance Goals and Measurement Data:

Action 1: Scalable Cybersecurity for Emerging Technologies and Threats ($14.9 million)

Performance Goal: Publications	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With increase	0	2	2	2	2	2
Without increase	0	1	0	1	0	1
Description	Number of new security automation specifications released each year (protocols, standards, etc.)					

Performance Goal: Validations	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With increase	50	110	170	230	290	350
Without increase	50	60	70	80	90	100
Description	Number of product validations granted each year for compliance with NIST security automation specifications					

Performance Goal: Cybersecurity assurance publications	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With increase	0	1	3	3	3	3
Without increase	0	0	1	0	1	1
Description	Number of standards and guidelines published each year for cybersecurity product assurance					

Performance Goal: Cloud computing Cybersecurity publications	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With increase	1	3	3	3	3	3
Without increase	1	1	1	1	1	1
Description	Number of standards and guidelines published each year for cloud computing security					

Action 2: National Program Office for the National Strategy for Trusted Identities in Cyberspace (NSTIC) and NSTIC Grant Program ($24.5 million)

Performance Goal: Publications	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With increase	0	5	10	12	10	12
Without increase	0	1	1	1	1	1
Description: Number of new related publications in the form of standards, frameworks, guidelines, interagency reports, consumer outreach, and gap analyses.						

Performance Goal: Pilots	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With increase	0	3-5	3-5	3-5	0	0
Without increase	0	0	0	0	0	0
Description: Minimum number of pilots conducted for trusted identity credentials.						

Performance Goal: Metrics and usability standards	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With increase	0	1	2	2	2	2
Without increase	0	0	1	1	1	1
Description: Number of new publications on metrics and usability standards for NSTIC.						

Action 3: National Initiative for Cybersecurity Education ($4.0 million)

Performance Goal: Number of new cybersecurity education business cases	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With increase	0	2	1	1	1	1
Without increase	0	0	0	0	0	0

Performance Goal: Number of cybersecurity education conferences or workshops	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With increase	2	2	3	4	4	4
Without increase	1	1	1	1	1	1

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amount in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Chief, Cybersecurity Advisor	Gaithersburg, MD	ZP V	2	$123,758	$247,516
Computer Scientist	Gaithersburg, MD	ZP V	4	123,758	495,032
Computer scientist	Gaithersburg, MD	ZP V	3	123,758	371,274
Engineer	Gaithersburg, MD	ZP V	2	123,758	247,516
IT Specialist	Gaithersburg, MD	ZP V	4	123,758	495,032
NICE Lead	Gaithersburg, MD	ZP V	1	123,758	123,758
NPO Collaboration Coordinator	Gaithersburg, MD	ZP V	1	123,758	123,758
NPO Identity Ecosystem Development/Technology Coordinator	Gaithersburg, MD	ZP V	1	123,758	123,758
NPO Privacy Civil Liberties Coordinator/Senior Privacy Advisor	Gaithersburg, MD	ZP V	1	123,758	123,758
NPO Program Manager	Gaithersburg, MD	ZP V	1	123,758	123,758
NPO Strategic Policy Advisor/Deputy Program Manager	Gaithersburg, MD	ZP V	1	123,758	123,758
NPO Support Resource Coordinator	Gaithersburg, MD	ZP V	1	123,758	123,758
NSTIC Standards Framework Lead	Gaithersburg, MD	ZP V	1	123,758	123,758
Pilot Project Manager	Gaithersburg, MD	ZP V	1	123,758	123,758
Privacy Policy Expert	Gaithersburg, MD	ZP V	1	123,758	123,758
Senior Policy Analyst	Gaithersburg, MD	ZP V	1	123,758	123,758
Statistics and Performance Metrics Experts	Gaithersburg, MD	ZP V	1	123,758	123,758
Track Liaison	Gaithersburg, MD	ZP V	2	123,758	247,516
Computer Scientist	Gaithersburg, MD	ZP IV	9	105,211	946,899
Computer scientist	Gaithersburg, MD	ZP IV	4	105,211	420,844
Electrical engineer	Gaithersburg, MD	ZP IV	2	105,211	210,422
Information Technologist	Gaithersburg, MD	ZP IV	1	105,211	105,211
Information technology specialist	Gaithersburg, MD	ZP IV	3	105,211	315,633
IT Specialist	Gaithersburg, MD	ZP IV	8	105,211	841,688
Mathematician	Gaithersburg, MD	ZP IV	2	105,211	210,422
Mathematician	Gaithersburg, MD	ZP IV	1	105,211	105,211

NPO Communications and Outreach Coordinator	Gaithersburg, MD	ZP IV	1	105,211	105,211
NSTIC Pilot Coordination	Gaithersburg, MD	ZP IV	1	105,211	105,211
Physicist	Gaithersburg, MD	ZP IV	1	105,211	105,211
Privacy and Security Analyst	Gaithersburg, MD	ZP IV	1	105,211	105,211
Technology Support	Gaithersburg, MD	ZP IV	1	105,211	105,211
Track Liaison	Gaithersburg, MD	ZP IV	2	105,211	210,422
Usability Expert	Gaithersburg, MD	ZP IV	1	105,211	105,211
Administrative Support	Gaithersburg, MD	ZA III	1	74,872	74,872
Computer scientist	Gaithersburg, MD	ZP III	4	74,872	299,488
Electrical engineer	Gaithersburg, MD	ZP III	2	74,872	149,744
Information technology specialist	Gaithersburg, MD	ZP III	3	74,872	224,616
Mathematician	Gaithersburg, MD	ZP III	2	74,872	149,744
Web Content Manager	Gaithersburg, MD	ZA III	1	74,872	74,872
Administrative/technical support	Gaithersburg, MD	ZA II	9	51,630	464,670
Total			89		9,025,006
Less Lapse		25%	(22)		(2,256,252)
Total full-time permanent (FTE)			67		6,768,755
2011 Pay Adjustment (0.0%)					0
2012 Pay Adjustment 0.0%)					0
TOTAL					6,768,755

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	67
Other than full-time permanent	0
Total	67
Authorized Positions:	
Full-time permanent	89
Other than full-time permanent	0
Total	89

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

	Object Class	2012 Increase
11	Personnel compensation	
11.1	Full-time permanent	$6,769
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	6,769
12	Civilian personnel benefits	1,862
13	Benefits for former personnel	0
21	Travel and transportation of persons	735
22	Transportation of things	11
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	1,771
24	Printing and reproduction	21
25.1	Advisory and assistance services	0
25.2	Other services	862
25.3	Purchases of goods & services from Gov't accounts	616
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	8,718
25.6	Medical care	0
25.7	Operation and maintenance of equipment	0
25.8	Subsistence and support of persons	0
26	Supplies and materials	264
31	Equipment	467
32	Lands and structures	468
33	Investments and loans	300
41	Grants, subsidies and contributions	21,834
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Direct obligations	44,698
	Transfer to the Working Capital Fund	1,302
	Total obligations	46,000
	Less administrative savings	(2,558)
	Total request	43,442

2. Interoperability Standards for Emerging Technologies (Base Funding: $11.202 million; Program Change: + 69 FTE and + $ 22.835 million).

NIST requests an increase of $22.835 million and 69 FTE for a total of $34.04 million to catalyze the development of standards and conformity assessment systems and associated architectural frameworks for emerging technologies that address national priorities such as Smart Grid, Healthcare Information Technology (Health IT) and Cloud Computing (CC).

This initiative supports the following goals and priorities:

- Providing the measurement tools and standards to enable innovation and enhance efficiency, a major objective outlined in the *U.S. Department of Commerce's Strategic Plan: FY 2011–2016*. This plan specifically directs NIST to develop interoperability standards for Smart Grid and Health IT so that industry has "confidence to invest in these new technologies by broadening the market and decreasing the limitations inherent in legacy systems".
- 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) 2007.
- Accelerating the deployment of electronic health records by providing expertise on Health IT implementations and the establishment of voluntary certification programs, and by performing pilot testing of standards and implementation specifications, as requested.
- Enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly set-up and made available with minimal management effort of service provider interaction.

Proposed Actions:

Specific actions, goals and objectives for this initiative are:

For Smart Grid ($9.134 million):
The proposed initiative will fund three critical areas of the NIST Smart Grid Program:

- **Architecture and Standards** – Created by NIST, the Smart Grid Interoperability Panel (SGIP) is a public/private partnership that provides an open process for Smart Grid stakeholders to participate in providing input and cooperating with NIST in the ongoing coordination, acceleration and harmonization of Smart Grid interoperability standards. Additional funding is required in order to manage the SGIP and accelerate the development of Smart Grid interoperability standards. As additional standards work is initiated for battery storage and other renewable distributed energy sources and new Smart Grid use cases are developed, additional resources will be required to manage and expedite the SGIP's activities to ensure interoperability standards are developed and coordinated.

- **Testing and Certification**– In addition to the underlying standards and measurement science, testing and certification of how standards are implemented in Smart Grid devices, systems, and processes are also essential to ensure interoperability and security under realistic operating conditions. As part of this proposed program, NIST, in consultation with industry, government, and other stakeholders, will require funds to implement a testing and certification framework that industry can use to ensure the interoperability and prevent the obsolescence of Smart Grid products that are currently in development.

- **Supporting Research** - The development of standards alone will not ensure a reliable and secure Smart Grid. Also required is the supporting measurement science necessary to develop and support the development of new Smart Grid products and devices. Increased funding will allow NIST to develop critical measurement tools in areas such as electric utility industry measurement, advanced network technology, industrial controls and interfaces, building and electrical infrastructure, and computer and network security. The research would also begin to examine the extension of the information infrastructure for the Smart Grid to apply intelligence and interoperate with other infrastructures, such as energy efficient smart buildings, gas, water and transportation systems.

<u>Health IT ($9.134 million):</u>

For Health IT, NIST's primary goals are:

- **Support the Accelerated Development and Harmonization of Standards** - Health IT includes deployment of a nationwide network and interoperable electronic health records (EHRs), through which a consumer's legal medical record will be available anywhere, anytime, but only to those authorized to access it. NIST will enable the acceleration of industry-led, consensus-based standards development and harmonization to help ensure that the full set of necessary basic query and retrieval functions, including security and privacy provisions, for clinical information exist. NIST will also advance other selected health IT technology standards as appropriate. Work will be done in collaboration with relevant SDOs, Federal agencies, professional societies, and industry. In collaboration with SDOs , standards harmonization bodies, and other interested parties, NIST will enable fully defined standards with implementation specifications for key infrastructure functions (e.g., securely find patients; discover patient information; retrieve patient information; send patient information; allow for pushing of information, e.g., lab results; quality measures).Through collaborations, NIST will develop a model-based, processable representation approach to define key infrastructure functions; moving standards definitions away from natural language format. NIST will continue to mature key infrastructure standards, while incorporating lessons learned from early adopters and will continue to adopt standards to evolving use cases. In collaboration with the Office of the National Coordinator for Health IT and others, NIST will ensure that harmonized standards are effectively represented in certification criteria, providing standards expertise to the criteria development process to help ensure that appropriate standards are chosen for a given purpose.

- **Create a Health IT Testing Infrastructure** - During the standards development and harmonization process, appropriate test tools and procedures can determine and provide feedback on ambiguities and gaps. Similarly, these test tools can guide the content of complete, user-friendly implementation guidelines. Once the recognized standards for health IT are implemented, a system to perform conformance testing and certification is necessary to:
  - ensure that the standards are implemented consistently, and
  - provide technology developers and buyers with independent measurements to judge system and software performance, thereby accelerating technology deployment.

NIST will collaborate with industry and others to ensure that a testing infrastructure is created. This testing infrastructure is modular by design and implementation. As additional standards are recognized, appropriate test tools can be developed, using the same infrastructure. Specifically, through industry collaboration, NIST will develop a virtual, scalable, testing infrastructure to meet the testing needs of health IT standards-based product developers, implementers of health IT systems, and related certification bodies. NIST will work with SDOs and other interested entities to determine the testing priority areas, to help define testing artifacts and measurement techniques, and to build the tools to support them. NIST will develop testing artifacts for validating implementation of health IT-related security specifications within the testing infrastructure. Baseline security configurations for common health IT platforms will be determined.

- **Support the Usability of Health IT technologies** - A lack of usability in the health IT environment will significantly impede adoption and use of health IT technologies. Systems with poor usability lead to critical errors that severely impact patient health and have other negative consequences. To address this, NIST will apply usability principles to improve electronic health record (EHR) workflow and personal health record (PHR) use. NIST will conduct research into usability and accessibility of health IT technology interfaces through collaboration on usability standards development in the healthcare domain, enabling the incorporation of usability requirements in the continuum from product design to certification. Methods to quantitatively measure usability and validate usability conformance will be researched and relevant test methods developed. NIST will collaborate with interested entities to identify and remove barriers that prevent people with disabilities from being able to use health IT. The scope of this effort is expected to extend beyond electronic health records to include other software, hardware, web portals, and other technologies.

- **Address Health Care Delivery Beyond Traditional Physical Locations** - There is an ever-growing need to provide remote and home healthcare for aging, underserved (e.g., rural), and chronically ill populations, which can be facilitated by leveraging existing and emerging health IT standards and testing. Telemedicine includes capabilities where wellness checkups and monitoring, diagnoses, and treatment can occur anyplace and anytime. Pervasive healthcare explores the use of emerging technologies such as body sensors, implants, and medical equipment for routine monitoring of chronic conditions. NIST will collaborate with industry to ensure that these technologies can be integrated into the nationwide healthcare infrastructure. Emerging technologies for telemedicine and healthcare delivery beyond traditional physical locations, including image quality, home health devices and personal health records will be researched.

- **Perform Cutting Edge research on Related Emerging Technologies, and Apply New Technologies to the Healthcare Domain** - The knowledge-base of the healthcare enterprise is increasing rapidly, and new technologies are constantly emerging. In many of these emerging technologies NIST is performing basic research that has immediate and potentially high impact applications in healthcare. NIST core competencies will be applied to expand research in these areas, in support of the goals of the health IT mandate, with specific attention to interoperability, reliability, robustness, security, and usability issues. Emerging technologies for pervasive healthcare and the application of new information technologies to the healthcare domain, particularly in utilizing radio and other wireless technologies to transfer medical, physiological, and control information between sensors, devices, and networks, will be researched. NIST will develop collaborations that will enable the development of standardized interfaces for connecting new healthcare devices to the U.S. healthcare infrastructure. Emerging technologies for personalized medicine will be researched. NIST will also research emerging technologies for addressing semantic interoperability in the healthcare domain, such as semantic consistency enforcement and semantic translation techniques for health IT.

Cloud Computing ($4.567 million):

For Cloud Computing, NIST's goals, objectives and associated proposed actions are to:

- **Develop a Comprehensive Strategy for Cloud Computing** – The efforts to develop a comprehensive strategy will include three objectives:

  - **Define USG Cloud Computing Business Use Cases** -NIST will lead interested USG agencies and industry to define target USG Cloud Computing business use cases (set of candidate deployments to be used as examples) for Cloud Computing model options, to identify specific risks, concerns and constraints. For example, a candidate deployment might be employee email or migration of a specific application system to a specific cloud computing model option. NIST will lead and facilitate this effort via the Federal CIO Council sponsored Cloud Computing Standards Working Group. A complete initial set of business use cases will be identified and developed to allow focus on tangible, high priority requirements.

  - **Define Cloud Computing Reference Architecture and Taxonomy** - NIST will lead interested USG agencies and industry to define a neutral cloud computing reference architecture and taxonomy to extend the NIST cloud computing model, to use as a frame of reference to facilitate communication, and to illustrate and understand various cloud services in the context of an overall Cloud Computing Model. NIST will lead and facilitate through open public stakeholder meetings, and working groups created through an open public invitation process. NIST will expand the NIST Cloud Computing Definition and develop a consistent reference architecture and taxonomy as public domain deliverables, which may correlate to, but not necessarily include or explicitly reference more detailed industry, SDO and other specific architecture and service reference implementations.

  - **Complete Cloud Computing Roadmap** - NIST will lead interested USG agencies and industry in the development of a Cloud Computing Roadmap by matching requirements from USG-based business use cases to the reference architecture & taxonomy components that address them. This process will identify technical issues leading to:
    - application of industry expertise,
    - further identification of necessary standards, policies, need for additional R&D,prototyping or piloting, governance, cost drivers,
    - leveraging of information for broad CIO community, and
    - iteratively send business use case alternatives or reference model questions to working groups.

- **Enable Broad Adoption of Cloud Computing** – The four objectives in support of this goal include:

  - **Development of Special Publications** - NIST will continue to develop a necessary set of Special Publications to spur adoption of Cloud Computing. These include general cloud computing guidance and periodic revisions, and cloud computing consumer and service provider "Roles and Responsibility" in response to GAO recommendations. Additional publications which relate to cloud computing and address issues unique to cloud such as interdependencies, quality of service, resource congestion, service level agreements, architectural and transition strategies will be considered. Specific security issues such as forensics, incident handling, electronic discovery, privacy and personally identifiable information, monitoring, and controls may also be considered. Special publication priorities will be identified in the Roadmap.

  - **Development of the Standards Acceleration to Jumpstart the Adoption of Cloud Computing (SAJACC)** - NIST will initially host a SAJACC portal populated with generic technical interoperability and portability use cases. These use cases will be vetted by cloud computing stakeholders in academia, government, and industry. After the use cases are refined, and published on the portal, candidate legacy cloud system interfaces, along with their reference implementations will be identified for validation against the use cases. The process of identifying new interfaces (with corresponding reference implementations) and new use cases will be ongoing.

  - **Cloud Computing Conformance Test System** - NIST will continue support of the Federal CIO Council, potentially in development of a Cloud Computing conformance test system. This plan will be revised to reflect this additional scope as it is defined.

  - **Modeling and Analysis of Complex Behaviors in Cloud Computing** - NIST will continue research into the modeling and analysis of complex behaviors in cloud computing. This project seeks to understand and predict behavior in large distributed information systems by using mathematical and statistical techniques applied by scientists to study physical systems. NIST has chosen specific cloud computing challenge problems to investigate in order to evaluate the methods.

Statement of Need and Economic Benefits:

Lack of standards that allow interoperability within and between cross-cutting technologies such as Smart Grid, Health IT, and CC 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.

Specific examples of the magnitude of this problem are evident in the drivers for interoperability in Smart Grid, Health IT, and CC.

The U.S. healthcare industry lacks a comprehensive nationwide information infrastructure. Healthcare is a large part of our economy, accounting for $1 out of every $6 spent in the U.S. The U.S. spends more money per capita ($5.7K) per year on healthcare than any other country, but ranks 24th in life expectancy.[4] Adults get, on average, only 55 percent of the recommended care for many common conditions.[5] Reports suggest that cost, quality, and availability are the main causes of inadequate care. The expanded use of health information technologies, the comprehensive management of health information and its secure exchange, is a key component of improving this situation.[6] Today's healthcare industry lags behind other fields in the use of information technology – for example, only 13 percent of doctors use any form of electronic health records. It is estimated that only 1.5 percent of U.S. hospitals have a comprehensive electronic-records system, and an additional 7.6 percent of U.S. hospitals have a basic system.[7] 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. Given these statistics, progress in achieving interoperability of electronic health records will have a significant impact. The Healthcare Information and Management Systems Society (HIMSS) stated in April 2009 that "lives can be saved, outcomes of care improved, and costs reduced by transforming the healthcare system through the appropriate use of information technology."

Similarly, in the deployment of a Smart Grid, we need to contend with an electrical grid that consists of more than 9000 power generation plants that are connected to more than 300,000 miles of transmission lines supplying electricity to residential and business consumers all over the country. 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 providing consumers the greatest economic benefit, while also helping achieve the goals of minimizing energy consumption. Investments in the development and acceleration of Smart Grid standards will reduce our dependence upon and vulnerability to foreign oil, and threats to the Nation's electrical grid, while improving cyber security of the grid, and grid reliability. It will also enable the development and deployment of electrical vehicles. All these factors will directly contribute to the development of U.S. jobs. Major appliance manufacturers such as Whirlpool Corporation and GE have publicly announced plans for introduction of smart appliances, and have indicated the lack of interoperability standards as the greatest risk to their plans. Thus, interoperability and seamless communication flow between these different components and systems is essential.

CC is a new paradigm in information technology and offers the promise of massive cost savings combined with increased IT agility. While definite numbers of the CC market are hard to determine, worldwide spending on cloud services in 2009 are estimated to surpass $54 billion[8]. The overall market for cloud services has been estimated to be about $150 billion in 2013.

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

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

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

[7] Jha AK, DesRoches CM, Campbell EG, et al. Use of electronic health records in U.S. hospitals. N Engl J Med 2009;360:1628-1638.

[8] http://www.information-age.com/channels/data-centre-and-it-infrastructure/perspectives-and-trends/1017852/cloud-computing-spending-leaps-21.thtml

The Federal government is keenly interested in adoption of CC models because the numerous benefits that CC provides including economic benefits through reduced duplication of systems, greater utilization of existing system, reduced infrastructure costs, reduced or minimal maintenance costs, etc. It is estimated that the Federal government CC market grows at about 40 percent CAGR, with annual spending estimated to reach $7 billion by 2015. Similarly, there is growing adoption and use of CC by the average citizen – whether in the form of web-based email services or web-based word processing tools, or accessing the internet through smartphones. CC is currently in fairly early stages of development and deployment with numerous service providers offering CC solutions that are either proprietary in nature, or are often not interoperable with other clouds. Interoperability standards and conformity assessment systems will help spur greater adoption and use of clouds, and consequently greater technological innovation by eliminating barriers to interoperability.

The common NIST role in these three areas—Smart Grid, Health IT, and CC—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:

- Terminology and definitions
- Roadmap identifying existing standards, standards gaps, conformity assessment requirements, etc.
- Identify technical requirements for standards that enable interoperability
- Work with standards and specification developers to catalyze timely development of standards and specifications that are of high quality, efficacy, and applicability
- Work with stakeholders, including regulators to develop required suites of testing protocols and conformity assessment methodologies.

Base Resource Assessment:

In the three specific technology sectors that will be covered by this initiative, NIST has made strong progress in leading the development of standards and/or conformity assessment systems and architectures. Details for each of the technology sectors follow:

<u>For Smart Grid</u>:

The Energy Independence and Security Act tasked NIST to coordinate the development of these standards, working with the private sector and other Federal agencies. Developing the standards framework for the smart grid presented a significant challenge due to the very large number of stakeholders - over 3100 electric utilities in the U.S., hundreds of suppliers, at least 27 different standards developing organizations that produce specifications relevant to the Smart Grid, state and local government level regulations, etc. NIST has successfully engaged these diverse stakeholders in a collaborative, fast track process that has produced a "Release 1.0" standards framework and established a permanent public/private partnership to support its ongoing development.

In April 2009, NIST laid out a multi- phase plan for its work. The first phase was completed in January of 2010 with the publication of the *NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0*, which took nine months, including a three month public comment period. The effort to produce it was initiated with a meeting at the White House in May 2009 where the Secretaries of Commerce and Energy engaged in a dialog with nearly 70 industry CEOs and senior executives to obtain their commitment to support the NIST program. In the ensuing months, NIST engaged over 1500 individuals representing hundreds of companies in developing Release 1.0 of the standards framework. It describes an architectural reference model for the Smart Grid which is now unifying industry efforts. It identifies 75 initial standards that provide a foundation for the ongoing development of the Smart Grid. It also identifies 15 high-priority gaps and harmonization issues for which new or revised standards are needed, and documents action plans with aggressive timelines by which designated standards-setting organizations (SSOs) are addressing these gaps. Release 1.0 also documents a cyber security strategy and requirements for the Smart Grid.

The second phase of the NIST program has put in place a permanent public/private partnership called the Smart Grid Interoperability Panel (SGIP) to support NIST in the ongoing development and refinement of the standards framework. The panel's members include electric utilities, manufacturers, associations, Federal and state agencies, universities and standards developers representing the diverse stakeholders in the Smart Grid. NIST formally launched the SGIP in November of 2009, and its membership already numbers over 600 private and public sector organizations and nearly 1800 registered participants representing these organizations.

Further, NIST is supporting research programs in Smart Grid in order to further accelerate development of SG standards and Technology. NIST is utilizing ARRA dollars to fund close to $5M of programs in 2010—2011 ranging from AMI security testing, phasor measurement performance test development, to AMI data usage standards development and common electricity pricing models.

For Health IT:

The Administration and Congress have made improving the healthcare information infrastructure a national priority and are committed to the adoption of Electronic Health Records (EHRs) and building a standards-based, secure, and interoperable nationwide healthcare information network, an enormous challenge. Noting in his inaugural address the high cost of health care, and the potential of IT to reduce the cost, while improving the quality of care, the President challenged the Nation to have Electronic Health Records and a nationwide health network by 2014. In addition, Congress included the Health Information Technology for Economic and Clinical Health (HITECH) Act mandates in the American Recovery and Reinvestment Act (ARRA), articulating numerous new and expanded health IT initiatives.

NIST's activities to-date have been critical to the standards development and harmonization process in that NIST has helped ensure that the requisite infrastructural standards are transparent and available regardless of application. NIST has also focused its efforts to help ensure that recognized standards are complete and unambiguous, often not the case today. Also, NIST expertise is continuing to ensure that the standards are further constrained and defined through detailed implementation guidelines reducing confusion during the implantation of the standard. NIST has played the lead role in developing test tools and a testing infrastructure, without which it would be impossible to determine whether or not the standards are implemented correctly, in ways that promote interoperability and usability. NIST testing activities reduce the cost to develop health IT systems by providing developers with an innovative, flexible and virtual test-bed to confirm that their systems can exchange clinical information with other systems. Without NIST's activities in this sector, interoperability, usability and security of health IT would be in jeopardy. Without these critical criteria, the EHR market will continue to move at a glacial pace, which in turn may have a detrimental and a lasting effect on medical research and public health, as the secondary uses of the data would be hampered by the inability to mine the data from interoperable EHRs.

For Cloud Computing:

NIST's efforts in accelerating standards development for CC have been focused on laying the foundation for the long term goal of providing thought leadership and guidance around the cloud computing paradigm to catalyze its use within industry and government. NIST aims to shorten the adoption cycle, which will enable near-term cost savings and increased ability to quickly create and deploy enterprise applications. NIST's efforts have been to foster cloud computing systems and practices that support interoperability and portability requirements that are appropriate and achievable for important usage scenarios.

NIST initiated this effort in FY10 through dissemination of the NIST Cloud Computing Definition and serving the role of Technical Advisor to the Federal Chief Information Officers' (CIO) Council. Clear high priorities relating to leading and facilitating the development of Cloud Computing standards, particularly to address interoperability, portability and address the risk of "vendor lock-in" to a particular cloud service provider solution, have been identified. In May 2010, NIST hosted a public Cloud Computing Forum and Workshop to initiate broader dialogue with standards developers, industry, and government stakeholders. NIST introduced the Standards Acceleration to Jumpstart the Adoption of Cloud Computing (SAJACC) strategy, process and portal. SAJACC supports cloud computing adoption in the interim period between the emergence of cloud computing technology and the point where portability and interoperability standards are formalized and implemented. The event also presented information on the Federal Risk and Authorization Management Program (FedRAMP) and the ongoing development of one in a series of NIST Special Publications related to Cloud Computing (e.g. SP 800-125 on virtualization security guidance).

Additionally, to "get ahead of the Cloud" technology trend, NIST initiated, and the U.S. CIO Council endorsed the NIST-led strategy to collaboratively develop a U.S. Government (USG) Cloud Computing Roadmap, to include three major process steps: developing business use cases, defining a reference architecture and taxonomy, and combining the two into a cohesive roadmap. This effort will exist alongside the tactical efforts including development of special publications, continued development of SAJACC, potential development of a conformance test system, and the modeling and analysis of complex behaviors in cloud computing.

Schedule and Milestones:

For Smart Grid:

1. **Lead the development of a cohesive, robust, and harmonized suite of standards for interoperable Smart Grid devices and systems (FY12-16).**

   a. Oversight of the Smart Grid Interoperability Panel
   b. Continued revision of the NIST Framework and Roadmap for Smart Grid Interoperability Standards

2. **Develop a Smart Grid testing and certification framework (FY12-16).**

   a. Coordinate nationwide framework for certification and testing in highest priority Smart Grid technical areas.

b. Select/define data communications testing infrastructure model and develop test requirements for conformity assessment.
c. Select/define security testing infrastructure model and test requirements and expand AMI test program.
d. Establish power conditioning system (PCS) performance conformity test methodologies.
e. Develop measurements and test bed to support integrating EVs into smart grid.

3. Develop the supporting measurement tools and protocols needed to enable industry to develop new Smart Grid devices and systems (FY 12-16).

a. Develop the standards and measurements needed to enable broad, state-of-the-grid monitoring, from wide area situational monitoring down to individual equipment.
b. Develop the standards and measurements needed to enable the effective integration of buildings and building systems with the Smart Grid.
c. Develop the models necessary to ensure industrial connectivity to the Smart Grid.
d. Develop cyber security standards and requirements for the Smart Grid.
e. Establish, in collaboration with standards development organizations, a suite of robust and harmonized networking standards for the Smart Grid.
f. Create Electric Storage-Distributed Energy Resources-Electric Transportation grid interconnection metrology laboratory.
g. Develop methods to accurately measure reactive power supplied by electric vehicles for improved grid management, power quality, stability, and robustness and resiliency.

For Health IT (FY12-14):

1. Accelerate development and harmonization of standards for health IT technologies (FY 12-14).

Recognized standards that are fully-defined and unambiguous

a. Robust specifications and constructs of recognized standards

2. Create a health IT technology testing infrastructure (FY 12-14).

NIST health IT testing infrastructure, including:

a. Ability for developers and purchasers to easily determine compliance to and correct implementation of recognized standards.

b. Ability to test for interoperability.

c. Ability to measure the degree to which users can use health IT effectively, efficiently, and without critical errors.

d. Provide the test method for testing and certification activities related to ARRA Stage 1 requirements.

3. **Support the usability of health IT technologies and continuous process improvement (FY 12-14).**

   a. Detailed plans and roadmap of activities.
   b. Well-defined usability requirements for health IT systems based on input from users and system developers.
   c. A well-defined, objective, and fair usability certification process, including test methods to assess compliance with standards.
   d. Specific objective pass/fail criteria for usability certification. The certification process may involve the application of behavioral, performance-based standards as well as design standards.
   e. User-friendly and publicly available information on the entirety of the NIST health IT portfolio and its relationship to the broader landscape.
   f. Collaboration with internal and external entities to enable implementation assistance.
   g. A robust conformity assessment program.

4. **Address healthcare delivery beyond traditional physical locations (FY12-14).**

   a. Improve interoperability of medical devices.
   b. Expand Goals I, II, and III for telemedicine.
   c. Extend standards-based IT infrastructure to PHRs.
   d. Expand testing infrastructure to include new standards and integrate the same into certification processes.
   e. Define measurement needs for emerging technologies such as body sensors, implants, image quality and color fidelity.

5. **Research emerging technologies and applications of new technologies to the healthcare domain (FY 12-14).**

   a. Improved interoperability of medical devices.
   b. Expansion of Goals 1, 2, and 3 for telemedicine, pervasive health technologies, personal health records, personalized medicine and other emerging technologies.
   c. Standards and guidelines for integrating emerging technologies into EHRs.
   d. Testing infrastructure expanded to include new standards, including work on new terminologies, and integrated into certification processes.
   e. Measurement needs defined for emerging technologies such as body sensors and implants.

f. Pilot implementation of integration of emerging technologies into the healthcare enterprise.

For Cloud Computing:

1. **Develop a comprehensive strategy for Cloud Computing (FY 12):**
    a. Strategic Cloud Computing program initiation completed
    b. Cloud Computing Strategy launched.
    c. Execution of Cloud Computing Strategy initiated.
    d. Phase I of Cloud Computing Strategy completed
    e. Progress of Phase I assessed and Phase 2 initiated.

2. **Enabling broad adoption of Cloud Computing (FY 12- ongoing)**
    a. SAJACC Phase 1 completed
    b. Complex Cloud Computing modeling work initiated
    c. Ongoing support for Federal Tech Advisory committee
    d. SAJACC Phases 2 & 3 initiated in a sequential manner upon completion of previous phases

Deliverables:

For Smart Grid:

1. **Lead the development of a cohesive, robust, and harmonized suite of standards for interoperable Smart Grid devices and systems (FY12-16).**
    - Release of revised Smart Grid standards list to FERC
    - Publication of revised NIST Framework and Roadmap for Smart Grid Interoperability Standards
    - Publication of Smart Grid Priority Action Plans
    - NIST-sponsored Smart Grid workshops

2. **Develop a Smart Grid testing and certification framework (FY12-16).**
    - Smart Grid testing and certification framework
    - Revised security testing models and test requirements for data communication protocols
    - Release of standardized PCS performance specifications and conformity testing methodologies.

3. **Develop the supporting measurement tools and protocols needed to enable industry to develop new Smart Grid devices and systems (FY 12-16).**
    - Real-time measurement capability for commercial power sensors and monitors
    - Performance evaluation tools for phasor measurement units (PMU)
    - Improved power/energy metering capabilities
    - New measurements tools to characterize energy efficiency
    - Release of electromagnetic interference standards
    - Publication of cyber security strategy for new Smart Grid technologies
    - Release of network standards for Smart Grid applications

- Development of new metrology to support widespread deployment of Electric Storage-Distributed Energy Resources-Electric Transportation.

For Health IT:

1. **Accelerate development and harmonization of standards for health IT technologies.**
   - FY 12: Standards-based IT infrastructure definition extended to maturing infrastructure standards
   - FY 12-14: Infrastructure expanded to additional clinical areas identified as national-level priorities

2. **Create a health IT technology testing infrastructure (FY 12-14).**
   - FY12: Testing infrastructure to include new standards and integrated into certification process
   - FY 12-13: Determination of feasibility of market-based testing infrastructure (go/no go point) and transitions
   - FY 14: Market based development and deployment of testing infrastructure

3. **Support the usability of health IT technologies and continuous process improvement (FY 12-14).**
   - FY 12: Voluntary NIST guidelines
   - FY 12: Operational certification processes
   - FY 13: Consensus based usability standards
   - FY 13: Quantitative analysis and reassessment of efforts to meet 2014 goals
   - FY 14: Usability standards that can be considered as criteria for certification

4. **Address healthcare delivery beyond traditional physical locations (FY12-14).**
   - FY 12: Defined measurement needs for emerging technologies such as body sensors and implants
   - FY 12: Identification of emerging technologies and their applications to clinical care
   - FY 13-14: Health IT infrastructure that can accommodate emerging technologies and their applications
5. **Research emerging technologies and applications of new technologies to the healthcare domain (FY 12-14).**
   - FY 12: Report on semantic consistency enforcement and translation techniques
   - FY 12: Initial outcomes of industry collaboration on personalized medicine information exchange standards
   - FY 13: Standards for body sensor/implant use and other emerging devices for healthcare
   - FY 13: Tools/repositories for semantic consistency and translation
   - FY 13: Solutions addressing technical barriers to adoption of personalized medicine standards.
   - FY 14: Solutions to adoption of body implant/sensor technology.
   - FY 14: Guidelines and best practices for integrating medical devices into the health information network.

For Cloud Computing:

1. **Develop a comprehensive strategy for Cloud Computing (FY 12)**
   - NIST Cloud Computing strategy
   - Draft Cloud Computing Roadmap ver 1 for public comment
   - Draft Cloud Computing Roadmap ver 2 for public comment (FY 13)

2. **Enabling broad adoption of Cloud Computing (FY 12 –ongoing)**
   - Updated SAJACC use cases and portal
   - Draft NIST Special Publications addressing specific aspects of Cloud Computing
   - Initial results of a Cloud as an Infrastructure model
   - Operational SAJACC portal

Performance Goals and Measurement Data

Performance Goal: Provide updated SG STDS framework document including additional Stds and Test programs	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	1	1	1	1	1	1
Without Increase	1	0	0	0	0	0
Description: Number of framework documents published by NIST						

Performance Goal: SGIP will produce a report that identifies new consensus standards, additional standards Priority Action Plans, and test and certification programs	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	1	1	1	1	1	1
Without Increase	0	0	0	0	0	0
Description: Number of reports published by SGIP						

Performance Goal: NIST will produce reports containing test requirements and test case development for use by standards setting organizations (SSOs) and other industry groups	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	5	4	4	4	4	4
Without Increase	3	1	1	1	1	1
Description: Number of reports supporting adoption of SG testing and certification programs delivered to the SSOs, and the SGIP included the Interoperability Knowledge Base (IKB)						

Performance Goal: Research supporting guidelines and standards in a number of Smart Grid areas for real-time measurement capability for commercial power sensor and monitors; power storage and electric vehicles; renewable energy sources; network standards and guidelines developed for SG applications	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	**23**	**21**	**21**	**21**	**21**	**21**
Without Increase	**20**	**2**	**2**	**2**	**2**	**2**
Description: Number of reports supporting SG standards development, implementation, and adoption delivered to the SSOs, and the SGIP included the Interoperability Knowledge Base (IKB)						

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amount in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Computer scientist	Gaithersburg	ZP V	2	$123,758	$247,516
Computer scientist	Gaithersburg	ZP V	8	123,758	990,064
Electrical engineer	Gaithersburg	ZP V	3	123,758	371,274
Electronics engineer	Gaithersburg	ZP V	1	123,758	123,758
Engineer	Gaithersburg	ZP V	1	123,758	123,758
IT Specialist	Gaithersburg	ZP V	2	123,758	247,516
Operations research analyst	Gaithersburg	ZP V	2	123,758	247,516
Physical scientist	Gaithersburg	ZP V	1	123,758	123,758
Physicist	Gaithersburg	ZP V	3	123,758	371,274
Social scientist	Gaithersburg	ZP V	2	123,758	247,516
Computer scientist	Gaithersburg	ZP IV	8	105,211	841,688
Computer scientist	Gaithersburg	ZP IV	2	105,211	210,422
Electrical engineer	Gaithersburg	ZP IV	4	105,211	420,844
Electronics engineer	Gaithersburg	ZP IV	3	105,211	315,633
Health specialist	Gaithersburg	ZP IV	1	105,211	105,211
IT Specialist	Gaithersburg	ZP IV	4	105,211	420,844
IT specialist	Gaithersburg	ZP IV	1	105,211	105,211
Mathematician	Gaithersburg	ZP IV	1	105,211	105,211
Physical Scientist	Gaithersburg	ZP IV	1	105,211	105,211
Physicist	Gaithersburg	ZP IV	3	105,211	315,633
Social scientist	Gaithersburg	ZP IV	1	105,211	105,211
Computer scientist	Gaithersburg	ZP III	1	74,872	74,872
Computer scientist	Gaithersburg	ZP III	9	74,872	673,848
Electrical engineer	Gaithersburg	ZP III	6	74,872	449,232
Electronics engineer	Gaithersburg	ZP III	1	74,872	74,872
Electronics Technician	Gaithersburg	ZP III	1	74,872	74,872
Information specialist	Gaithersburg	ZP III	1	74,872	74,872
Physicist	Gaithersburg	ZP III	7	74,872	524,104
Electronics technician	Gaithersburg	ZT III	2	56,857	113,714
Administrative/technical support	Gaithersburg	ZA II	9	51,630	464,670
Secretary	Gaithersburg	ZS III	1	37,983	37,983
Total			92		8,708,108

Less Lapse	25%	(23)	(2,177,027)
Total full-time permanent (FTE)		69	6,531,081
2011 Pay Adjustment (0.0%)			0
2012 Pay Adjustment 0.0%)			0
TOTAL			6,531,081

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	69
Other than full-time permanent	0
Total	69
Authorized Positions:	
Full-time permanent	92
Other than full-time permanent	0
Total	92

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

	Object Class	2012 Increase
11	Personnel compensation	
11.1	Full-time permanent	$6,531
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	6,531
12	Civilian personnel benefits	1,796
13	Benefits for former personnel	0
21	Travel and transportation of persons	925
22	Transportation of things	92
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	1,761
24	Printing and reproduction	23
25.1	Advisory and assistance services	0
25.2	Other services	866
25.3	Purchases of goods & services from Gov't accounts	1,994
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	7,226
25.6	Medical care	0
25.7	Operation and maintenance of equipment	377
25.8	Subsistence and support of persons	0
26	Supplies and materials	883
31	Equipment	874
32	Lands and structures	1,000
33	Investments and loans	500
41	Grants, subsidies and contributions	0
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Direct obligations	24,848
	Transfer to the Working Capital Fund	152
	Total obligations	25,000
	Less admininistrative savings	(2,165)
	Total requested	22,835

<u>3. Strengthening Measurement Services in Support of Industry Needs (Base Funding: $13.284 million; Program Change: +37 FTE and +$20.016 million).</u>

This request of $20.016 million and 37 FTE for a total of $33.3 million, would strengthen and expand the physical science-based measurement system, which NIST supports by advancing cutting edge measurement science, developing and providing new measurement services such as calibrations and reference methods, and accreditation and testing services that are essential to a successful high-tech industry base. The physical measurement system provided by NIST underpins a substantial part of the national and global technology infrastructure, from telecommunications and information networks, to electric power distribution, to positioning and navigation systems such as GPS, to many crucial applications in national defense, intelligence, and homeland security. Through this initiative NIST will develop new measurement services that support growth in multiple industry areas such advanced photovoltaics and telecommunications; revitalize the infrastructure for time and synchronization services distribution to meet growing demand, and develop new measurement tools that will improve efficiency and eliminate the need for costly calibration chains.

This initiative supports the Department's Strategic Goals of Innovation and Entrepreneurship, and Science and Information (objectives 3, 5, 13, and 14), as well as the Secretary's FY 2012 Priorities under *Innovation and Intellectual Property: "Creating an Environment for Future Growth" (Innovation and Entrepreneurship).* Furthermore, this initiative is a top strategic priority for NIST as stated in NIST's Three Year Programmatic Plan:

Strengthen and focus NIST's Laboratories and facilities to ensure U.S. leadership in measurement science and standards.

- Enhance support of other Federal agencies in meeting U.S. Government needs for voluntary consensus standards.
- Advance the state-of-the-art in measurement science.
- Enhance the facilities and equipment that enable cutting-edge research.

Proposed Actions:

Substantial parts of the national technical and commercial infrastructure rely upon a foundational measurement infrastructure that is essential for ensuring the accuracy, safety, and efficiency of operations, and the equitability of transactions. NIST supports this measurement infrastructure by providing industry and government with a wide range of physical science-based measurement services, such as calibrations, measurement methodologies, traceable reference materials and data, and accreditation and validation services. For example, positioning and navigation (GPS and related systems), telecommunications and information networks, electric power distribution, and electronic trading systems illustrate technologies that are thoroughly embedded in daily economic activity and quality of life, and that would not be possible without the measurement support provided by NIST.

This initiative will provide NIST with the necessary resources to:

- **Enhance NIST measurement services distribution system to meet increased demand** - NIST provides precision timing and synchronization services to the Nation that support multiple industries and commercial activities that comprise a substantial share of national economic activity. For example, telecommunications networks represent an estimated

$400 billion of annual economic activity; approximately $250 billion of electric power is distributed throughout the U.S. each year; more than $50 trillion in electronic trading each year depends on ordering of electronic transactions using precision time-stamping; and the civilian economic benefits of GPS are estimated at approximately $70 billion per year and growing rapidly. Planned improvements in electric power distribution (Smart Grid), GPS, broadband networks and other national systems will increase reliance on the precision timing and synchronization services provided by NIST, and meeting this demand will require the upgrade of the current NIST time and synchronization infrastructure.

- **Develop new measurement services necessary to support growth in high-technology industries and emerging technology sectors** - Advances in high-technology industries such as aerospace, semiconductor, electronics, and photovoltaics, combined with evolving needs of the Department of Defense (DoD) and Department of Energy (DoE) have resulted in measurement demands and the need for calibration services beyond the current portfolio provided by NIST. Examples of measurements needed include: high-voltage pulses, high-magnitude and high-frequency electrical current measurements, vector network analysis, wideband power measurements, and arbitrary waveform characterization.

- **Support measurement science research targeting next generation measurement tools that will improve the efficiency of the Nation's measurement infrastructure** - Laboratory research to develop the future core measurements and measurement services is required to ensure that NIST is proactively positioned to efficiently and effectively meet the evolving needs of industry and other agencies. For example, NIST research targeting the development of quantum-based standards will enable dissemination of measurements with unparalleled accuracy. If NIST develops and disseminates quantum standards, primary standards labs like those in DoD, DoE, GM, Boeing, and elsewhere will be able to achieve previously unattainable uncertainties without needing direct calibrations from NIST, thereby improving efficiencies and quality while reducing costs.

Statement of Need and Economic Benefits:

Accurate measurements are critical for the efficient and effective manufacture of goods and the distribution of services. Entire industrial sectors require substantial expenditures in the infrastructure of measurement science to effectively compete in world markets. NIST measurement services directly support industry measurement needs. NIST regularly evaluates the impact of its measurement services the results of these studies can be seen in the following table:

Outputs and Outcomes of NIST Laboratory Research

Industry: Project	NIST Lab[1]/Year	Output	Outcomes	Measures[2]
communications: electromagnetic interference	EEEL/1991	test methods	lower transaction costs	SRR: 266%
semiconductors: electromigration	EEEL/1992	test methods	increase R&D efficiency transactions costs	SRR: 117%
photonics: optical fiber	EEEL/1992	test methods (acceptance)	lower transaction costs	SRR: 423%
automation: real-time control systems	MEL/1995	generic architecture	increase R&D efficiency	SRR: 149%
energy: electric meter calibration	EEEL/1995	test methods (calibration)	lower transaction costs	SRR: 117% BCR: 12
communications: ISDN	ITL/1995	interoperability standards	lower transaction costs	SRR: 156%
computers: software conformance	ITL/1995	test methods (acceptance)	lower transaction costs	SRR: 41%
photonics: spectral irradiance	PL/1995	test method (calibration)	increase productivity lower transaction costs	SRR: 145% BCR: 13
construction: building codes	BFRL/1996	technical basis for standards	energy conservation energy cost savings	SRR*: 57%
construction: roofing shingles	BFRL/1996	materials properties	increased durability	SRR*: 90%
construction: fire safety evaluation system	BFRL/1996	technical basis for standards	lower compliance costs	SRR*: 35%
automation: machine tool software error compensation	MEL/1996	quality control algorithm	increase R&D efficiency increase productivity	SRR: 99% BCR: 85

Industry: Project	NIST Lab[1]/Year	Output	Outcomes	Measures[2]
materials: thermocouples	CSTL/1997	standard reference data (calibration)	lower transaction costs increase product quality	SRR: 32% BCR: 3
pharmaceuticals: radiopharmaceuticals	PL/1997	standard reference materials	increase product quality	SRR: 138% BCR: 97
photonics: optical detector calibration	PL/1997	standards and calibration services	increase productivity	SRR: 72% BCR: 3
chemicals: alternative refrigerants	CSTL/1998	standard reference data	increase R&D efficiency increase productivity	SRR: 433% BCR: 4
materials: phase equilibria for advanced ceramics	MSEL/1998	standard reference data	increase R&D efficiency increase productivity	SRR: 33% BCR: 10
semiconductors: software for design automation (IGBT semiconductors)	EEEL/1999	software model	increase R&D efficiency increase productivity	SRR: 76% BCR: 23 NPV: $10M
pharmaceuticals: cholesterol measurement	CSTL/2000	standard reference materials	increase productivity decrease transaction costs	SRR: 154% BCR: 4.5 NPV: $3.5M
photonics: laser and fiberoptic power and energy calibration	EEEL/2000	calibrations	increase productivity decrease transaction costs	SRR: 43%-136% BCR: 3-11 NPV: $48M
electronics: Josephson voltage standard	EEEL/2001	standard reference materials	Increase R&D efficiency Increase productivity Enable new markets	SRR: 877 BCR: 5 NPV: $18M
chemicals: SRMs for sulfur in fossil fuels	CSTL/2000	standard reference materials	increase productivity reduce transaction costs	SRR: 1,056% BCR: 113 NPV: $409M

Industry: Project	NIST Lab[1]/Year	Output	Outcomes	Measures[2]
communications: security (data encryption standards)	ITL/2001	standard conformance test methods/services	Increase R&D efficiency Enable new markets	SRR: 267-272% BCR: 58-145 NPV: $345M-$1.2B
communications: security (role-based access control)	ITL/2001	generic technology reference models	Enable new markets Increase R&D efficiency	SRR: 44% BCR: 109 NPV: $292M
chemicals: National Traceable Reference Materials Program (NTRM)	CSTL/2002	reference data; calibration services	Increase efficiency of regulatory compliance (content & production efficiencies for standards)	SRR: 221% BCR: 21 NPV: $49M
manufacturing: standards for product data exchange (STEP)	MEL/2002	standards development; conformance test methods/services	Increase quality and assimilation of standards; accelerate standards development	SRR: 32% BCR: 8 NPV: $180M
semiconductors: models and techniques for superfilling	MSEL/2008	models and techniques for research	Increase R&D efficiency	SRR: 79 BCR: 6 NPV: $6.4M
semiconductors: characterization data for low-k materials	MSEL/2008	materials characterization	Increase R&D, production, and technology adoption efficiency	SRR: -- BCR: 9 NPV: $21M
materials: combinatorial methods consortium	MSEL/2009	combinatorial methods for polymer research	Increase R&D efficiency and technology transfer	SRR: 161 BCR: 9 NPV: $118M

[1]**NIST Laboratories (Labs):**
EEEL: Electronics and Electrical Engineering Laboratory
MEL: Manufacturing Engineering Laboratory
CSTL: Chemical Science and Technology Laboratory
PL: Physics Laboratory
MSEL: Materials Science and Engineering Laboratory
BFRL: Building and Fire Research Laboratory
ITL: Information Technology Laboratory
[2]**Measures:**
SRR: social (internal) rate of return
SRR*: social (implied) rate of return
BCR: benefit-cost ratio
NPV: net present value

Collectively, the entire set of economic impact studies conducted to date demonstrates that the rates of return on NIST infratechnologies consistently match or exceed rates of return to private investment in technology. In addition, these studies and other economic analyses suggest that public investment in infratechnologies complements private investment in proprietary technologies, which in turn generates higher rates of economic growth.

Base Resource Assessment:

For over a century, the measurement services programs of NIST have ensured the accuracy and reliability of physical science-based measurements that impact multiple industry sectors and government agencies, including the DoD and the DoE. The essential need for NIST is obvious from the huge leverage that is observed from a relatively small number of NIST calibrations for these agencies. For example, NIST calibrations ensure the accuracy and reliability of over 1.8 million Navy calibrations performed on approximately 140,000 different types of instruments – essentially "every weapon system, ship, and plane are supported in some way or another via traceability to NIST." (quote from Gerald Marts, U.S. Navy) Similarly, in 2009 NIST performed 203 calibrations for DoE that supported over 70,000 subsequent calibrations in support of the reliability and performance of the entire U.S. nuclear arsenal. In fact, the DoE Development and Production Manual (Chapter 13.2) tasks the Sandia Primary Standards Laboratory with providing traceability from NIST to all DoE programs. Working in collaboration with Intel, NIST determined how various measurement impairments (including those due to cable and fixture losses and high-speed oscilloscope response) could be removed in Intel's testing of a semiconductor chip, thus greatly improving testing efficiency and reducing unnecessary rejections.

This initiative primarily targets efforts focused on the development of time and electrical-based measurement services where the demand for upgrades to current services and the development of new measurement capabilities is the highest.

The current NIST time and synchronization measurement system comprises approximately $6.0 million of STRS funding and approximately 20 FTE.

The present NIST measurement program in electrical metrology is funded at approximately $7 million per year and consists of 17 technical staff, which is less than half of the staff dedicated to this area in 1990.

Schedule and Milestones:

Enhance NIST Measurement Services Distribution

- Strengthen network distribution of official U.S. time for applications that impact all critical infrastructure sectors and the general public, to meet the growing demands. (FY 2014)

- Modernize the NIST time and synchronization radio broadcast system used by many millions of citizens every day. The usefulness of the current broadcasts is threatened by radio-frequency interference from the growing number of wireless and electronic devices. Increasing broadcast power and developing new broadcast code techniques will overcome this interference. (FY 2015)

- Develop improved systems to distribute official U.S. time through GPS and similar satellite navigation systems. Customers with stringent timing and synchronization requirements include telecommunications providers, aerospace and defense systems manufacturers, electric power distribution systems, and many others. Using GPS and other navigation systems can provide the customers with a fully-automated system of extremely precise NIST time and synchronization information, continuously available to the customer at any time, at any location. (FY 2014)

- Develop new optical fiber-based time and synchronization distribution systems to take advantage of the improvements in accuracy and precision afforded by optical transmission compared to standard electrical or radio transmission methods. (FY 2015)

- Develop new methods to provide precision time and synchronization information to key customers in the defense, intelligence, and homeland security communities, and for applications such as Smart Grid. Each customer has unique needs for precision, reliability, and security of information. NIST will work directly with each agency to develop the unique solutions required for their applications. (FY 2014)

Develop New Measurement Services

- The precise dissemination of measurements requires both an excellent primary standard and a superior means of transferring that value to other labs. This includes the need to scale the reference values over many orders of magnitude with little loss of accuracy. NIST will develop new transfer standards and scaling capabilities for very high resistance (>100 GΩ), for AC voltage over a very broad frequency, current, and voltage range, and for high voltage and current signals. NIST will also work to use quantum arrays to achieve a broad range of direct quantum based values. These capabilities and tools will be transferred to DoD and DoE primary standards labs, thus enabling them to better transfer their capabilities to secondary calibration labs. (FY 2014)

- Expanded or advanced measurement areas: New areas of measurement needs continually develop and NIST must perform research in these areas to ensure that NIST can meet the future needs of key U.S. government agencies and industry. Areas of measurement in which DoE and DoD have expressed a need, but where NIST does not have sufficient capabilities, include pulsed high voltage, high current, AC resistance, arbitrary waveform analysis, and ultrahigh speed oscilloscope calibrations (>100 GHz). Also, development and deployment of advanced digital signal processing techniques to NIST calibrations will enable improved measurement services to NIST customers and will enable these same techniques to be disseminated to DoD, DoE, and industry labs for their use in calibration services. (FY 2015)

- Develop new primary frequency standards (official atomic clocks) with improved accuracy equivalent to about one second in 500 million years to meet current and future needs for time and synchronization standards for telecommunications, navigation and positioning, and defense applications. (FY 2013)

- Replace the aging and nearly obsolete time scale which is calibrated by the primary frequency standards, and which is the direct source of all NIST time and synchronization services, with more accurate and reliable systems. (FY 2014)

Support Measurement Science R&D

- The scientific and technological communities require a self-consistent set of values of the basic fundamental constants so that measurements of quantities such as charge and light can be made with sufficient accuracy and precision. Towards this end, NIST will develop the quantum-based measurement tools needed to define a natural system of International System of Units (SI). As part of this effort, NIST will also fund the NIST Precision Measurements Grants program, which is focused on supporting academic research in the field of fundamental measurement or the determination of fundamental constants. (FY 2017)

- Quantum standards enable dissemination of measurements with unparalleled accuracy. By developing quantum standards for the entire suite of electrical measurements, primary standards labs will be able to achieve previously unattainable uncertainties without direct calibrations from NIST, thereby improving efficiencies and quality while reducing costs. Some quantum standards exist, but they are complicated and expensive. NIST will develop turnkey systems for use in all types of measurement labs (particularly DoD and DoE primary standards labs) to disseminate resistance, capacitance, voltage (DC, AC, and arbitrary waveforms), and electric power. NIST will also develop improved electron-counting techniques that are critical to creating new quantum-based voltage, current and capacitance standards. (FY 2014 - FY 2016)

- Develop new atomic clocks (primary frequency standards) based on new technologies that will eventually be 100 to 1,000 times more accurate than the current best clocks, to meet growing future needs. The new technologies include clocks based on optical transitions in atoms compared to the current microwave transitions, and clocks based on quantum logic and optical lattice manipulation. (FY 2015)

- Investigate optimal quantum states and measurement protocols, including the means to generate and characterize the novel quantum states, that may improve future timing and synchronization measurements beyond the standard quantum limit. (FY 2015)

- Develop new ultraprecise sensors based on atomic clocks. Such sensors operate by detecting very small changes in the ticking rate (frequency) of atomic clocks due to the effects of magnetic fields, small changes in gravity, and other environmental conditions. These atomic sensors can be used for such applications as:
  - Ultraprecise magnetic field measurements for measuring the tiny magnetic fields created by brain and heart activity, with the potential for new medical imaging technologies. (FY 2014)
  - Precision gravity measurements for detection of underground resources (petroleum, minerals, etc.) and for "signal free" undersea navigation based on gravity maps of the ocean floor. (FY 2015)
  - Ultrasmall and ultraprecise gyroscopes and accelerometers to provide precision navigation and positioning when systems such as GPS are not available, either due to interference with GPS, or for use in buildings and environments where GPS signals are not available. (FY 2016)

- Develop next generation photon sources and detectors that provide both better sensitivity and more accurate timing to improve both sensitivity and synchronization of timing signals. The photon sources and detectors should also support the development and characterization of novel quantum states and future optical standards. (FY 2015)

Deliverables:

- New primary frequency standards (official atomic clocks) with improved accuracy equivalent to about one second in 500 million years.

- Robust new NIST time scale to ensure accurate, reliable, and continuously available time and synchronization information for all NIST time users.

- Improved NIST realization of official U.S. time.

- Improved services to NIST time and synchronization users, including:
  - Robust system for network-based timing and synchronization, able to reliably and accurately provide service for more than ten billion requests per day.
  - Enhanced radio broadcasts of NIST time and synchronization information to better serve customers across the entire lower 48 states, particularly the eastern third of the U.S., parts of which currently experience poor reception.

- New technologies to deliver the most accurate and precise time and frequency information through fiber optic networks, significantly surpassing current technologies relying on radio signals.

- Enhanced time and synchronization distribution for a broad range of national priority applications, including Smart Grid, national defense, and homeland security.

- World-leading new atomic clocks to meet future needs of national timing and synchronization applications and infrastructures.

- Tools for characterization of novel quantum states for future improvements in time and synchronization.

- More efficient quantum-based fundamental standards for voltage, resistance, and capacitance:
  - New turnkey quantum-based DC voltage systems that can be operated in almost any laboratory.
  - An easily disseminated room temperature quantum resistance standard based upon graphene technology.
  - A new table-top quantum standard for capacitance for easy dissemination of values with unprecedented accuracy.

- High precision transfer standards and scaling techniques for resistance, voltage, and current:
  - Reduced uncertainties of measurements for high resistance values greater than 100 GΩ by developing improved transfer standards and by improving scaling techniques using cryogenic current comparators.
  - Quantum Hall arrays for quantum-based resistance scaling to greatly improve accuracy at extremely high and low resistance values.
  - Thin film thermal converters for dissemination of AC voltage and current measurements with lower uncertainties over a much broader range of current, voltage, and frequency.

- Expanded and advanced measurement capabilities for voltage, power, resistance, and impedance:
    - New methods of measurement traceability for DC, AC, and pulsed high voltage and high current measurements.
    - New capabilities for measuring arbitrary waveforms with unprecedented ease and accuracy, including extremely high frequencies (>100 GHz).
    - Improved AC resistance measurement capabilities in support of improved AC impedance and temperature measurements.
    - More precise measurement techniques to enable accurate power measurements in the presence of harmonics and noise.
    - Implementation of advanced digital signal processing based technologies for all AC measurement services to reduce uncertainties, improve reliability, improve transportability, and expand ranges of performance.
    - Modernized and improved NIST electrical measurement calibration services including all forms of voltage, resistance, low frequency power, and impedance.

Performance Goals and Measurement Data

Performance Goal: Performance Measure: Total number of new quantum standards developed for dissemination	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	**0**	**0**	**1**	**1**	**2**	**3**
Without Increase	**0**	**0**	**0**	**0**	**0**	**0**
Description						

Performance Goal: Performance Measure: Total number of new measurement technologies or instruments delivered to Industry, DoE and/or DoD primary standards labs	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	**0**	**0**	**1**	**2**	**4**	**7**
Without Increase	**0**	**0**	**0**	**0**	**0**	**0**
Description						

Performance Goal: Performance Measure: Total number of NIST electrical measurement calibration services modernized and upgraded	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	**0**	**0**	**1**	**2**	**3**	**4**
Without Increase	**0**	**0**	**0**	**0**	**0**	**0**
Description						

Performance Goal: Performance Measurement: Daily synchronizations of computer clocks to official NIST time	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	**3 billion**	**4 billion**	**5 billion**	**6 billion**	**7 billion**	**8 billion**
Without Increase	**3 billion**	**3 billion**	**3 billion**	**3 billion**	**3 billion**	**3 billion**
Description						

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amount in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Electronics engineer	Boulder, CO	ZP V	1	$123,758	$123,758
Physicist	Boulder, CO	ZP V	5	123,758	618,790
Electrical engineer	Gaithersburg, MD	ZP IV	7	105,211	736,477
Electrical engineer	Boulder, CO	ZP IV	1	105,211	105,211
Electronics engineer	Boulder, CO	ZP IV	2	105,211	210,422
Electronics engineer	Gaithersburg, MD	ZP IV	1	105,211	105,211
Physicist	Boulder, CO	ZP IV	7	105,211	736,477
Physicist	Gaithersburg, MD	ZP IV	11	105,211	1,157,321
Electrical engineer	Gaithersburg, MD	ZP III	3	74,872	224,616
Electrical engineer	Boulder, CO	ZP III	1	74,872	74,872
Physicist	Boulder, CO	ZP III	2	74,872	149,744
Physicist	Gaithersburg, MD	ZP III	1	74,872	74,872
Technician	Boulder, CO	ZT IV	2	74,872	149,744
Admin./technical support	Boulder, CO	ZA II	2	51,630	103,260
Admin./technical support	Gaithersburg, MD	ZA II	3	51,630	154,890
Secretary	Gaithersburg, MD	ZS III	1	37,983	37,983
Total			50		4,763,648
Less Lapse		25%	(13)		(1,190,912)
Total full-time permanent (FTE)			37		3,572,736
2011 Pay Adjustment (1.4%)					0
2012 Pay Adjustment 2.3%)					0
TOTAL					3,572,736

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	37
Other than full-time permanent	0
Total	37
Authorized Positions:	
Full-time permanent	50
Other than full-time permanent	0
Total	50

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

	Object Class	2012 Increase
11	Personnel compensation	
11.1	Full-time permanent	$3,573
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	3,573
12	Civilian personnel benefits	983
13	Benefits for former personnel	0
21	Travel and transportation of persons	442
22	Transportation of things	99
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	1,200
24	Printing and reproduction	11
25.1	Advisory and assistance services	0
25.2	Other services	2,072
25.3	Purchases of goods & services from Gov't accounts	1,918
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	2,550
25.6	Medical care	0
25.7	Operation and maintenance of equipment	242
25.8	Subsistence and support of persons	0
26	Supplies and materials	867
31	Equipment	1,143
32	Lands and structures	1,000
33	Investments and loans	0
41	Grants, subsidies and contributions	2,000
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Direct obligations	18,100
	Transfer to NIST Working Capital Fund	3,100
	Total obligations	21,200
	Less administrative savings	(1,184)
	Total requested	20,016

4. Advanced Materials for Industry (Base Funding: $2.0 million; Program Change: +23 FTE and + $14.242 million).

NIST requests an increase of $14.242 million and 23 FTE for a total of $16.242 million to develop the measurement science, tools and standards necessary to enable greatly improved efficiency in the Nation's development and manufacture of new products and services based on innovative materials. The funds would enable NIST to extend its expertise in the development and use of materials modeling and simulation directed at manufacturing, and to create a National measurement and standards infrastructure that would substantially lower the cost of both design and manufacturing for industries seeking to realize the benefits of computer-based materials discovery and optimization.

Proposed Actions:
The generation and evaluation of physical reference data and the development of databases that can be widely used by industry is mandated by the NIST mission. NIST has expertise in data generation, collection, assessment, and dissemination, as well as model design and validation from atomic scale to the device scale. This expertise has provided a theoretical underpinning for its experimental program for some time. As a result, NIST is uniquely positioned to develop a vastly accelerated program for the Nation to provide materials property data utilizing modeling and simulation approaches, sometimes known as "virtual measurements." The proposed initiative seeks to fund efforts in the following focused areas:

- **Standard Reference Database Development** – NIST will assemble databases of evaluated data on physical, chemical and mechanical properties of materials generated through both computational models and experiments, including data describing thermodynamic properties; multi-component diffusion; thermal conductivities (temperature sensitivity); lattice parameters (density); chemical reactivity of surfaces; thermophysical properties of fluids; composition and functional properties of semiconductor, insulator, composite, and metallic alloys; interatomic potentials to describe atomic interactions; microstructure formation models; and other, as identified by partners in government, industry and academia. This enables improved computation of materials properties and design of products.

- **Data Assessment Techniques and Tools** – Materials property data cannot be relied upon unless it is carefully documented for both its origin and accuracy. NIST has a long history of evaluating data obtained from physical experiments, at NIST and elsewhere, to precisely determine the uncertainty in reported results. The same must be done for property data obtained from mathematical models and computational simulations. Unfortunately, methodologies for verification and validation of computer models and techniques for characterizing the uncertainty in their outputs are far from mature. NIST will develop a measurement science infrastructure for models and simulations that is on par with that of physical experimentation. Not only will this ensure the quality of NIST data, but the techniques and tools developed will also be usable by industry to increase confidence in predictions of the models and simulations they use in materials discovery.

- **Standards Determination, Implementation and Dissemination** – Materials property databases will not achieve their full potential impact unless they are easily searchable, with results provided in a form amenable to automated processing by client models and analysis tools. Such capabilities are enabled by formal standards for data representation and standard protocols for their automated interchange. This standards development exercise will necessarily engage much of the materials modeling community (public-private partnerships). Community consensus will be developed through workshops, planning grants and road-mapping exercises enabling the scope of needed data standards to be determined. This includes standards for documenting data origin, software standards, the mathematical descriptions of calculated quantities, associated experimental data, manuscripts, and other relevant materials.

- **Standard Reference Materials Development** – Tightly integrated with any quantitative modeling effort is an experimental effort aimed at providing key data against which the models can be calibrated and validated. Indeed, these efforts must be linked iteratively, as models provide guidance for experiments and vice-versa, yielding a cycle of improved accuracy and predictive power. In this effort we will develop a new paradigm for NIST's Standard Reference Materials program, distributing materials data and models along with the physical sample, allowing for an enormous value-add to the customers using standard reference materials (SRMs) in their industrial processes. Such an effort would also allow others to validate their models both against NIST-developed models and the associated SRMs.

- **Model Development, Integration and Standard Reference Simulations** – The above effort is founded on a basis of scientific software developed at multiple institutions around the world. NIST will undertake a substantial effort in the development and integration of materials models in order to benchmark these technologies and maintain depth of competence in state-of-the-art materials modeling. Such an approach is necessary to support the manufacturing community, which has specific materials performance criteria but often limited capability to perform materials by design. This includes efforts to strengthen the modeling efforts to predict with known confidence the microstructure evolution as well as bulk properties of materials systems. Additionally, NIST will develop powerful abstraction methods to enable multiscale integration and discovery of new macroscopic physical properties derived from models at shorter length and time scales. This effort will directly couple back to the data efforts, by both enhancing the usefulness of the disseminated information and quantifying the high-dimensional parameter space contributing to predictive uncertainty (i.e. controlling and understanding uncertainty). NIST models and associated software will provide a capability for "standard reference simulations" in two ways: (1) The release of open-source software that would represent a community-developed representation of the state-of-the-art against which modelers could benchmark their own software or proposed improvements, and (2) The development of standardized benchmark problems, along with highly accurate computational solutions which could be compared against by those wishing to validate their own modeling software. The latter could be tied to the specific SRMs described above. These are necessary steps to the development of "traceability" for models and simulations comparable to traceability for physical measurement.

Statement of Need and Economic Benefits:

Today, the discovery and optimization of new materials for innovative products is a time-consuming and laborious process, as much a craft practiced by skilled artisans as a science. Expensive trial-and-error-based experimentation results in a highly inefficient exploration of the potential candidates for a desired new system. This is in part because the materials design space is highly complex. For example, in metals, whether high strength steel for automobiles or lightweight aluminum for airplanes, a few percent change in composition or slight modification in manufacturing processes can make a such a large difference that performance metrics, such as strength, can vary by 50 percent or more, where ultimately these different properties result from different arrangements of the atoms. Another example would be the high performance alloys developed in the 1960's for nuclear reactors, which have effective lifetimes that differ by a factor of two depending on subtle variations in composition. The investigation of all possible variations of the composition of such alloys would be prohibitively expensive and time-consuming, involving numerous tests of strength and other properties, as well as microstructural analyses to determine the arrangements of the atoms. Alloys with major composition alterations are frequently not examined at all because of the time and cost associated with insertion of new materials into engineering systems. Identical arguments can be made for such diverse applications as sensor materials for detection of atmospheric pollutants to the creation of new pharmaceuticals. The result is much lost opportunity for the discovery and optimization of new materials on which new higher performance products can be based.

However, a powerful new paradigm for materials discovery and optimization has begun to emerge: materials by design. In contrast to an empirical trial-and-error-based approach that may take a decade to implement, computational approaches based on physics-based material models can lead to hugely reduced development time, materials of higher performance, and far more effective and cheaper products. DOE's Oak Ridge National Laboratory is currently using these methods to direct alloy development for Gen 4 nuclear reactors. GE has cut their jet engine alloy development cycle from fifteen years to nine years by using computational approaches and hopes to cut the time by half again using improved models and data. Products ranging from automobile engines to computer chips to the previously mentioned next generation nuclear power plants are ripe to benefit from such modern methods of materials engineering – clearly a major enabler for the future of manufacturing and American industry.

A prerequisite to the effective use of modeling and simulation is reliable data on the fundamental physical properties of materials at all relevant scales. The most fundamental is based on interactions at the atomic scale. Today such data remains spotty and of highly variable quality. Some data is measured at various labs around the world, but in an uncoordinated manner and with incompatible formats. This problem is particularly severe when researchers must tie one scale of modeling to another, say the atomic scale to the scale of cell phone components or turbine blades in order to study the full range of material performance characteristics.

Modeling and simulation can also be used to generate necessary materials parameters and data for higher-level engineering models when data are not available. Atomic and sub-atomic scale models provide such data when measurements are too expensive or uncertain, or even impossible to measure. Examples of materials data very difficult and expensive to measure yet amenable to modeling are interface energies between solid phases, and barriers to diffusion, or mixing of solids on the atomic scale. Such atomistic methods have matured in the past decade, and are being investigated by cutting edge industry, such as Intel, for product design. But major efforts in both theory and experiment are needed to provide the data that underlies successful modeling at all these length scales. These efforts are central to providing the interoperability, validity and confidence levels necessary to ensure adoption by industry of modeling and simulation for materials by design, and are directly aligned with NIST's role in establishing data quality.

Finally, we quote from the National Research Council Report on Integrated Computational Materials Engineering (2008):

"Materials innovations have been at the core of the vast majority of major changes in technology since the start of the industrial revolution. Modern transportation, electronics, space exploration, the information age, and medical prosthetics were all enabled by today's metallic, polymeric, ceramic, semiconductor, and multifunctional materials. For decades, the development of advanced materials and their incorporation into the design of new products enabled the United States to maintain a significant competitive advantage in the global economy. Modern computational engineering tools generally have radically reduced the time required to optimize new products. However, analogous computational tools do not exist for materials engineering.

As a result, the product design and development cycle now outpaces the materials development cycle, leading to a considerable mismatch. The insertion of new materials technologies has become much more difficult and less frequent, with materials themselves increasingly becoming a constraint on the design process. The materials development and optimization cycle can no longer operate at the rapid pace required, and this potentially threatens U.S. competitiveness in powerhouse industries such as electronics, automotive, and aerospace, in which the synergy among product design, materials, and manufacturing has given our Nation a competitive advantage. Moreover, this deficiency leads to suboptimal materials and engineering solutions to national security needs. Until materials engineering, component design, and manufacturing engineering are integrated, designers will not attempt to optimize a product's properties through processing, and one route to improving the competitiveness of U.S. manufacturers will be closed off."

Base Resource Assessment:

For many years, NIST has recognized the needs of manufacturers to employ state-of-the-art modeling and simulation tools to accelerate the insertion of new materials into the design process. However, while the need was clear, the existing software and computer power was insufficient to model the enormously complex problems that are central to understanding and predicting materials performance. As part of a National and international effort in these areas, NIST has maintained active leadership in the modeling of materials microstructure, including the creation of the NIST Center for Theoretical and Computational Materials Science (CTCMS). This center, now part of the Materials Measurement Laboratory, is focused on developing, solving, and quantifying materials models using state-of-the-art computational approaches and developing powerful new tools for materials theory and modeling and accelerating their integration into industrial research. In 2008, the NIST Metallurgy Division created the NIST Interatomic Potentials Repository, a first of its kind resource for researchers seeking the software needed to predict materials properties at the atomic scale. NIST has also invested substantial resources through its Information Technology Laboratory in the areas of uncertainty quantification and in fast and accurate solution methods for the mathematical models of materials that predict the complex microstructures that control materials properties at the macro-scale. NIST has also supported the Virtual Cement and Concrete Testing Laboratory and its associated VCCTL Consortium, which aims to develop a computer-based virtual laboratory for evaluating and optimizing cement-based materials.

In addition, for the past ten years, the Computational Chemistry Group (CCG) at NIST has dedicated significant efforts aimed at the development, validation and application of modern quantum chemistry methodologies to aid in the experimental characterization of chemical, electrical, magnetic, and optical properties of materials at the nanoscale. A good example of these activities is the development of reliable and computational efficient theoretical methodologies to study behavior? of molecular wires interfaced to metallic and semi-conductor electrodes, which constitutes an integral component of the nanoelectronics program at NIST. Another example from the activities in the CCG showcasing the impact of modeling and simulations in industrial applications is the collaborative work with scientists and engineers at KRAFT Foods entailing the use of quantum chemical methodologies in order to rationally design "smart materials and food packages".

It is now clear, through successful demonstrations at a handful of companies and Labs (see above), that the technologies developed both inside and outside of NIST are poised to make revolutionary changes in how manufacturers use materials, enabling the direct incorporation of new materials, developed in real time, into the product development cycle. To realize this transformation of U.S. manufacturing practice involves a government-wide effort, where NIST will play a central role in developing the standards in data needed to ensure success. Recognizing this imperative, NIST has invested several million dollars per year to begin developing the data and software needed to do Materials by Design, but the effort has necessarily been piecemeal, as a coherent effort involves a confluence of several factors that are only now coming into alignment: (i) recognition of a National need by both the National Research Council (see above) and a WTEC 2008 report on simulation based science and engineering; (ii) the evolution of computer hardware and software to a state where the solution of these problems is now tenable and (iii) the crucial cultural shift within the materials engineering community that *requires materials science to be done in a wholly new manner, where modeling and simulation exist in a tightly bound loop with experiment.* These factors are all now in place, setting the stage for NIST to invest in a substantially increased effort in Materials by Design. This effort will be both timely and, if done in concert with the right stakeholders, yield significant impacts on manufacturing and the National economy.

Schedule and Milestones:

1. **Standard Reference Database (SRD) Development**
    a. FY12-14: Develop an archive capability for digital materials data
    b. FY12-16: Develop and implement a common interface to all relevant NIST SRDs
    c. FY 12-16: Develop novel search, retrieval, and analysis tools for materials data
    d. FY 13-18: Implement emerging standards and protocols for access to NIST SRDs
    e. FY 12-18: Develop federated database technology enabling integrated search across materials data maintained by multiple parties
    f. FY 12-18: Develop thermodynamic databases of multi-component alloys
    g. FY 12-18: Develop databases of multi-component diffusion coefficients and atomic mobilities
    h. FY 13-18: Develop databases of thermal/electrical conductivities
    i. FY 14-18: Develop databases of crystal lattice parameters (density/molar volume)
    j. FY 12-18: Broaden the scope of the interatomic potential repository to include reference data and property evaluations for a wide range of materials
    k. FY 12-18 Develop quantum/ab-initio database
    l. FY 12-18 Develop a reference chemical kinetic database for vapor-phase reactions used in material growth using thermochemical deposition processes.
    m. FY 12-18 Develop a quantum chemistry database with thermochemical, electrical, magnetic and optical properties data of small nanostructures (< 1,000 atoms).
    n. FY 12-18 Develop a database with optical properties such as phonon shift and band-gap energies to determine composition and functional properties of semiconductor and insulator alloys. to our stakeholders of the above developed databases

2. **Data Assessment Techniques and Tools**
    a. FY12-16: Reference standards for quantified verification of the numerical accuracy of computational models: benchmark problems and solutions, a posteriori error estimators, convergence analysis, and the method of manufactured solutions
    b. FY12-16: Tools and analyses to assess the error propagation that occurs as a result of multi-model chaining—i.e., outputs of one model are used as inputs for another model
    c. FY12-16: Develop standardized methods for uncertainty analysis in property calculations, reference data, materials informatics, and connections between scales
    d. FY12-16: Develop standardized protocols for evaluating properties in molecular simulation (automated property evaluations)

e. FY 12-16 Develop database of reference data with full pedigree (similar to Chemistry WebBook)

3. **Standards Determination and Implementation**
   a. FY12-17: Facilitate the community-based development of standardized terminologies and taxonomies for materials data
   b. FY13-17: Facilitate the community-based development of standardized representations for materials data and associated meta-data
   c. FY 14-17: Facilitate the community-based development of standardized protocols for the interchange of materials data among databases, simulation systems, and analysis tools
   d. FY13-17: Develop reference implementations and conformance tests for emerging community standards for materials data representation and interchange
   e. FY12-17: Develop comprehensive and flexible taxonomies for classifying materials information
   f. FY12-17: Standard reference states for thermodynamic and diffusion data and models
   g. FY12-17: Standardized formats for representing interatomic potentials

4. **Standard Reference Materials Development**
   a. FY12-16: Experimental effort aimed at providing key, yet sparse, data sets for selected materials against which the databases in section I can be validated. New Standard Reference Materials will be identified that can be used for inter-laboratory agreement on selected data sets

5. **Model Development and Integration**
   a. FY12-18: Development of standard reference simulations, including challenge problems, software, and associated results, that can be used as benchmarks for development and application of modeling software
   b. FY12-18: Development of open hardware/software platforms that enable integration of models representing multiple physical processes, time, and length scales
   c. FY12-18: Development of software repositories to provide wide community access to state-of-the-art tools
   d. FY12-16: Formulation of advanced predictive microstructure evolution models using sharp interface and phase field methods. Both full scale and approximate semi-analytical models will be employed. Models will utilize data from the thermodynamic and diffusion databases
   e. FY12-16: Formulation of model to predict bulk mechanical properties of metallic materials as a function of microstructure.

Deliverables:

1. **Standard Reference Database (SRD) Development**
   a. Open access to our stakeholders of the above developed databases
   b. Roll out these changes to the public, in conjunction with quality control issues discussed below
   c. Code repositories

2. **Data Assessment Techniques and Tools**
   a. Understanding the limits of numerical accuracy obtained from non-linear computations of materials data at the atomic level and continuum models of microstructure – properties prediction performed on different hardware and software platforms
   b. Methods to evaluate error propagation from linked models
   c. Recommended practice guides for property calculations and uncertainty analysis

3. **Standards Determination and Implementation**
   a. Recommendations for common ways to transfer information between programs and scales
4. **Standard Reference Materials Development**
   a. Standard reference materials for validating models

5. **Model Development and Integration**
   a. Model of how precipitate size/morphology and density affect the strength, fatigue, fracture resistance, creep and other mechanical properties of alloys
   b. Methods for error propagation
   c. Comparisons of models with reference data (particularly experimental)

Performance Goals and Measurement Data

Performance Goal: Develop databases and integrated data collections	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	**5**	**10**	**25**	**50**	**75**	**100%**
Without Increase	**0**	**0**	**0**	**0**	**0**	**0%**
Description: Databases must be developed, and integrated.						

Performance Goal: Obtain archive capabilities for materials data and models	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	**5**	**15**	**30**	**40**	**60**	**80%**
Without Increase	**5**	**10**	**20**	**30**	**30**	**30%**
Description: , Databases must be populated with data appropriate to Materials by Design. Percentages indicated the state of population of the databases for the classes described above. 100% is impossible.						

Performance Goal: Develop best practices for determining uncertainties	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	**5**	**10**	**25**	**50**	**75**	**90%**
Without Increase	**0**	**0**	**0**	**0**	**0**	**0%**
Description: The determination of best practices, while evolutionary, will inform all the other activities in this effort.						

Performance Goal: Best practices for archiving data, results, and the required programs and files to regenerate results (reproducibility)	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	**10**	**15**	**30**	**45**	**65**	**90%**
Without Increase	**5**	**10**	**15**	**15**	**20**	**20%**
Description: The determination of best practices, while evolutionary, will inform all the other activities in this effort.						

Performance Goal: Develop standard ways of passing information and file formats	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	**5**	**15**	**45**	**65**	**85**	**95%**
Without Increase	**0**	**0**	**0**	**0**	**0**	**0%**
Description: This is the critical informatics piece of this effort. The percentages indicate the development of the "ecosystem" of standards necessary to achieve materials by design. 100% is impossible.						

PROGRAM CHANGE PERSONNEL DETAIL

(Dollar amount in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Materials scientist	Gaithersburg, MD	ZP IV	5	$105,211	$526,055
Materials scientist	Gaithersburg, MD	ZP III	2	74,872	149,744
Engineering technician	Gaithersburg, MD	ZT III	1	56,857	56,857
Computer scientist	Gaithersburg, MD	ZP IV	3	105,211	315,633
Research chemist	Gaithersburg, MD	ZP IV	2	105,211	210,422
Research chemist	Gaithersburg, MD	ZP V	4	123,758	495,032
Research physicist	Gaithersburg, MD	ZP IV	2	105,211	210,422
Research physicist	Gaithersburg, MD	ZP III	2	74,872	149,744
Research physicist	Gaithersburg, MD	ZP V	3	123,758	371,274
Research mathematician	Gaithersburg, MD	ZP IV	3	105,211	315,633
Research statistician	Gaithersburg, MD	ZP IV	1	105,211	105,211
Administrative/technical support	Gaithersburg, MD	ZA II	3	51,630	154,890
Total			31		3,060,917
Less Lapse		25%	(8)		(765,229)
Total full-time permanent (FTE)			23		2,295,688
2011 Pay Adjustment (1.4%)					0
2012 Pay Adjustment 2.3%)					0
TOTAL					2,295,688

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	23
Other than full-time permanent	0
Total	23
Authorized Positions:	
Full-time permanent	31
Other than full-time permanent	0
Total	31

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

	Object Class	Increase
11	Personnel compensation	
11.1	Full-time permanent	$2,296
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	2,296
12	Civilian personnel benefits	631
13	Benefits for former personnel	0
21	Travel and transportation of persons	285
22	Transportation of things	98
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	611
24	Printing and reproduction	43
25.1	Advisory and assistance services	0
25.2	Other services	332
25.3	Purchases of goods & services from Gov't accounts	1,843
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	2,500
25.6	Medical care	0
25.7	Operation and maintenance of equipment	103
25.8	Subsistence and support of persons	0
26	Supplies and materials	675
31	Equipment	1,583
32	Lands and structures	0
33	Investments and loans	0
41	Grants, subsidies and contributions	4,000
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Total obligations	15,000
	Less administrative savings	(758)
	Total reqeust	14,242

5. Innovations for 21st Century U.S. Manufacturing: Faster, Smarter and Cleaner (Base Funding: $5.619 million; Program Change: + 18 FTE and + $13.331 million).

NIST requests an increase of $13.331 million and 18 FTE for a total of $18.95 million to develop the measurement science, tools and standards that will provide the infrastructure to enable faster, cleaner, and more intelligent manufacturing.

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.

Secondly, 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."[9]

Lastly, promoting innovative technologies to reduce dependence on energy imports and to mitigate the impact of greenhouse gas emissions while creating green jobs and new businesses, is a priority of the Administration.

Proposed Actions:

This program represents a critical step in providing an advanced technical infrastructure for the future growth and prosperity of U.S. manufacturing. Three major technological areas will be emphasized: additive manufacturing, intelligent and autonomous robotic systems, and sustainable manufacturing. To achieve rapid, cost effective, environmentally friendly manufacturing capabilities, new measurement methods, and associated standards are needed. Working with industry and academia NIST will engage in research and standards efforts that advance:

- **Additive manufacturing:** In this program, NIST will conduct and sponsor research and development in technology areas central to a transformational future of U.S. manufacturers through additive manufacturing. 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."[10] 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. Additive manufacturing and rapid prototyping systems will provide the agility needed to rapidly make innovative customized complex products that are not realizable by more traditional

[9] Executive Office of the President, December 2009, "*A Framework for Revitalizing American Manufacturing*"
[10] "Roadmap for Additive Manufacturing Identifying the Future of Freeform Processing", 2009, University of Texas at Austin

manufacturing technologies or need to be produced cost-effectively in low-to-moderate volumes.[11]

- **Intelligent robotics and automated 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."[12] NIST will develop the measurement science needed to increase the versatility, agility, and ability of robots and automation equipment to (1) work safely in collaboration with and in close proximity to humans, and (2) augment human abilities with strength, dexterity, high precision, and repeatability to attain smart assembly and manufacturing. Ultimately, NIST will develop the measurement science for autonomy of robots that robustly and reliably serve as co-workers on the factory floor, augmenting and assisting human workers to achieve new levels of product quality and productivity
- **Sustainable Manufacturing:** 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.[13,14] 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 will 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.

Statement of Need and Economic Benefits:

A robust and 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 generates an additional $1.43 in economic activity in the rest of the economy for each $1 in merchandise sales (more than all other sectors,); 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.[17]

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[11] National Academy of Engineering, Lawrence Rhoades, "The Transformation of Manufacturing in the 21st Century," 2005, http://www.nae.edu/File.aspx?id=7297

[12] "A Roadmap for U.S. Robotics: From Internet to Robotics," CCC and CRA (NSF-funded), 2009, http://www.us-robotics.us/

[13] http://trade.gov/competitiveness/sustainablemanufacturing/2009_sustainability_summit.asp

[14] Report http://www.nist.gov/customcf/get_pdf.cfm?pub_id=905065

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

Globalization has placed new pressures upon the manufacturing sector. Today global markets are becoming increasingly technology-based. The U. S. manufacturing sector must adopt new technologies and processes to compete effectively in the future. Working with industry NIST has identified the following areas where increased measurement and standards would facilitate and accelerate the adoption of these new technologies and processes:

- **Additive manufacturing:** Additive manufacturing has the potential to enable U.S. manufacturers to dramatically reduce time-to-market and rapidly and cost-effectively produce complex—and even individualized—components for innovative products. Additive manufacturing promises to achieve this longstanding goal of manufacturers by reducing or eliminating the specialized tools that are usually needed to produce custom products, and by allowing part geometries and combinations of different materials that are not possible with conventional manufacturing processes.

  However, to realize this potential, several measurement barriers must be addressed. The 2009 Roadmap for Additive Manufacturing highlights the need for better measurement and characterization of surface quality, part accuracy, fabrication speed, and material properties.

  Intelligent Robotics: 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". [18] The Computing Community Consortium (CCC) Roadmap for U.S. Robotics[19] – a key document guiding OSTP views on robotics R&D needs – notes that "Robotics is a key transformative technology that can revolutionize manufacturing… the promise of flexible automation and automation for mass customization has not been realized except for special cases…. Robots [need] to be smarter, more flexible, and able to operate safely in less structured environments shared with human workers." A recent analysis distilled the technology development recommendations from four robotics roadmaps, including the one by CCC, into a single document.[20] NIST research and development in this program provides the missing performance measures and standards needed in these key technology areas in order to catalyze and accelerate progress in intelligent robotics and automation for agile manufacturing.

- **Sustainable Manufacturing:** 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 need defined measures and tools to demonstrate, deploy, and recognize new sustainable manufacturing practices to survive and grow in a global market. Furthermore, 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

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[18] Executive Office of the President, December 2009, "*A Framework for Revitalizing American Manufacturing*" http://www.whitehouse.gov/sites/default/files/microsites/20091216-maunfacturing-framework.pdf

[19] ibid.

[20] http://www.roboticsbusinessreview.com/articles/newsletter_view/roadmapping-robotics-opportunities

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.

Base Resource Assessment:

NIST currently has exploratory program efforts related to additive manufacturing, intelligent robotics, and sustainable manufacturing, as follows:

Measurement and Standards for Science-based Manufacturing: The program focuses on metrology and standards infrastructure necessary for a science-based approach to the manufacture of complex, high-value, knowledge-intensive products. Research topics include: material processing, preliminary work in metal-based additive processes, coordinated 5-axis motion, in-situ 3-degree fabricated parts; performance metrics for manufacturing equipment used as measuring tools; and manufacturing process monitoring and control using wireless sensor networks.

Measurement Science for Intelligent Manufacturing Robotics and Automation: This program aims to develop performance measurement science to characterize constituent components of intelligent manufacturing systems, define the target performance goals, and measure how well a component or overall system meets the goals for a limited set of manufacturing robotics technologies.

Sustainable and Lifecycle Information-based Manufacturing: Program work includes analysis of standards requirements and initial identification of best practices for sustainable manufacturing; creation of a limited set of lifecycle information models for interoperability among systems and tools that support sustainable manufacturing; and validation and testing of information models for sustainable design and manufacturing.

In support of the proposed activities it is noted that NIST has deep technical expertise in measurement science for manufacturing processes, equipment, and systems, and in intelligent systems theory, architectures, performance metrics, and standards. It has unique manufacturing process measurement capabilities and laboratory facilities—including state-of-the-art manufacturing equipment and control systems—that are required to develop the needed measurement science and standards for smart manufacturing. The program has several unique features that distinguish it from manufacturing research in industry and academia: 1) emphasis on infrastructural performance metrics, metrology, and standards that can be applied to a broad class of measurement and manufacturing technology challenges, 2) emphasis on development of rigorous and generic procedures to characterize measurement uncertainty that comply with international standards, and 3) long-term commitment, expertise, and neutrality essential for the development of harmonized and unbiased national and international standards. NIST has the necessary expertise, program focus, and government mandate to address the high-priority infrastructural measurement and standards challenges most needed by U.S. industry.

Schedule and Milestones:

Additive Manufacturing:

- New measurement methods, tools, and test specimens developed to improve system performance, materials qualification, and part quality for additive manufacturing processes. Completion in FY13.
- NIST additive manufacturing research testbed facility established. Completion in FY13.
- Standard methods and metrics developed for assessing additive manufacturing system performance. Completion in FY14.
- Methods and tools developed for characterizing, optimizing, and controlling innovative additive processes within the overall production system. Completion in FY15.

Intelligent Robotics:

- Performance measures and standards developed for industrial robot safety systems that allow safe operation in proximity to humans. Completion of ISO 10218 by FY13, ISO 10218 performance measures by FY14, and less restrictive standards by FY16.
- Performance measures developed for imaging sensors and perception for situational awareness in dynamic unstructured environments. Completion in FY14.
- Performance measures developed for tactile/force sensors, mechanisms, and algorithms to improve the manipulation capability of robotic systems. Completion in FY15.
- Performance measures and standards developed for next-generation robot systems that can perform a wider range of manufacturing operations. Completion of mixed palletizing in FY13, small manufacturer collaborative robotics by FY16.
- Methods developed to assess the planning and decision-making of robots. Completion in FY15.
- Standard representation of manufacturing and general knowledge required to support situational awareness and communication by robots developed. Completion in FY16.
- Metrics and standards developed for measuring the accuracy of robot situational awareness, including future predictions. Completion in FY16.
- Standard measurement framework developed for the replanning and adaptation by robots. Completion in FY16.
- Standard autonomy metrics framework developed that allows practitioners to define the autonomy requirements for their manufacturing operations and measure the autonomy capabilities of candidate robot solutions to ensure that they are appropriate. Completion in FY16.

Sustainable Manufacturing:

- Models and information flow in forward and reverse supply chains developed (reuse, recycle, remanufacturing, retake chains), working closely with U.S. industries. Completion in FY14.
- Sustainable manufacturing methods, best practices, and processes developed and documented by working with lead industries in key industrial sectors. Completion in FY15.
- Harmonized standards and information models developed for materials used in products to support regulations, which require rigorous and traceable data, working in cooperation with industrial consortia. Completion in FY15.
- Harmonized sustainability metrics and indicators appropriate for various regions and industrial segments developed, in cooperation with national and international standards bodies. Completion in FY15.
- Harmonized standards and information models developed, in cooperation with industrial consortia, for materials and chemicals used in manufacturing processes. Completion in FY16.

- Test sustainability metrics piloted through a Baldrige Performance Excellence Program type framework for a similar national award for sustainable manufacturing. Completion in FY16.
- Best practices deployed in key industrial sectors by working with MEP and their regional/academic partners. Completion in FY16.

Deliverables:

Additive Manufacturing:
- New measurement methods, tools, and test specimens to improve system performance, materials qualification, and part quality for additive manufacturing processes.
- Standard methods and metrics for assessing additive manufacturing system performance.
- Methods and tools for characterizing, optimizing, and controlling innovative additive processes within the overall production system.

Intelligent Robotics:
- Performance measures and standards for industrial robot safety systems that allow safe operation in proximity to humans
- Performance measures for imaging sensors and perception for situational awareness in dynamic unstructured environments
- Performance measures for tactile/force sensors, mechanisms, and algorithms to improve the manipulation capability of robotic systems
- Performance measures and standards for next-generation robot systems that can perform a wider range of manufacturing operations
- Methods to assess the planning and decision-making of robots
- Standard representation of manufacturing and general knowledge required to support situational awareness and communication by robots
- Metrics and standards for measuring the accuracy of robot situational awareness
- Standard measurement framework for the replanning and adaptation by robots
- A standard autonomy metrics framework that allows practitioners to define the autonomy requirements for their manufacturing operations and measure the autonomy capabilities of candidate robot solutions to ensure that they are appropriate

Sustainable Manufacturing:
- Models for forward and reverse supply chains (reuse, recycle, remanufacturing, retake chains)
- Sustainable manufacturing methods, best practices, and processes documents
- Harmonized standards and information models for materials used in products to support regulations, which require rigorous and traceable data
  - Harmonized sustainability metrics and indicators appropriate for various regions and industrial segments
  - Harmonized standards and information models for materials and chemicals used in manufacturing processes

Performance Goals and Measurement Data:

Additive Manufacturing:

Performance Goal: Number of measurement methods, tools, and test specimen types	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	-	2	4	-	-	-
Without Increase	-	0	0	-	-	-
Description: A total of 6 measurement methods, tools, and test specimen types developed to improve additive manufacturing system performance, materials qualification, and part quality.						

Performance Goal: Number of standard methods and metrics for assessing additive manufacturing system performance	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	-	-	1	4	-	-
Without Increase	-	-	0	0	-	-
Description: A total of 5 standard additive manufacturing performance assessment methods and metrics developed.						

Performance Goal: Number of methods and tools for characterizing, optimizing, and controlling additive manufacturing within the overall production system	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	-	-	-	2	2	-
Without Increase	-	-	-	0	0	-
Description: A total of 4 methods and tools for characterizing, optimizing, and controlling additive manufacturing within the overall production system.						

Intelligent Robotics:

Performance Goal: Number of performance metrics and standards for next generation robot safety systems	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	-	-	1	1	0	2
Without Increase	-	-	0	0	0	0
Description: A total of 4 performance metrics and standards for next generation robot safety systems that allow safe operation in proximity to humans.						

Performance Goal: Number of performance metrics for sensing, perception, and manipulation	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	-	4	2	1	2	1
Without Increase	-	0	0	0	0	0
Description: A total of 10 performance metrics for sensing, perception, and manipulation.						

Performance Goal: Number of performance metrics and standards for robot planning, decision-making, and adaptation	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	-	-	1	2	2	1
Without Increase	-	-	0	0	0	0
Description: A total of 6 performance metrics and standards for robot planning, decision-making, and adaptation.						

Performance Goal: Number of performance metrics and standards for assessing and improving robot situational awareness and communication	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	-	-	2	1	2	2
Without Increase	-	-	0	0	0	0
Description: A total of 7 performance metrics and standards for assessing and improving robot situational awareness and communication.						

Performance Goal: Standard autonomy metrics framework that allows specification and assessment of autonomy capabilities of robotic solutions	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	-	-	-	-	-	1
Without Increase	-	-	-	-	-	0
Description: A standard autonomy metrics framework developed that allows specification and assessment of autonomy capabilities of robotic solutions.						

Sustainable Manufacturing:

Performance Goal: Number of models and information flows in forward and reverse supply chains.	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	-	2	3	3	-	-
Without Increase	-	0	0	0	-	-
Description: A total of 8 models and information flows for reuse, recycle, remanufacturing, and retake chains in forward and reverse supply chains. (4x2)						

Performance Goal: Number of sustainable manufacturing methods, best practices, and processes.	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	-	2	3	3	2	2
Without Increase	-	0	0	0	0	0
Description: A total of 12 best practices, processes and methods for sustainability, developed, piloted and deployed.						

Performance Goal: Number of harmonized standards and information models developed for material usage in products and in manufacturing processes.	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	-	4	4	4	4	2
Without Increase	-	0	0	0	0	0
Description: A total of 18 harmonized standards and information models for materials declaration for sustainability of manufactured products and sustainable manufacturing processes.						

Performance Goal: Number of harmonized sustainability metrics and indicators.	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	-	5	5	5	5	5
Without Increase	-	0	0	0	0	0
Description: A total of 25 harmonized sustainability metrics and indicators for sustainability, developed, standardized and deployed.						

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amount in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Supervisory industrial engineer	Gaithersburg, MD	ZP V	1	$123,758	$123,758
Industrial engineer	Gaithersburg, MD	ZP V	1	123,758	123,758
Industrial engineer	Gaithersburg, MD	ZP IV	1	105,211	105,211
Supervisory mechanical engineer	Gaithersburg, MD	ZP V	1	123,758	123,758
Mechanical engineer	Gaithersburg, MD	ZP IV	1	105,211	105,211
Supervisory computer scientist	Gaithersburg, MD	ZP V	1	123,758	123,758
Computer scientist	Gaithersburg, MD	ZP IV	1	105,211	105,211
Electronics engineer	Gaithersburg, MD	ZP V	1	123,758	123,758
Electronics engineer	Gaithersburg, MD	ZP IV	2	105,211	210,422
Electrical engineer	Gaithersburg, MD	ZP V	3	123,758	371,274
Mechanical engineer	Gaithersburg, MD	ZP V	5	123,758	618,790
Computer scientist	Gaithersburg, MD	ZP V	4	123,758	495,032
Administrative/technical support	Gaithersburg, MD	ZP IV	2	51,630	103,260
Total			24		2,733,201
Less Lapse		25%	(6)		(683,300)
Total full-time permanent (FTE)			18		2,049,901
2011 Pay Adjustment (1.4%)					0
2012 Pay Adjustment 2.3%)					0
TOTAL					2,049,901

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	18
Other than full-time permanent	0
Total	18
Authorized Positions:	
Full-time permanent	24
Other than full-time permanent	0
Total	24

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

	Object Class	2012 Increase
11	Personnel compensation	
11.1	Full-time permanent	$2,050
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	2,050
12	Civilian personnel benefits	564
13	Benefits for former personnel	0
21	Travel and transportation of persons	248
22	Transportation of things	61
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	578
24	Printing and reproduction	44
25.1	Advisory and assistance services	0
25.2	Other services	1,869
25.3	Purchases of goods & services from Gov't accounts	2,109
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	2,412
25.6	Medical care	0
25.7	Operation and maintenance of equipment	233
25.8	Subsistence and support of persons	0
26	Supplies and materials	754
31	Equipment	1,578
32	Lands and structures	0
33	Investments and loans	0
41	Grants, subsidies and contributions	1,500
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Total obligations	14,000
	Less administrative savings	(669)
	Total request	13,331

6. Measurement Science and Standards to Support Biomanufacturing (Base Funding: $5.8 million; Program Change: + 18 FTE and + $9.526 million).

NIST requests an increase of $9.526 million and 18 FTE for a total of $15.326 million to create the measurement and standards infrastructure necessary to efficient and effective manufacture and characterization of biologic drugs.

Within the current manufacturing paradigm for the biotechnology industry, manufacturing costs are high, production efficiency is low, process understanding is limited, and manufacturing processes and product quality remain largely frozen. This NIST program will develop measurement methods, protocols, and standards for improved, real-time measurement of biologic products during manufacturing. NIST will work closely with industry, the FDA, and other standards organizations with the goal of developing metrology infrastructure to achieve greater process understanding, higher quality biologic products through continuous improvement of manufacturing processes, and agile biomanufacturing processes required for next generation products such as stem cells and personalized biotherapeutics.

Proposed Actions:

Through this initiative NIST will develop measurement science, process monitoring tools, and standards for the biotechnology industry to enable more cost efficient manufacturing of a range of biologic products. This suite of metrology tools will also be generators of manufacturing knowledge that will allow rational process improvements leading to higher quality, lower cost biologic products. To accomplish these goals, the program will target two primary objectives:

- Develop a test-bed bioreactor facility to benchmark and validate the performance of models and measurement tools used for in-line and at-line bioprocess monitoring. The facility will be used to develop protocols, standards and measurement science underpinning the use of these tools so they provide robust, accurate results. The test-bed bioreactor will also be used as a platform for research aimed at achieving a higher level of process understanding and control capability.
- Benchmark and develop measurement science, protocols, and standards for sensors or instruments used in bioprocess monitoring. Metrology will be developed for both current generation sensor technologies and next-generation sensor technologies. Current generation tools are sensors that are currently used by the industry and they typically measure global properties such as temperature, pH, dissolved gases, nutrient molecules, or small molecules metabolites. These sensors also tend to be used in conjunction with multivariate data analysis (MVDA) models that are correlated with product trajectory during manufacturing. Next generation tools are advanced sensors that will directly measure critical quality attributes of biologic products or biomolecular signatures of bioprocesses that are direct indicators of product quality. NIST has held several workshops with industry to assess future measurement needs for bioprocess monitoring. One example of a need voiced by industry is technology for online monitoring of cell metabolism where the ability to monitor cell-distress and communication signals in real time would provide direct, real-time feedback on the cell culture process.
- Develop the measurement services and tools to aid in the characterization of the safety and efficacy of biologic drugs including standards and references to measure critical factors such as immunogenicity, 3-D protein structure, and post-translational modifications such as gycosylation that can affect the efficacy and reactivity of a biological drug.

Statement of Need and Economic Benefits:

The high cost of biotechnology medicines is adversely impacting the U.S. healthcare system and economy. Biotechnology drugs, currently dominated by protein therapeutics, are the fastest-growing class of pharmaceuticals and the fastest growing (~20%/year) category of health care spending.[28] Manufacturing costs contribute significantly to the high cost of these drugs. Some have estimated that the biotech industry wastes ~$15B/yr due to inefficient manufacturing, as much as it spends on R&D for discovery and development of new drugs.[29] Dr. Mark McClellan, Director of the Engelberg Center for Health Care Reform and former FDA commissioner in the Bush administration, has long advocated that manufacturing needs to be a part of the general health care policy debate: "Keep improving pharma manufacturing, since manufacturing costs are one of the largest components of our spending on prescription drugs, and, thus, an important factor in reducing health care costs."[30] On the horizon are potentially even costlier regenerative medicine products such as stem cells. Production of complex stem cell therapeutics represents significant challenges and robust, commercial-scale manufacturing processes for these products have not yet been established and validated. Nonetheless, given the complexity of these products, it is likely that the manufacturing costs for stem cell therapies will greatly exceed those for protein drugs.

There are several factors that are responsible for the high manufacturing costs of biologic products. These therapeutics are produced by living cells that are highly sensitive to external conditions such as temperature, pH, and the composition of the complex surrounding medium. As a result, manufacturing processes can be highly variable and are typically poorly understood. Under the current paradigm, manufacturing of biologic drugs is a slow (1-3 weeks), highly empirical, recipe-driven, batch mode process where product quality is ensured by end-product testing. Production processes are frozen for the fear that manufacturing changes will alter the safety and efficacy of products in an unknown, immeasurable way. Thus, even minor manufacturing changes need regulatory approval and expensive clinical studies of the product in animals or humans may be required. Therefore, biologic products do not undergo continuous improvement like that for other manufactured goods such as electronics or autos. As a result, patients do not receive the benefit of increasing quality and lower costs of biologic products.

NIST is ideally positioned to work with industry and the FDA to understand measurement problems, develop innovative solutions, and help achieve consensus in standards development. The biotechnology industry is a major driver of economic activity with U.S. companies recording $72B of sales and a market cap of $482B in 2007.[31] Biotechnology products comprise the fastest-growing sector in drug development, and they are expected to account for more than 50 percent of all new product approvals by 2015 and ~70 percent by 2025.[32]

A NIST measurement program focused on improved manufacturing of biologic drugs will not only support the manufacturing of current products, but also next-generation products including:

- Manufacturing of cost-saving biosimilars. Biosimilars are generic versions (although not identical copies) of biotech drugs that will help drive costs down of many expensive therapies that currently have market exclusivity.
- Personalized medicines and manufacturing of biologic therapies tailored to individuals' genetic makeup. Biologic drugs are likely to figure prominently in personalized healthcare strategies, a role that will only be possible with efficient, agile biomanufacturing strategies that can meet the regulatory and economic requirements for successful commercialization.

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[28] Biotech 2008 – Life Sciences: A 20/20 Vision to 2020, Burrill and Company, 2008.
[29] J. Macher, J. Nickerson, Pharmaceutical Manufacturing Research Project, Sept. 2006. (http://faculty.msb.edu/jtm4/PMRP%20results/)
[30] A. Shanley, "Industry Rx: Manufacturing Research", Pharmaceutical Manufacturing, Oct. 2007, 9-14.
[31] "Biotech 2007: A Global Transformation" Burrill & Compnay, 2007.
[32] "The Billion-Plus Blockbusters: The Top 25 Biotech Drugs" BioWorld, M. Harris, http://www.bioworld.com/servlet/com.accumedia.web.Dispatcher?next=bioWorldHeadlines_article&forceid=51907

Base Resource Assessment:

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.

Schedule and Milestones:

- Develop test-bed bioreactor with uniquely flexible instrumentation and control capabilities (FY13)
- Compare performance of multiple sensors for temperature, dissolved oxygen, and pH in the test-bed reactor and in a laboratory setting (FY14)
- Implement software for process control of bioreactor (FY15)
- Develop procedures to allow instrumentation developers access to test bed reactor (FY14)
- Demonstrate process control using multiple process models (FY17)
- Develop test-bed bioreactor for cell products with uniquely flexible instrumentation and control capabilities (FY16)
- Standard Reference Materials for common biomanufacturing feedstocks (FY16)
- Improved method for validating in-line ionic conductivity meters (FY14)
- Complete assessment of measurement uncertainties due to non-uniform conditions in bioreactors and impact on process understanding (FY14)
- Complete metrological assessment of sensor technology for disposable bioreactors (FY15)
- Standardized methods and reference materials for validating host cell protein assays (FY17)
- Standard Reference Materials and validated methods for characterizing trace impurities in common biomanufacturing feedstocks (FY15)
- Develop data sets for validation of MVDA implementations for bioreactor control (FY14)
- Complete simulation studies of effects of measurement errors (FY13)
- Develop MVDA models that are integrated with latest bioreactor process models (FY16)
- Derive simplified control algorithms from results of full MVDA analysis (FY17)
- Develop and validate tools for real-time measurement of monoclonal antibody product concentration (FY14)
- Develop and validate tools for rapid glycosylation analysis (FY16)
- Develop and validate tools for early detection of protein aggregation in bioprocesses (FY15)
- Develop and validate tools for cell therapy products including those to assess the viability and function of cell therapies (FY17)

Deliverables:

The major outputs of this program will be:

- validated protocols, standards, the benchmarking of existing methods, and the development of new metrology tools that will result in greater confidence in bioprocess measurements,
- improved process understanding, and increased manufacturing efficiency due to less waste and fewer product rejections.

Performance Goals and Measurement Data

Performance Goal: Establish a partnership for a biomanufacturing testbed.	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		1	1	1	1	1
Without Increase		0	0	0	0	0
Description: Number of testbeds created						

Performance Goal: Provide new measurement tools to the FDA and biotechnology industry	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		10%	25%	50%	75%	100%
Without Increase		0	5%	5%	5%	5%
Description: Percentage of proposed measurement tools and services delivered						

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amount in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Project manager	Gaithersburg	ZP V	1	$123,758	$123,758
Biophysicist	Gaithersburg	ZP V	1	123,758	123,758
Mass spectrometrist	Gaithersburg	ZP V	1	123,758	123,758
Analytical chemist	Gaithersburg	ZP IV	1	105,211	105,211
Protein nmr spectrometrist	Gaithersburg	ZP IV	1	105,211	105,211
Analytical chemist	Gaithersburg	ZP III	1	74,872	74,872
Immunologist	Gaithersburg	ZP III	2	74,872	149,744
Bioanalytical chemist	Gaithersburg	ZP III	1	74,872	74,872
Protein biochemist	Gaithersburg	ZP III	1	74,872	74,872
Molecular biologist	Gaithersburg	ZP III	1	74,872	74,872
Neutron biophysicist	Gaithersburg	ZP III	1	74,872	74,872
Analytical mass spectrometrist	Gaithersburg	ZP III	1	74,872	74,872
Bioprocess engineer	Gaithersburg	ZP III	1	74,872	74,872
Applied geneticist	Gaithersburg	ZP III	1	74,872	74,872
Cell biologist	Gaithersburg	ZP III	1	74,872	74,872
Bioinfomaticist	Gaithersburg	ZP III	2	74,872	149,744
Assay biologist	Gaithersburg	ZP III	1	74,872	74,872
Technician	Gaithersburg	ZT III	3	56,857	170,571
Administrative support	Gaithersburg	ZA II	2	51,630	103,260
Total			24		1,903,735
Less Lapse		25%	(6)		(475,934)
Total full-time permanent (FTE)			18		1,427,801
2011 Pay Adjustment (0.0%)					0
2012 Pay Adjustment 0.0%)					0
TOTAL					1,427,801

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	18
Other than full-time permanent	0
Total	18
Authorized Positions:	
Full-time permanent	24
Other than full-time permanent	0
Total	24

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

	Object Class	2,012 Increase
11	Personnel compensation	
11.1	Full-time permanent	$1,428
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	1,428
12	Civilian personnel benefits	393
13	Benefits for former personnel	0
21	Travel and transportation of persons	215
22	Transportation of things	13
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	398
24	Printing and reproduction	5
25.1	Advisory and assistance services	0
25.2	Other services	173
25.3	Purchases of goods & services from Gov't accounts	121
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	400
25.6	Medical care	0
25.7	Operation and maintenance of equipment	170
25.8	Subsistence and support of persons	0
26	Supplies and materials	383
31	Equipment	51
32	Lands and structures	0
33	Investments and loans	0
41	Grants, subsidies and contributions	4,000
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Direct obligations	7,750
	Transfer to the NIST Working Capital Fund	2,250
	Total obligations	10,000
	Less administrative savings	(474)
	Total requested	9,526

7. Measurements to Support the Manufacture and Production of Nanotechnology-based Products (Base Funding: $13.852 million; Program Change: +58 FTE and + $28.256 million).

NIST requests an increase of $28.256 million and 58 FTE for a total of $42.108 million to support a number of projects and improvements that will enable industry to fully take advantage of recent innovations in nanotechnology.

Proposed Actions:

Economic recovery and economic growth are the pre-eminent priorities for the Department of Commerce [33] and the Administration[34]. A strong economy hinges on revitalizing U.S. manufacturing by fostering innovation, commercializing new products, and creating new jobs. In the President's *Framework for Revitalizing American Manufacturing*[35], nanotechnology is called out as having the "promise to transform production processes and consumer products for everything from traditionally high-tech products like computers to less obvious sources of innovation and growth like sunscreen and paint." This initiative focuses on addressing four key areas that can enable significant innovations, and breakthroughs in manufacturing, through adoption and development of nanotechnology. The key areas are (i) recapitalization of the NIST Center for Nanoscale Science and Technology, (ii) Nanomaterial Environmental, Health and Safety (Nano-EHS), (iii) High-Volume Nanomanufacturing with Advanced Materials, and (iv) Measurements to Enable the Manufacture of Advanced 3rd Generation Photovoltaics.

Recapitalization of the NIST Center for Nanoscale Science and Technology (CNST) ($5.180 million):

This component of the initiative support the recapitalization and updating of the equipment and instrumentation in the NIST Center for Nanoscale Science and Technology (CNST) in order to provide the cutting edge research environment required by the nanoscale measurement and fabrication needs of industry and other stakeholders. By providing the latest tools and methods to stimulate advances in nanotechnology and nanomanufacturing, this initiative directly supports the DOC goal of promoting innovation and entrepreneurship by providing access to technologies critical to transforming our economy and fostering U.S. competitiveness. Additionally, this initiative will ensure the availability of the infrastructure necessary to support key elements of the National Nanotechnology Initiative (NNI), including the NNI Signature Initiatives related to nanomanufacturing, nanoelectronics, and energy technologies.

The proposed initiative will provide the resources necessary to replace and update the existing NanoFab instrumentation. The current NanoFab, which will include ARRA-purchased tools (on order), operates 90 tools required for the measurement and manufacturing of nanoscale materials and devices. These tools represent a capital investment of $30 million which, based on tool-lifetimes and advances in technology, will require an estimated annual investment of $5.5 million to purchase and install new tools. The proposed funding will allow for the replacement of these tools to maintain or augment current program capabilities, and to ensure that the provided tool set meets the advanced requirements of our stakeholders.

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[33] Secretary Locke Testimony to the U.S. Senate Committee on Appropriations, Hearing on FY 2011 Commerce Dept. Budget, March 4, 2010, http://appropriations.senate.gov/ht-commerce.cfm?method=hearings.download&id=9324323f-b7d6-44bd-89e6-e80a26400465

[34] *Science and Technology Priorities for the FY 2011 Budget,* P. R. Orszag and J. P. Holdren, August 4, 2009, http://www.whitehouse.gov/omb/assets/memoranda_fy2009/m09-27.pdf

[35] *A Framework for Revitalizing American Manufacturing,* Executive Office of the President, December 2009, http://www.whitehouse.gov/sites/default/files/microsites/20091216-maunfacturing-framework.pdf

Nano-EHS ($8.477 million):

NIST will continue its efforts to develop well-defined and validated measurement methods, tools, standards and protocols that can help contribute to an enhanced understanding of the safety of nanomaterials, and the mechanisms of interaction between nanomaterials, the environment and humans – all of which will contribute to improved understanding about the safety of nanomaterials. This fundamental work will also help better understand the toxicology of nanomaterials. To enable the safe manufacture, use, and disposal of Engineered Nanomaterials (ENMs) and ENM-enabled products, NIST will:

- Generate standardized methods for collecting samples of air containing ENMs in manufacturing plants and the surrounding environment, including statistical modeling to assure unbiased, representative, and reproducible sampling.
- Develop and disseminate reference materials and test methods to accurately measure the concentration and distribution of critical properties—size, shape, and surface area and composition—of airborne ENMs in samples.
- Design standard assays to identify the critical properties of airborne ENMs that determine the primary hazards—inhalation toxicity and dermal penetration.
- Develop and disseminate standards and methods to accurately measure, and models to predict, the release of ENMs during use and disposal of nanomaterial-enabled products.

To maximize the impact of investment, NIST will focus on ENMs of greatest regulatory concern based on production volume, widespread use in products, and potential hazards, namely silver, titanium dioxide, and cerium oxide nanoparticles, carbon nanotubes, and clay-based nanocomposites. These five specific materials encompass the major classes of ENMs—metals, oxides, carbon-based, and composites—and thus measurement tools developed for this group are relevant to other specific ENMs in the same class.

High-Volume Nanomanufacturing with Advanced Materials ($6.876 million):

This component of the initiative will provide the critical tools needed for successful realization of high-volume nanomanufacturing with advanced materials, and the associated revitalization of some aspects of the U.S. manufacturing industry.

Efforts will focus on the development of suitable in-line measurement techniques to enable closed-loop process control, thereby overcoming a principal obstacle to large-scale nanomanufacturing. Methods that can report on the nanoscale structure/properties of a material or device array, in a cost-effective manner, as it moves by at high speed will be developed. Advances shall be made in the development of measurement and manufacturing infrastructure to ensure product quality made through nanomanufacturing processes. To ensure that these measurement tools and standards can be disseminated rapidly to the manufacturing community, NIST will develop appropriate partnerships with industry and other U.S. government agencies to both seek input, and enable technology transfer.

Measurements to Enable the Manufacture of Advanced 3rd Generation Photovoltaics ($7.723 million):

This component of the initiative focuses on the application nanomeasurement capabilities to the challenges and barriers to the development and manufacture of 3rd generation solar technologies. 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. 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. To dramatically improve performance and overcome these barriers, new third-generation photovoltaics technologies seek to exploit mutilayers, nanostructures, and interfaces. Unfortunately, realization of commercial third-generation PV is currently limited by the lack of reproducible measurements of critical phenomena such as photogeneration, carrier transport, and losses at the relevant length scales. New measurement tools must be devised to nondestructively measure the 3-D spatial and temporal dependence of photogeneration and carrier transport under realistic conditions. The initiative seeks to fund additional research in the following focused areas:

- Nondestructive spatially-resolved characterization of electronic structure and potentials, and carrier transport
- Develop new precision measurements of composition, properties, and processes at critical interfaces which govern photogeneration and transport, and will enable advances in a new generation of solar cells
- Measurements to Characterize PV Device Degradation and Reliability
- Test Structures and Reference Materials for Dissemination of New Measurements

Statement of Need and Economic Benefits:

In the President's *Framework for Revitalizing American Manufacturing*[36], nanotechnology is called out as having the "promise to transform production processes and consumer products for everything from traditionally high-tech products like computers to less obvious sources of innovation and growth like sunscreen and paint." The work proposed here directly supports these manufacturing and economic priorities. This work is unique given the potential of nanotechnology, but associated concerns about the safety of nanotechnology. Successfully addressing questions and concerns about the safety of nanotechnology will have a direct impact on the adoption and growth of this technology, and enable further innovations through disruptive technologies such as high volume nanomanufacturing using advanced materials.

By one estimate, total revenue from products incorporating nanotechnology is expected to be $2.5 trillion in 2015[37]. As these products are incorporated in more and more technologies, and completely new nanoscale devices are developed, nanotechnology will have a significant impact on the global market. Realization of this potential economic impact and the translation of the government's investment in nanotechnology R&D into advanced nanotechnology manufacturing capabilities will require continued advances in measurement capabilities. The CNST provides a unique national resource, coupling a world-class tool-set for nanomanufacturing in the NanoFab with the metrology expertise across the NIST laboratories, as highlighted in the latest National Research Council review of the CNST which noted that *"Coupling and exploiting the unique strengths of the CNST and NIST, in metrology, for example, and making these available to the R&D community would be a significant contribution to the U.S. research base and a tremendous asset in the United States."*[38] Recapitalization of the CNST will enable the CNST, a national user facility, to provide access to unique state-of-the-art instrumentation and methods required to make and measure components at the nanoscale level, to researchers and technologists, who would otherwise be unable to access such instruments due to the limited availability and high costs.

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[36] *A Framework for Revitalizing American Manufacturing,* Executive Office of the President, December 2009, http://www.whitehouse.gov/sites/default/files/microsites/20091216-maunfacturing-framework.pdf

[37] *The Recession's Ripple Effect on Nanotech,* Lux Research, LRNI-R-09-03, June 2009.

[38] An Assessment of the National Institute of Standards and Technology Center for Nanoscale Science and Technology: Fiscal Year 2009, Panel on Nanoscale Science and Technology, National Research Council.

Nanotechnology is also anticipated to play a key role in manufacturing by either reviving or replacing the traditional manufacturing industry with high volume nanomanufacturing based on advanced materials. The U.S. is a technological lead in developing new materials and technologies, but must work hard to translate that into commercial success. One of the principal obstacles to scaling up nanomanufacturing is the absence of suitable in-line measurement techniques to enable closed-loop process control. Methods are needed that are capable of reporting on the nanoscale structure/properties of a material or device array, in a cost-effective manner, as it moves by at high speed. The demonstration of a new technology typically involves producing a small number of working devices under highly optimized laboratory environments. Commercialization requires producing thousands or millions of these devices with small numbers of defects and good yields. This requires developing the measurement and manufacturing infrastructure to ensure product quality. Currently, the measurement science and technology needed to enable nanomanufacturing in the U.S. does not exist. At the same time countries in Asia and Europe are investing significant resources either directly in the companies trying to commercialize technologies that require nanomanufacturing or in consortia and Government-supported technology parks to facilitate the manufacturing and commercialization of such technologies, putting the U.S. at a significant potentially competitive disadvantage.

Third-generation photovoltaics are a prime example of how the application of advanced nanotechnology and nanomanufacturing capabilities can revolutionize a technology. For the U.S. to maintain competitive in this field it must invest in the development and manufacture of these new technologies. Currently China had 20 percent of global PV manufacturing in 2006 and 35 percent in 2007. In 2008, China produced 2.4 GW of solar cells. Plans are underway for the Ordos New Energy Industry Demonstration Zone (NEIDZ), which will implement 11,950 MW of renewable energy including 3,900 MW of PV solar and 720 MW of concentrating solar thermal. Construction on the first phase is expected to begin in 2010, and will further China's efforts toward reaching its renewable energy goal of 15 percent by 2020.

Despite the potential and promise of nanotechnology, the economic and social benefits may never be fully realized due to unknown EHS risks of Engineered Nanomaterials (ENMs) and ENM-enabled products throughout all stages of their lifecycles. These risks stifle commercial manufacture of raw ENMs and products containing ENMs, as industry is reluctant to invest in the development and manufacturing of ENM products for several reasons: consumer concerns regarding the safety of ENM products will limit sales; overly conservative regulations will increase production costs; and under-regulation will limit manufacturers' confidence in their ability to protect workers, the public, and the environment. According to the NIOSH report *Approaches to Safe Nanotechnology* [39], the greatest worker and public risk from ENMs is their ability "to enter the body through the respiratory system if they are airborne and in the form of respirable-size [nano]particles." Lesser risks are uptake of ENMs into the human body by skin penetration and ingestion. Exposure of workers to airborne ENMs can occur during production of ENMs, incorporation of ENMs into products, and maintenance of manufacturing facilities. Exposure of the public to ENMs is most likely to occur by the release from ENM-enabled products. EHS risks need to be identified and assessed in order to enable commercial manufacture of raw ENMs and products containing ENMs. Knowledge of risks will enable appropriate regulatory measures to be established, thus alleviating consumer concerns and spurring development and manufacturing of ENM products. The economic benefits of such products are projected to be substantial[40]. Industry and regulatory agencies need measurement tools—reference materials, standard test methods, and predictive models—to generate accurate data describing ENM

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[39] *Approaches to Safe Nanotechnology: Managing the Health and Safety Concerns Associated with Engineered Nanomaterials*, National Institute for Occupational Safety and Health (NIOSH) report, March 2009, http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf

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

properties and hazards for the purpose of science-based identification and assessment of nano-EHS risks.

Base Resource Assessment:

The initiative builds upon multiple program areas across NIST with resources totaling $13.852 million that serves the U.S. industrial and scientific research communities through the provision of highly collaborative, multidisciplinary research staff and the NanoFab shared-use facility; and, through the provision of critical measurement technologies and services to researchers in industry, academia, and government that support the innovation and application of nanotechnology to critical national challenges.

Schedule and Milestones:

<u>CNST Recapitalization:</u>

1. Annual tool capability assessment, user needs assessment, and market research (FY12–FY16)
2. Annual tool acquisitions and installations in the following categories (FY12–FY16):
   - Nanolithography
   - Metal deposition
   - Atomic layer deposition
   - Wet chemistry
   - Dry etching

<u>Nano-EHS:</u>

1. Sampling air containing airborne nanomaterials
   - Standardized methods to sample air at various locations in a manufacturing plant and the surrounding environment. (FY12–FY13)
   - Devices and methods to sample air in the breathing zone of a worker. (FY13–FY14)
   - Standard test methods and novel instruments as required for real-time, in-field sampling of air for continuous monitoring. (FY14–FY15)
   - Statistical models to optimize air-sampling parameters such as volume of air and frequency of sampling. (FY12–FY14)

2. Concentration and properties of airborne nanomaterials
   - Standard test methods and reference materials to measure the background concentrations of incidental airborne nanomaterials in a manufacturing environment before production, processing, or handling of an ENM. (FY13–FY14)
   - Standard test methods and reference materials to measure the number concentration of a single type of ENM in an air sample (FY14–FY15) and the number concentrations of different types of ENMs in an air sample. (FY16)
   - Standard test methods and reference materials to measure the size and shape distributions of a single type of ENM in an air sample (FY14–FY15) and the distributions of different types of ENMs in an air sample. (FY15–FY16)

- Standard test methods and reference materials to measure the surface area distribution of a single type of ENM in an air sample (FY13–FY14) and the distributions of different types of ENMs in an air sample. (FY14–FY15)
- Standard test methods to measure the surface composition distribution of a single type of ENM in an air sample. (FY14–FY16)

3. Inhalation toxicity and dermal penetration of airborne nanomaterials
   - Reference biomarkers and other indicators to enable interlaboratory studies of dermal penetration of ENMs (FY13) and interlaboratory studies of genotoxic and cytotoxic responses to ENMs in lung tissue. (FY14)
   - Standard assays to assess the dermal penetration of airborne ENMs. (FY14–FY15)
   - Standard assays to assess the toxicological response of lung tissue to airborne ENMs. (FY14–FY16)
   - High throughput methods to assess inhalation toxicity (FY15–FY16) and dermal penetration. (FY16)

4. Release of ENMs from products during use and disposal
   - High-throughput test methods and reference materials to measure the extents and rates of release of ENMs from products into the environment due to wear (FY12–FY13), incineration (FY12–FY14), and chemical reactions. (FY15–FY16)
   - Comprehensive data sets of the extents and rates of releases of ENMs in relevant media and use and disposal conditions. (FY13–FY16)
   - Models to predict release of ENMs in relevant media and use and disposal conditions. (FY14–FY16)

<u>High Volume Nanomanufacturing:</u>

1. **In-line metrology tools for CNT synthesis and CNT-based composite material fabrication (FY 12-17)**
   - Metrology techniques to monitor the uniformity of components and composite materials incorporating CNTs, and used for nanomanufacturing.
   - Metrology techniques to identify critical defects.

2. **Assessment methods for EHS risk assessment during fabrication of CNT- based composite materials (FY 12 – 16)**
   - Critical measurement science for understanding the mechanisms, measuring and modeling the rate, and characterizing properties of nanoparticles released from nanocomposite products during fabrication, forming, service and post-service.
   - Methods for determining quantity and nature of CNTs released from products during life cycle use.

3. **Measurement infrastructure for manufacturing of flexible and printed electronics (FY 12-14)**
   - Measurements to establish the use of high-throughput, inexpensive, printing technologies to reliably manufacture robust electronic components on mechanically flexible substrates using electronically-functional and printable inks.
4. **Measurement testbed for robust roll-to-roll nanomanufacturing (FY 12-16)**
   - Flexible nanomanufacturing testbed with the following qualities:

- Ability to translate a large variety of sheet or web substrates, via the industry-relevant roll-to-roll process, at manufacturing speeds.
- Ability to outfit the roll-to-roll testbed with modules for printing, deposition and patterning of a wide variety of model functional nanomaterials or nanostructures that represent a broad cross-section of viable nanomanufactured products, from structural nanocomposites to novel electronics devices.
- Ability to outfit the roll-to-roll testbed with online measurement modules, developed at NIST and in industry, in order to assess the ability of this instrumentation to assess factors including adherence to process windows, product quality control, and defect detection.
- Ability to produce a wide variety of model specimens suitable for benchmarking tests and predictions of product lifetime and reliability.

Measurements to Enable the Manufacture of Advanced 3rd Generation Photovoltaics

1. **Develop nondestructive spatially-resolved characterization of electronic structure and potentials, and carrier transport to enable the next generation of photovoltaics.**
   - FY 2012 - FY 2018: Develop time/space resolved microwave photoconductivity for excitonic PVs.
   - FY 2012 - FY 2018: Develop new scanned probe-based defect energy and density measurements based on spectroscopic photocapacitance (SPC) and Fourier transform deep level transient spectroscopy (FT-DLTS) for excitonic PVs.
   - FY 2012 - FY 2017: Develop non-destructive field distribution measurements using electro-optic techniques.
   - FY 2012 - FY 2017: Develop current-voltage and impedance spectroscopy measurement methodology.
2. **Develop novel measurements of chemical and molecular composition and electronic structure at interfaces that will enable advances in a new generation of solar** cells.
   - FY 2012-FY 2016: Develop solid-state nuclear magnetic resonance (NMR) measurements of the molecular structure of interfaces.
   - FY 2012-FY 2016: Develop optical spectroscopies for real-time depth dependent characterization of charge separation and material structures.
   - FY 2012-FY 2016: Develop x-ray absorption spectroscopy (XAS) capability to measure electronic structure of photovoltaics.
   - FY 2012-FY 2016: Develop x-ray and neutron scattering methods to quantify phase behavior and morphology of bulk heterojunction excitonic PV devices.
   - FY 2012-FY 2016: Develop an x-ray photoelectron (XPS) microscope for quantitative nanoscale mapping and imaging of chemical/electronic materials structure at buried interfaces.
3. **Develop new measurements to improve understanding of PV device degradation and reliability.**
   - FY 2012-FY 2017: Demonstrate use of defect probes for reliability measurement.
   - FY 2012- FY 2016: Develop measurement methods and standards for failure analysis of PV devices.
   - FY 2012-FY 2017: Develop device models and numerical simulations to accurately describe device operation and degradation.
4. **Provide validation and traceability for critical measurements via test structures and reference materials.**
   - FY 2012-FY 2016: Develop and validate prototype selective epitaxial structures for scanning probe calibrations.

- FY 2012-FY 2016: Develop standards for emergent atom probe tomography measurement for 3rd Gen PV material systems.

Deliverables:

CNST Recapitalization

(FY 12-16) State-of-the-art shared-use capabilities for:

- Nanolithography, such as electron-beam lithography, laser pattern generation, nanoimprint lithography;
- Metal deposition, such as electron-beam evaporation and sputter deposition;
- Atomic layer deposition, such as thermal and plasma coatings of oxides, nitrides, and metals;
- Wet chemistry, such as heated acid etching and buffered oxide etching;
- Dry etching, such as multipurpose plasma etching and deep reactive ion etching;
- Inspection, such as electron and ion-beam microscopy, atomic force microscopy, and stress measurement; and
- Post processing, such as wafer dicing, wire bonding, and critical point drying.

High Volume Nanomanufacturing

1. **In-line metrology tools for CNT synthesis and CNT-based composite material fabrication (FY 12-17)**
   - Critical process parameters associated process window data for growth of specific tube types/morphologies (FY 13).
   - High-throughput, robust metrology tools to enable closed-loop process control in volume manufacturing environment (FY 15).
   - Morphological descriptors and models for complex CNT assemblies (FY 13).
   - Measurement methods and standards to quantify the chirality distribution and semiconducting/metallic ratios for composite electronic, sensor and shielding applications (FY 15).
   - Structure-property relationships determination through a combination of models and measurements (FY 14).
   - Models linking detailed structure-property relationships to ensemble/macroscopic measurement methods in CNT-based composite materials (FY 15).
   - Measurement techniques for volume manufacturing (FY 17).

2. **Assessment methods for EHS risk assessment during fabrication of CNT- based composite materials (FY 12 – 16)**
   - Methods and models for accurately measuring and estimating the CNT release rate from industry-relevant composite matrices (FY 14).
   - Measurement science for characterizing the chemical composition, size, and morphology of the released/aerosolized CNTs from product matrix degradation during exposure to various environments (FY 16).

3. **Measurement infrastructure for manufacturing of flexible and printed electronics (FY 12-14)**
   - Measurement protocols, metrics and standards for advanced materials based flexible and printed electronic devices (FY 13).
   - Measurement protocols, metrics and standards for industrial adaption of traditional printing processes for deposition of electrically active materials on flexible substrates (FY 14).
   - Quantitative tools, measurements, and metrics to evaluate printed electronic devices for large scale nanomanufacturing (FY 14).

4. **Measurement testbed for robust roll-to-roll nanomanufacturing (FY 12-16)**
   - NIST led industry and government consortium for nanomanufacturing related fabrication and measurement modules, and technology transfer (FY 14)
   - Basic Roll-to-Roll facility for benchmarking model fabrication equipment and online measurement modules (FY 15).
   - Expansion of Roll-to-Roll facility (FY 16).

Measurements to Enable the Manufacture of Advanced 3rd Generation Photovoltaics

1. **Develop nondestructive spatially-resolved characterization of electronic structure and potentials, and carrier transport to enable the next generation of photovoltaics.**
   - Disseminate new time-resolved scanned probe microwave photoconductivity microscopy with improved spatial and spectroscopic resolution
   - Disseminate new scanned probe-based defect energy and density measurements with improved spatial and energy resolution
   - New tools for accelerated reliability testing of excitonic PV devices
   - New spatially resolved measurements of internal electric fields in next generation devices
   - New current-voltage and impedance spectroscopy measurements to identify deep trap states which limits performance

2. **Develop novel measurements of chemical and molecular composition and electronic structure at interfaces that will enable advances in a new generation of solar cells.**
   - Transferable measurements of critical microstructural and interfacial properties and fundamental charge transport processes
   - Techniques that correlate microstructural and interfacial properties with aggregate transient charge harvesting efficiency and transport
   - New measurements of precise reaction pathways of photochemical processes in dye-sensitized PV devices with sub-picosecond resolution
   - Nanoscale mapping of chemical structure in advanced PVs with 30 nm spatial resolution
   - Measurement methods that could determine failure mechanisms due to chemical and microstructural instabilities

3. **Develop new measurements to improve understanding of PV device degradation and reliability.**
   - Improved understanding of temporal properties of defects under environmental stress and aging of critical scale-relevant PV substructures

- Predictive and quantitative physics based models using data from accelerated reliability testing of excitonic PV devices
- Best practice guides includes a description of the instrumentation, an overview of the measurement technique, and a set of evaluated specimens that will be made available to PV reliability researchers

4. **Provide validation and traceability for critical measurements via test structures and reference materials.**

   NIST reference materials that improve the calibration of current and novel scanning microscopy instruments, which will include the following:

   - Carrier concentration measurements to within ten percent, with improved calibration procedures that are 10x faster
   - Band gap measurements to within 0.1 eV with 100 nm spatial resolution
   - Minority carrier diffusion length measurements to within 40 nm
   - Minority carrier lifetime measurements over the range of 1 ns to 1 μs with spatial resolution between 40 nm and the minority carrier diffusion length of the sample under test

Performance Goals and Measurement Data:

Performance Goal: Enable CNST to identify and adapt to evolving user needs	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		**100%**	**100%**	**100%**	**100%**	**100%**
Without Increase		**0**	**0**	**0**	**0**	**0**
Description: Annual tool capability assessment, user needs assessment, and market research.						

Performance Goal: Continually maintain relevant NanoFab toolset	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		**20%**	**40%**	**60%**	**80%**	**100%**
Without Increase		**0**	**0**	**0**	**0**	**0**
Description: Tool acquisitions and installations to maintain world-class nanoscale measurement and fabrication capabilities for industry, academic, and government researchers. (100% = complete tool update)						

Performance Goal: Provide U.S. industry and regulatory agencies with the essential measurement tools to *sample air containing ENMs in manufacturing plants and the surrounding environment*	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		**30%**	**60%**	**80%**	**100%**	
Without Increase	**0**	**0**	**0**	**0**	**0**	**0**
Description: Percent planned SRMs completed						

Performance Goal: Provide U.S. industry and regulatory agencies with the essential measurement tools to *accurately measure the concentration and distribution of critical properties of airborne ENMs.*	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		20%	50%	75%	80%	
Without Increase	0	0	0	0	0	0
Description: Percentage of planned measurement tools completed						

Performance Goal: Provide U.S. industry and regulatory agencies with the essential measurement tools to *identify the critical properties of airborne ENMs that determine inhalation toxicity and dermal penetration.*	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase			25%	50%	80%	100%
Without Increase	0	0	0	0	0	0
Description: Percentage of planned measurement tools completed						

Performance Goal: Provide U.S. industry and regulatory agencies with the essential measurement tools to *accurately measure and predict the release of ENMs during use and disposal of nanomaterial-enabled products.*	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		20 %	40 %	60 %	80 %	100 %
Without Increase	3	6	9	12	15	18
Description: Percentage of planned measurement tools completed						

Performance Goal: Achieve sub-20 nm spatial resolution with TRMC and SPC and quantify the distribution of electrically active in-gap states at grain boundaries by using FT-DLTS.	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		10%	25%	50%	75%	90%
Without Increase		0	0	0	0	0
Description:						

Performance Goal: Demonstrate chemically sensitive non-destructive field distribution and potential mapping at critical interfaces with 1 nm vertical resolution.	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		15%	30%	40%	60%	80%
Without Increase		10%	20%	30%	30%	30%
Description:						

Performance Goal: Develop X-ray absorption spectroscopy (XAS) capability to measure electronic structures of photovoltaics, with sub-nanometer depth resolution.	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		15%	30%	45%	65%	90%
Without Increase		10%	10%	15%	15%	20%
Description:						

Performance Goal: Develop new measurements of PV device degradation and reliability to improve performance	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		15%	30%	45%	70%	85%
Without Increase		0	0	0	0	0
Description:						

Performance Goal: Develop test structures and reference materials to disseminate traceability and validation	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		15%	30%	45%	70%	90%
Without Increase		0	0	0	0	0
Description:						

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amount in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Biomedical engineer	Gaithersburg, MD	ZP IV	4	$105,211	$420,844
Biomedical engineer	Gaithersburg, MD	ZP III	3	74,872	224,616
Physical scientist	Gaithersburg, MD	ZP IV	5	105,211	526,055
Chemist	Gaithersburg, MD	ZP IV	4	105,211	420,844
Chemist	Gaithersburg, MD	ZP III	4	74,872	299,488
Mathematician	Gaithersburg, MD	ZP IV	1	105,211	105,211
Physicist	Gaithersburg, MD	ZP IV	9	105,211	946,899
Electronics engineer	Gaithersburg, MD	ZP IV	5	105,211	526,055
Physical scientist	Gaithersburg, MD	ZP IV	2	105,211	210,422
Research chemist	Gaithersburg, MD	ZP V	2	123,758	247,516
Physical scientist	Gaithersburg, MD	ZP III	4	74,872	299,488
Research chemist	Gaithersburg, MD	ZP III	2	74,872	149,744
Physicist	Gaithersburg, MD	ZP III	7	74,872	524,104
Mechanical engineer	Gaithersburg, MD	ZP III	1	74,872	74,872
Information technology specialist	Gaithersburg, MD	ZP III	1	74,872	74,872
Mechanical engineer	Gaithersburg, MD	ZP IV	1	105,211	105,211
Environmental engineer	Gaithersburg, MD	ZP IV	1	105,211	105,211
Physical scientist	Gaithersburg, MD	ZP IV	1	105,211	105,211
Chemical engineer	Gaithersburg, MD	ZP IV	1	105,211	105,211
Fire research engineer	Gaithersburg, MD	ZP IV	2	105,211	210,422
Physicist	Gaithersburg, MD	ZP V	2	123,758	247,516
Electronics engineer	Gaithersburg, MD	ZP III	2	74,872	149,744
Electrical engineer	Gaithersburg, MD	ZP IV	1	105,211	105,211
Electrical engineer	Gaithersburg, MD	ZP III	1	74,872	74,872
Materials engineer	Gaithersburg, MD	ZP IV	1	105,211	105,211
Materials engineer	Gaithersburg, MD	ZP III	1	74,872	74,872
Electronics technician	Gaithersburg, MD	ZP III	1	42,209	42,209
Materials engineer	Gaithersburg, MD	ZT II	1	74,872	74,872
Administrative/technical support	Gaithersburg, MD	ZP III	8	51,630	413,040
Total			78		6,969,843

Less Lapse	25%	(20)	(1,742,461)
Total full-time permanent (FTE)		58	5,227,382
2011 Pay Adjustment (1.4%)			0
2012 Pay Adjustment 2.3%)			0
TOTAL			5,227,382

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	58
Other than full-time permanent	0
Total	58
Authorized Positions:	
Full-time permanent	78
Other than full-time permanent	0
Total	78

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

	Object Class	2012 Increase
11	Personnel compensation	
11.1	Full-time permanent	$5,227
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	5,227
12	Civilian personnel benefits	1,438
13	Benefits for former personnel	0
21	Travel and transportation of persons	617
22	Transportation of things	162
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	1,436
24	Printing and reproduction	46
25.1	Advisory and assistance services	0
25.2	Other services	2,505
25.3	Purchases of goods & services from Gov't accounts	2,730
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	4,221
25.6	Medical care	0
25.7	Operation and maintenance of equipment	584
25.8	Subsistence and support of persons	0
26	Supplies and materials	1,924
31	Equipment	5,550
32	Lands and structures	0
33	Investments and loans	0
41	Grants, subsidies and contributions	3,560
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Total obligations	30,000
	Less administrative savings	(1,744)
	Total request	28,256

8. Measurements and Standards to Support Increased Energy Efficiency and Reduced Environmental Impact (Base Funding: $18.265 million; Program Change: +23 FTE and +$13.270 million).

NIST requests $13.270 million and 23 FTE for a total of $31.535 million to support increased energy efficiency and reduce environmental impact. Developing innovative energy technologies is an important component to reducing energy usage and harmful emissions that can negatively impact the climate. But equally important is the ability to assess if these new technologies are truly reducing the impact of greenhouse gas emissions and for this capability, high-accuracy measurement techniques and standards are necessary. To address both of these issues, this new request focuses on two high-priority areas: net-zero energy, high-performance buildings and greenhouse gas inventory measurements.

The decision to focus specifically on net-zero energy buildings comes from the fact that buildings in the U.S. consume 72 percent of all electrical energy produce in this country. 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.

However, to measure the impact of new energy technologies on mitigating the impact of greenhouse gas emissions, including those employed in net-zero energy buildings, one must also be able to accurately measure the greenhouse gas inventory with sufficient accuracy. The inability to quantify greenhouse gas inventories is a key issue that could also impede future international agreements on emissions reductions where demonstrated and robust methodologies are critical for verification. From an operational viewpoint, techniques for assess greenhouse gas inventories are currently in their infancy. The lack of robust and demonstrated methodologies tying inventories to increases in atmospheric GHG levels contributes significantly to reduced confidence by decision makers and the public alike in gauging the impact of human-made greenhouse gas emissions on the Earth's atmosphere and biosphere. Several quantification approaches are necessary that combine satellite and enhanced surface-network based observations. This initiative addresses the needs for a comprehensive surface-based observing and modeling effort.

This request supports both economic growth and environmental stewardship, which represent the two themes of the U.S. Department of Commerce's Strategic Plan: FY 2011–2016. Specifically, this proposed program supports the Strategic Plan's objectives to promote and support the advancement of green and blue technologies (Objective 6) as well as enhance climate reporting and forecasting (Objective 15). This proposed program is also in line with the FY 2012 science and technological priorities outlined by OMP and OSTP[41] that directs agencies to focus resources on programs that include research for measuring, reporting, and verifying greenhouse gas emissions in addition to programs that invest in the research and development of clean energy technologies for sustainable green buildings. The goals set out for this new program are also consistent with the recommendations outlined in the National Research Council's report on *Verifying Greenhouse Gas Emissions: Methods to Support International Climate Agreements*[42] as well the National Science and

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[41] Peter Orszag and John Holdren Memorandum for the Heads of Executive Departments and Agencies, Office of Management and Budget, July 21, 2010.

[42] Verifying Greenhouse Gas Emissions: Methods to Support International Climate Agreements, Committee on Methods for Estimating Greenhouse Gas Emissions, Board on Atmospheric Science and Climate, Division on Earth and Life Studies, National Research Council of the National Academies, The National Academies Press, Washington D.C., April 2010.

Technology Council's *Federal Research and Development Agenda for Net-Zero Energy, High-Performance Green Buildings*[43].

Proposed Actions:

Consistent with recommendations from key stakeholders, the proposed technical program that is focused on supporting the development of net-zero energy, high-performance green buildings will enable NIST to:

- **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.

- **Promote 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

[43] Federal Research and Development Agenda for Net-Zero Energy, High-Performance Green Buildings, Report of the Subcommittee on Buildings Technology Research and Development, National Science and Technology Council Committee on Technology, October 2008.

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.

For the portion of the proposed program that is focused on the development of greenhouse gas inventory methodologies, NIST will:

- **Demonstrate a High-spatial-density Regional Greenhouse Gas Measurements Network** – Development and implementation of a reliable, robust and accurate operational network would impact a broad range of users, e.g., quantification of methane emissions from a range of agricultural operations and from landfills and of carbon dioxide uptake by crops, woodlands, forest, and similar features of the biosphere. In market-based approaches to GHG reduction, GHG offsets are a critical element, some of which are currently difficult to quantify at levels similar to that of traditional emission sources. With such an operational capability, such offsets will be more reliable quantitatively and MRV strategies will benefit from a significantly improved quantitative basis that is more difficult to dispute and could become a world-recognized approach emulated by many nations.

- **Assess and Improve Comparability Between Bottom-up and Top-down Inventories Based on Measurements** - Successful local, state, national or international greenhouse gas measurements and mitigation programs require the ability to reconcile bottom-up inventories based on accounting for all the greenhouse-gas sources and sinks with top down measurements of increase in atmospheric greenhouse gases due to total emissions for the spatial region. The lack of agreement between the top-down and bottom-up measurements makes it difficult to establish science-based caps to overall emission levels, to sector emissions levels, and to geographical area emissions levels. Additionally, such lack of agreement makes it difficult to challenge the accuracy of inventories generated by states or countries since satellite-based top-down measurements do not provide a robust measure of bottom-up levels.

  Develop and Validate Measurement Tools for the Quantitative Determination and Verification of Inventories of Greenhouse Gas (GHG) Sources and Sinks - Methods to accurately quantify the emission and absorption of greenhouse gases from large area sources or sinks, such as landfills, forests, estuaries, and agriculture land, are required to ensure accurate and complete greenhouse gas inventories and consistency of bottom-up inventory approaches with top-down atmospheric concentration measurements. The measurements are challenged by the need to measure both local atmospheric concentrations of greenhouse gases as well as fluxes of greenhouse gases from or to the source or sink. Ideally, such measurements would be standoff, i.e., made without actually requiring placing instruments on the site since the terrain might not be easily or safely navigated.

Statement of Need and Economic Benefits:

Net-Zero Energy, High-Performance Buildings

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 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 2011, provide the measurement science required to achieve Net-Zero Energy, High-Performance Green Buildings when undertaken in a holistic, integrated manner.

Greenhouse Gas Inventory Measurements

Internationally, the President has spoken to the need for verification as part of any "meaningful" international emission reduction accord. In his remarks at the United Nations Climate Change Conference in Copenhagen, the President said:

> *"we must have a mechanism to review whether we are keeping our commitments, and exchange this information in a transparent manner. These measures need not be intrusive, or infringe upon sovereignty. They must, however, ensure that an accord is credible, and that we're living up to our obligations. Without such accountability, any agreement would be empty words on a page."*[44]

[44] Remarks by the President at the Morning Plenary Session of the United Nations Climate Change Conference, Bella Center, Copenhagen, Denmark, Office of the Press Secretary, The White House, December 18, 2009.

Internationally recognized, reliable measurements are foundational to GHG inventories and for the accountability needed by (a) international agreements to verify GHG emission inventories, (b) GHG regulations, and (c) "carbon market" transparency. The measurement tools funded by this initiative will be vital to the public, industry, and our government to obtain verifiable GHGs inventories that can be trusted by all.

Development and implementation of a reliable, robust and accurate operational network would impact a broad range of users, e.g., quantification of methane emissions from a range of agricultural operations and from landfills and of carbon dioxide uptake by crops, woodlands, forest, and similar features of the biosphere. In market-based approaches to GHG reduction, GHG offsets are a critical element, some of which are currently difficult to quantify at levels similar to that of traditional emission sources. With such an operational capability, such offsets will be more reliable quantitatively and measurement, reporting and verification strategies will benefit from a significantly improved quantitative basis that is more difficult to dispute and could become a world-recognized approach emulated by many nations.

The following stakeholders would benefit from the measurement tools outlined in this proposal that are essential to the implementation of any regulatory and/or market-based scheme to the reduction of GHG emissions:

- Agencies and organizations seeking to reduce the carbon footprint of the Nation;
- Agencies and organizations seeking to determine the effects of GHG emissions (e.g., NOAA, NASA, NSF, USDA, academia) and the general public;
- Federal, State, and local governments seeking to reduce carbon footprint via incentives and/or market-based approaches (e.g., California's Assembly Bill 32: Global Warming Solutions Act, [45] which requires the GHG emissions be reduced to 1990 levels by 2020);
- Carbon markets (e.g., Regional Greenhouse Gas Initiative and the Chicago Climate Exchange); and
- Industries producing technologies with smaller carbon footprints.

Base Resource Assessment:

The current NIST Net-Zero Energy, High-Performance Green Buildings Program consists of the following areas:

1. Improved Building Energy Performance
2. Embedded Intelligence in Buildings
3. Advanced Building Energy Technologies
4. Automated and Integrated Infrastructure Construction Processes
5. Service Life Prediction of Concrete Building and Infrastructure Materials
6. Service Life Prediction of High Performance Polymers and Composites

The current NIST Greenhouse Gas Measurements Program consists of the following areas:

1. Point Emission Source Metrology – Continuous Emissions Monitoring Testbed
2. Distributed Emission Source Metrology
3. GHG Standards and Metrology Tools
4. GHG Inventory and Regional Emissions Profile Methodologies

[45] http://www.arb.ca.gov/cc/ab32/ab32.htm

5. Advanced Field Deployable Detection Technologies
6. Satellite Calibration Standards and Methodologies
7. Atmospheric Aerosols Measurement Science and Standards
8. Measurement Standards for Climate Data Continuity

These efforts, which amount to $16.5 million for FY 2011, support the development of measurement science and standards in both the areas of building research and climate science.

Schedule and Milestones:

The milestones for this initiative encompass the following priority areas:

Net-Zero Energy, High-Performance Green Buildings

1. 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)

2. 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)

3. 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)

Greenhouse Gas Inventory Measurements

1. Establishment of a high-spatial-density regional GHG measurements network (FY 2012 – FY 2014)
   - Identify an appropriate demonstration region to evaluate the proposed approach. This geographical region should the size of a city or small county (i.e., 1000 sq. km) and should have a diverse population of GHG sources and sinks including: industrial sources, transportation sources, agricultural sources, forests, wetlands, and/or near coastal regions. In addition, the availability of a high-density private/public observation network (e.g., a weather observation network) is essential to the objectives of this project.
   - Perform a gap analysis of the high-density network and augment its spatial observation resolution in the selected demonstration region as needed.
   - Evaluate commercially available continuous GHG measurements instrumentation for deployment in the high-density network and resolve associated deployment issues (e.g., GHG sampling issues and IT issues).
   - Deploy continuous GHG measurements instrumentation in the high-density network.
   - Complement the high-density observation network with the observations of a high-accuracy low-density network (e.g., NOAA's Tall Towers or NASA's Advanced Global Atmospheric Gases Experiment network).

2. Validation of inverse modeling atmospheric transport schemes for the determination of GHG sources and sinks. (FY 2013-FY 2015)
   - Identify inverse modeling atmospheric transport capabilities that using GHG observation data, weather data and velocity dispersion models can determine the location of GHG sources and sinks in the demonstration region.
   - Determine the performance of the inverse modeling atmospheric transport schemes in sub-regions with well-characterized sources (e.g., a power plant or a farm).
   - Ascertain the magnitude of GHG sinks in the demonstration region with the help of the observation data and the inverse modeling atmospheric transport capability.

3. Reconciliation of the top-down and bottom-up inventories at level ten times better than current. (FY 2014-FY 2016)
   - Compare the results of the inverse modeling atmospheric transport schemes with current available bottom-up GHG inventories (e.g., those maintain by local authorities using the UNFCCC methodology for National inventories).
   - Compare the results of the inverse modeling atmospheric transport schemes with current available top-down GHG inventories [e.g., those obtained from observations from the Japanese Greenhouse Gases Observing Satellite (GOSAT), or NASA's Atmospheric Infrared Sounder (AIRS), and when available, from NASA's Orbiting Carbon Observatory (OCO)].

Deliverables:

Net-Zero Energy, High-Performance Green Buildings

- Energy performance standards for new and existing buildings and their embodiment in building codes.
- Tools to improve the life and performance of sustainable materials components and systems used in net-zero, high-performance green buildings.
- Measurement protocols to assess indoor air quality to ensure that reductions in building energy consumption do not degrade indoor environments.

Greenhouse Gas Inventory Measurements

- Regional methodology, based on ground-based mesonet systems, to determine accurate GHG inventories in support of regulatory and/or market-based emissions reduction approaches.
- Tools for the assessing the spatial density needed by ground-based mesonet systems to be use in the determination of GHG inventories.
- Evaluation of commercially available GHG continuous measurements instrumentation for applications in ground-based mesonet systems used for determinations of GHG inventories.
- Tools for mapping of GHG sources/sinks in a geographical region based on GHG observations produced and inverse modeling techniques.
- Tools for estimating the size of GHG sinks in a geographical region based on limited GHG observations and modeling capabilities.
- Ability to reconcile top-down and bottom-up inventories at level ten times better than current using the above described tools.

Performance Goals and Measurement Data

Net-Zero Energy, High-Performance Green Buildings

Performance Goal: Establishment of energy performance standards for new and existing buildings	FY 11 Target	FY 12 Target	FY 13 Target	FY 14 Target	FY 15 Target	FY 16 Target
With increase		5%	10%	25%	50%	100%
Without increase	0	0	0	0	0	0

Performance Goal: Development of test methods and models to enable the development of improved sustainable materials. components and systems	FY 11 Target	FY 12 Target	FY 13 Target	FY 14 Target	FY 15 Target	FY 16 Target
With increase		25%	50%	100%		
Without increase	0	0	0	0	0	0

Performance Goal: Establishment of indoor air quality protocols and standards	FY 11 Target	FY 12 Target	FY 13 Target	FY 14 Target	FY 15 Target	FY 16 Target
With increase			25%	50%	80%	100%
Without increase	0	0	0	0	0	0

Greenhouse Gas Inventory Measurements

Performance Goal: Establishment of a high-spatial-density regional GHG measurements network	FY 11 Target	FY 12 Target	FY 13 Target	FY 14 Target	FY 15 Target	FY 16 Target
With increase		25%	75%	100%		
Without increase	0	0	0	0	0	0

Performance Goal: Validation of inverse modeling atmospheric transport schemes for the determination of GHG sources and sinks	FY 11 Target	FY 12 Target	FY 13 Target	FY 14 Target	FY 15 Target	FY 16 Target
With increase			40%	80%	100%	
Without increase	0	0	0	0	0	0

Performance Goal: Reconciliation of the top-down and bottom-up inventories at level 10 times better than current	FY 11 Target	FY 12 Target	FY 13 Target	FY 14 Target	FY 15 Target	FY 16 Target
With increase				25%	75%	100%
Without increase	0	0	0	0	0	0

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amount in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Mechanical engineer	Gaithersburg, MD	ZP IV	2	$105,211	$210,422
Mechanical engineer	Gaithersburg, MD	ZP III	1	74,872	74,872
Materials research engineer	Gaithersburg, MD	ZP IV	2	105,211	210,422
Materials scientist	Gaithersburg, MD	ZP IV	3	105,211	315,633
Materials scientist	Gaithersburg, MD	ZP III	1	74,872	74,872
Engineering technician	Gaithersburg, MD	ZT III	1	56,857	56,857
Computer scientist	Gaithersburg, MD	ZP IV	1	105,211	105,211
Economist	Gaithersburg, MD	ZP IV	2	105,211	210,422
Research chemist	Gaithersburg, MD	ZP IV	1	105,211	105,211
Research chemist	Gaithersburg, MD	ZP V	2	123,758	247,516
Research physicist	Gaithersburg, MD	ZP IV	2	105,211	210,422
Physicist	Gaithersburg, MD	ZP III	2	74,872	149,744
Research physicist	Gaithersburg, MD	ZP V	2	123,758	247,516
Research mathematician	Gaithersburg, MD	ZP IV	2	105,211	210,422
Research statistician	Gaithersburg, MD	ZP IV	2	105,211	210,422
Research statistician	Gaithersburg, MD	ZP III	2	74,872	149,744
Administrative/technical support	Gaithersburg, MD	ZA II	3	51,630	154,890
Total			31		2,944,598
Less Lapse		25%	(8)		(736,150)
Total full-time permanent (FTE)			23		2,208,448
2011 Pay Adjustment (1.4%)					0
2012 Pay Adjustment 2.3%)					0
TOTAL					2,208,448

Personnel Data	Number
Full-Time Equivalent Employmer	
Full-time permanent	23
Other than full-time permanent	0
Total	23
Authorized Positions:	
Full-time permanent	31
Other than full-time permanent	0
Total	31

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

	Object Class	2012 Increase
11	Personnel compensation	
11.1	Full-time permanent	$2,208
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	2,208
12	Civilian personnel benefits	607
13	Benefits for former personnel	0
21	Travel and transportation of persons	254
22	Transportation of things	47
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	582
24	Printing and reproduction	35
25.1	Advisory and assistance services	0
25.2	Other services	932
25.3	Purchases of goods & services from Gov't accounts	2,287
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	750
25.6	Medical care	0
25.7	Operation and maintenance of equipment	224
25.8	Subsistence and support of persons	0
26	Supplies and materials	503
31	Equipment	1,071
32	Lands and structures	0
33	Investments and loans	0
41	Grants, subsidies and contributions	3,000
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Direct obligations	12,500
	Transfer to NIST Working Capital Fund	1,500
	Total obligations	14,000
	Less administrative savings	(730)
	Total request	13,270

9. Measurements and Standards to Support Advanced Infrastructure Delivery and Resilience (Base Funding: $5.475 million; Program Change: +19 FTE and + $10.571 million).

NIST requests an increase of $10.571 million and 19 FTE for a total of $16.046 million to provide long overdue improvements to our physical infrastructure that will both increase the resilience of our building infrastructure to damage from earthquake, windstorms, and fire; and that will enable U.S. industry to improve productivity by transforming the delivery of construction and infrastructure projects, which represent nearly five percent of our Nation's GDP.

Proposed Actions

Action 1: Disaster Resilient Buildings and Infrastructure ($3.803 million)
A large percentage of the Nation's buildings and infrastructure is concentrated in disaster-prone regions of the Nation.[46] 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[47] 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 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.

Action 2: Sustainable and Resilient Physical Infrastructure ($5.013 million)
Improving and protecting our transportation infrastructure and protecting our citizens are specific Administration priorities.[48] The Department of Commerce has identified improving public safety (Science and Information), development of sustainable and resilient environments (Environmental Stewardship), and developing transformational technologies for our economy (Innovation and Entrepreneurship) as agency priorities.[49] Additionally, NIST has identified renewing our Physical Infrastructure as an investment priority area. Responding to these Administration and Departmental priorities, NIST proposes to develop critical measurement science tools needed by U.S. industry for: (1) risk-based condition assessment of aging infrastructure systems; (2) determining the remaining service life—and guiding development and use—of sustainable infrastructure materials; and (3) for ensuring the disaster resilience of structures under extreme conditions (specifically, hurricanes, tornadoes, and other windstorms).

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[46] *Improved Seismic Monitoring – Improved Decision Making: Assessing the Value of Reduced Uncertainty*, National Academies Press, 2006.
[47] 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).
[48] Memo on Science and Technology Priorities for the FY11 Budget, Peter Orszag, OMB budget office, M-09-27, 9/4/2009.
[49] Department of Commerce scorecard, rev. 4/01/10.

Physical Infrastructure, a combination of fundamental systems that support a community, region, or country includes everything from water and sewer systems to road and rail networks to the national power and natural gas grids.[50] Current annual spending on physical infrastructure is $400 billion/year.[51] Even with this level of investment; the National Academy of Engineering identifies restoring and improving the urban infrastructure as one of the Grand Challenges for Engineering.[52] Repairing and upgrading all the infrastructure needs simultaneously is not economically viable, making the sequencing of repairs extremely important. Measurement science tools in the areas of condition assessment, predicting in-service performance of materials, and performance of structures in extreme events are critically important in providing accurate science-based guidance for prioritizing investment in renewing our Nation's physical infrastructure.

Action 3: Advancing Construction Productivity ($1.755 million)
As part of improving infrastructure delivery, engineering, construction, manufacturing and research organizations must address the eroding productivity demonstrated on many construction projects. During the past 40 years, studies have illustrated how construction productivity has declined at an average annual rate of 0.6 percent.[53] This trend is in stark contrast to all other non-farm industries (e.g., manufacturing) which have improved labor productivity at an average rate of 1.8 percent per year. Industry studies have identified inefficiencies ranging from 25 percent to 50 percent in coordinating labor and managing, moving and installing construction materials.[54] Leaders in the construction industry[55] know the success and benefits[56] that have accrued from the investments in measuring and monitoring construction safety and see the potential for similar improvements in construction productivity with integrated and automated processes using advanced technology. With this request NIST will invest in the following projects to improve construction productivity:

- **Automated Access and Integration of Diverse Information Systems** –One of the features of the construction industry's complexity and variability is the extraordinarily large number of highly diverse information systems that are used over the lifecycle of physical infrastructure and across the many disciplines and organizations that participate in the engineering, fabrication, construction and inspection decisions and activities. *NIST will develop the measurement science to enable validation of data models and data exchange protocols, conformance assessment of construction information systems and interoperability testing, with the ultimate goal of enabling automated access to and integration of those systems.* NIST will work with industry to develop and demonstrate interoperability standards and conformance test suites to automate and integrate priority capabilities and remove sources of inefficiencies and errors.
- **Construction Site Monitoring and IACJS Testbed** – The manufacturing industry has successfully developed integration and automation technologies to gain real-time control of its processes, resulting in increased productivity, decreased time-to-market. To enable these advances in the construction industry NIST will develop metrics, standards and guidelines for real-time sensing and monitoring of automated construction and will establish the Integrated and Automated Construction Jobsite (IACJS) Testbed for implementing,

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[50] http://www.engineeringchallenges.org/cms/8996/9136.aspx
[51] Issues and Options in Infrastructure Investment, Congressional Budget Office, May, 2008.
[52] http://www.engineeringchallenges.org/cms/8996/9221.aspx
[53] Paul Teicholz, "Labor Productivity Declines in the Construction Industry: Causes and Remedies," *AECbytes Viewpoint,* Issue 4, April 14, 2004.
[54] National Research Council Report, *"Sustainable Critical Infrastructure Systems – A Framework for Meeting 21st Century Imperatives"*. Available at http://www.nap.edu/catalog.php?record_id=12638
[55] American Institute of Architects (AIA), Associated General Contractors of America (AGC), Construction Industry Institute (CII), Construction Users Roundtable (CURT), Electric Power Research Institute (EPRI), and FIATECH.
[56] Construction Industry Institute, *2006 Safety Report*, Austin, TX, 2007.

assessing and demonstrating advanced construction technologies and processes in practice. This testbed will enable breakthrough levels of real-time construction monitoring and control by extending and refining an open and scalable reference model architecture for real-time control systems (RCS), originally developed by NIST for manufacturing and robotics applications, for use in construction. *NIST will use the IACJS Testbed to measure the productivity impacts of new construction technologies and processes and to demonstrate and transfer results to industry.*

- **Metrics and Tools for Construction Productivity** – NIST will develop (1) a multifactor productivity approach for measuring construction productivity to enable separable estimates of contributions at discrete and aggregate levels, and (2) a technology readiness index and toolkit to provide effective mechanisms to assess risks and readiness of technologies for integrating and automating the delivery of physical infrastructures. NIST, in collaboration with the Bureau of Labor Statistics and industry organizations, will use a multifactor productivity approach to produce productivity metrics at the task, single project, project class, and industry-levels for selected construction industry sectors.

Statement of Need and Economic Benefits:

Disaster Resilience – 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 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 is focused 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 initiative 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 initiative 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 is used by standards, codes, and practitioners around the world. This initiative addresses two critical national needs for disaster reliance: disaster and failure event studies and fire performance of structures. This initiative also recognized significant investments are required to meet the current and future physical infrastructure needs. The Congressional Budget Office (CBO) estimates that the direct investment by the U.S. economy is $400 billion/year for physical infrastructure. Additionally, the opportunity cost and subsequent required investment in the wake of a failure of any single event such as a bridge collapse, water main break, or major windstorm is not included and are estimated to be in the tens to hundreds of billions of dollars.

Construction Productivity – Significant investments are required to meet the current and future physical infrastructure needs. The Congressional Budget Office estimates that the direct investment by the U. S. economy is $400 billion/year for physical infrastructure. The expected growth in the

U.S. will require significant expansion of our existing physical infrastructure, e.g., projected power generation and distribution investment needs could be an additional $1.5 - $2.0 trillion by 2030.[57] Even small savings in the cost of delivering these infrastructure projects will result in significant savings, job creation and economic growth to the U. S. economy.

Base Resource Assessment:
In the areas of disaster resilience NIST invested $600 thousand in base STRS funds in FY 2010 for risk-based condition assessment tools, $400 thousand for service life prediction tools, and $1.14 million for windstorm impact reduction. In the area of construction productivity NIST invested $1.22 million base STRS funds in FY 2010; including $220 thousand for metrics and tools for construction productivity, $400 thousand for intelligent and automated construction jobsite, and $600 thousand for virtual project data integration testbed.

Schedule and Milestones:

***Action 1: Disaster Resilient Buildings and Infrastructure* ($3.803 million)**
- 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 social and economic factors that affect pre-disaster mitigation activities and post-disaster response efforts.
- 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.
- 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.
- 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.
- Develop (1) NSFRL laboratory/testing operational procedures, including structural loading, specimen support and restraint, fire load application, instrumentation and data acquisition, and safety measures; (2) a comprehensive NSFRL safety program including training requirements; and (3) 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.
- 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.

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[57] National Research Council Report, *"Sustainable Critical Infrastructure Systems – A Framework for Meeting 21st Century Imperatives"*. Available at http://www.nap.edu/catalog.php?record_id=12638

***Action 2: Sustainable and Resilient Physical Infrastructure* (\$5.013 million)**

Risk-Based Condition Assessment Tools:

- Reduce error and uncertainty in nondestructive evaluation for infrastructure inspection.
- Establish reference artifacts for baseline evaluation of sensor signals; reference artifacts that are field-compatible will be a particular focus. (FY 2012-FY 2016)
- Establish "gold standard" NDE methods for cross-correlation and qualification of new sensor devices. (FY 2012-FY 2016)
- Provide SRMs with intentionally induced flaws for field calibration of NDE tools. (FY 2012-FY 2016)
- Lead the development of consensus standards for inspection procedures to improve uniformity and further reduce error. (FY 2014-FY 2016)

Quantify in-service performance of materials to mechanical, degradation and aging effects:

- Measure the mechanical response of structural materials to understand the effects of low temperature, such as freeze/thaw cycles, high temperature such as fire, fatigue, and high strain rate such as blast or impact. (FY 2012-FY 2016)
- Develop a database of degradation and aging effects for common infrastructure materials, structural systems, and sensing technologies. The database will include data from experiments conducted by NIST and others, data collected from condition assessments of structures, and data collected from the literature. NIST will make the data broadly available for use by other NIST programs and outside organizations. (FY 2014-FY 2016)
- Incorporate these measurements and observations into simple but accurate numerical models capture the overall system response to extreme conditions in its current degraded state. (FY 2014-FY 2016)

Service Life Prediction Tools for Infrastructure Materials:

- For each infrastructure material type (i.e., cementitious, polymeric and metallic) select representative reference materials from which a fundamental understanding of the degradation rates and mechanisms can be gained and quantitative models built. This research will provide the basis for the development of standard reference materials and accelerated tests. (FY 2012-FY 2016)
- Develop measurement science tools for quantitatively characterizing a range of field exposure variables in which each variable is measured with the same degree of precision and accuracy as measured in the laboratory, and develop validated models that can transform these measurements into parameters having a direct link to materials degradation. (FY 2013-FY 2016)
- Develop and standardize laboratory test protocols that elucidate the effects each exposure variable, acting individually or in combination, has on the degradation response of a material. (FY 2014-FY 2016)
- Develop the scientific basis for analytical and computational tools that can predict changes in a material's performance over time as a function of the intensity of the exposure variables to which the material is subjected. (FY 2015-FY 2016)
- Derive and transfer to industry service life prediction models using laboratory data as input for predicting field performance. (FY 2016)

Disaster Resilience of Structures: Windstorm Impact Reduction

- Improve the understanding of windstorms and their impact on structures, support the development of improved codes standards and practices and promote the adoption of windstorm impact reduction measures. (FY 2015)
- Develop a database of real wind loads and building response, and disseminate to the research and design communities. (FY 2016)

- Develop improved methodologies for estimating the wind hazards in the United States. (FY2016)
- Develop computational wind engineering tools, methodologies, guidelines and pre-standards for the design of structures to resist wind loads. (FY 2016)

***Action 3: Advancing Construction Productivity* ($1.755 million)**
Automated Access and Integration of Diverse Information Systems

- Metrics for data model validation and reference data alignment (FY 2012)
- Infrastructure information delivery and management framework (FY 2012)
- Interoperability protocols for priority processes (FY 2013)
- Conformance test suite library (FY 2013)
- Metrics and guidelines for data integrity across construction automation tools (FY 2014)
- Framework for evaluating automated access and integration across construction automation tools (FY 2015)
- Interoperability and integration standards, conformance test suites and industry guidelines (FY 2016)

Construction Site Real-Time Monitoring and IACJS Testbed

- Real-time control system (RCS) adapted to construction processes (FY 2012)
- Performance metrics for real-time sensors adapted to construction (FY 2013)
- Performance metrics for construction site monitoring and object tracking (FY 2014)
- Performance metrics for real-time construction site sensing and control systems (FY 2015)
- RCS reference architecture for construction (FY 2016)

Metrics and Tools for Construction Productivity

- Task-level productivity metrics (FY 2012)
- Project-level productivity metrics and analysis tools (FY 2013)
- Test single factor productivity metrics for construction industry sectors (FY 2014)
- Technology readiness metrics (FY 2014)
- Test multifactor productivity metrics for construction industry sectors (FY 2015)
- Prototype technology readiness index (FY 2015)
- Technology readiness index (FY 2016)
- Construction productivity assessment toolkit (FY 2016)

Deliverables:

***Action 1: Disaster Resilient Buildings and Infrastructure* ($3.803 million)**

- A National Disaster and Failure Events Database on natural and man-made hazard events, the performance of the built environment during hazard events, associated emergency response and evacuation procedures, and pre-disaster mitigation studies 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.

Action 2: Sustainable and Resilient Physical Infrastructure* (\$5.013 million*)

- Standard reference material for sensor calibration for infrastructure evaluation.
- Database of degradation and aging effects for common infrastructure materials, structural systems, and sensing technologies.
- In-situ service life prediction tools for infrastructure materials
- Tools, methodologies, guidelines and standards for the design of structures to resist wind loads.

Action 3: Advancing Construction Productivity* (\$1.755 million*)

- Interoperability and integration standards for automated access and integration of information systems for infrastructure delivery.
- Reference architecture and protocols for real time monitoring and control of construction processes.
- Metrics and tools for measuring construction productivity at the task, single project, project class, and industry levels.
- Technology readiness index for high-risk, high-cost, high-impact construction-related technology, product, and process innovations.

Performance Goals and Measurement Data

Action 1: Disaster Resilient Buildings and Infrastructure* (\$3.803 million*)

Performance Goal: Development of Disaster and Events Failure Database	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		20%	40%	60%	80%	100%
Without Increase		6%	12%	18%	24%	30%
Description: Database on natural and man-made hazard events percentage of completed milestones						

Action 2: Sustainable and Resilient Physical Infrastructure* (\$5.013 million*)

Performance Goal: Development of reference materials for infrastructure resilience	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		20%	40%	60%	80%	100%
Without Increase		6%	12%	18%	24%	30%
Description: Percentage of milestones completed leading to the development of reference materials for sustainable and resilient physical infrastructure						

Action 3: Advancing Construction Productivity* (\$1.755 million*)

Performance Goal: Development of measurement tools and testbeds to increase construction productivity	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		20%	40%	60%	80%	100%
Without Increase		7%	14%	22%	29%	36%
Description: Percentage of Milestones for advancing construction productivity completed						

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amount in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Lead database architect	Gaithersburg, MD	ZP IV	1	$105,211	$105,211
Technician	Gaithersburg, MD	ZT IV	1	74,872	74,872
Program assistant	Gaithersburg, MD	ZA III	1	74,872	74,872
Domain expert - earthquake	Gaithersburg, MD	ZP IV	1	105,211	105,211
Domain expert - wind	Gaithersburg, MD	ZP IV	1	105,211	105,211
Domain expert - fire	Gaithersburg, MD	ZP IV	1	105,211	105,211
Domain expert - structures	Gaithersburg, MD	ZP IV	1	105,211	105,211
Director	Gaithersburg, MD	ZP V	1	123,758	123,758
Information systems engineer	Gaithersburg, MD	ZP IV	1	105,211	105,211
Sensor network engineer	Gaithersburg, MD	ZP IV	1	105,211	105,211
Domain expert - robotics & controls	Gaithersburg, MD	ZP III	1	74,872	74,872
Domain expert - construction automation	Gaithersburg, MD	ZP III	1	74,872	74,872
Domain expert - industrial engineer	Gaithersburg, MD	ZP III	1	74,872	74,872
NWIRP director	Gaithersburg, MD	ZP V	1	123,758	123,758
Secretary	Gaithersburg, MD	ZS III	1	37,983	37,983
Wind engineer	Gaithersburg, MD	ZP IV	1	105,211	105,211
Materials research engineer	Gaithersburg, MD	ZP IV	2	105,211	210,422
Research chemist	Gaithersburg, MD	ZP IV	1	105,211	105,211
Research engineer	Gaithersburg, MD	ZP III	1	74,872	74,872
Physical scientist	Gaithersburg, MD	ZP IV	1	105,211	105,211
Electronics technician	Gaithersburg, MD	ZT III	1	56,857	56,857
Structural engineer	Gaithersburg, MD	ZP III	1	74,872	74,872
Administrative/technical support	Gaithersburg, MD	ZA II	2	51,630	103,260
Total			25		2,232,252
Less Lapse		25%	(6)		(558,063)
Total full-time permanent (FTE)			19		1,674,189
2011 Pay Adjustment (1.4%)					0
2012 Pay Adjustment 2.3%)					0
TOTAL					1,674,189

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	19
Other than full-time permanent	0
Total	19
Authorized Positions:	
Full-time permanent	25
Other than full-time permanent	0
Total	25

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

	Object Class	2012 Increase
11	Personnel compensation	
11.1	Full-time permanent	$1,674
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	1,674
12	Civilian personnel benefits	460
13	Benefits for former personnel	0
21	Travel and transportation of persons	268
22	Transportation of things	95
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	457
24	Printing and reproduction	40
25.1	Advisory and assistance services	0
25.2	Other services	1,184
25.3	Purchases of goods & services from Gov't accounts	837
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	2,046
25.6	Medical care	0
25.7	Operation and maintenance of equipment	183
25.8	Subsistence and support of persons	0
26	Supplies and materials	638
31	Equipment	1,305
32	Lands and structures	232
33	Investments and loans	0
41	Grants, subsidies and contributions	1,170
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Direct obligations	10,589
	Transfer to NIST Working Capital Fund	530
	Total obligations	11,119
	Less administrative savings	(548)
	Total request	10,571

10. Postdoctoral Research Associateship Program (Base Funding: $ 11.448 million; Program Change: + 17 FTE and + $2.979 million).

NIST requests an increase of $2.979 million and 17 FTE for a total of $14.427 million to expand the NIST postdoctoral research program to offer more opportunities for young scientists to conduct research at NIST.

Proposed Actions:

The requested increase of $2.979 million for NIST's Postdoctoral Research Associateship Program in Measurement Science advances the Administration's goals for Science, Technology, Engineering, and Mathematics (STEM) education. The importance of STEM education in ensuring that the U.S. has a well educated and globally competitive and skilled workforce has been recognized by President Obama and by Congress in its bipartisan support of the America COMPETES Reauthorization Act of 2010, that the President signed into law on January 4, 2011. At a press conference in late December 2010, President Obama stated "My singular focus over the next two years is not rescuing the economy from potential disaster, but rather jumpstarting the economy so that we actually start making a dent in the unemployment rate and we are equipping ourselves so that we can compete in the 21st century, and *that means we've got to focus on education*, that means we have to focus on research and development, we have to focus on innovation."

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 Associateship 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.

Statement of Need and Economic Benefits:

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 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 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 Postdoctoral Research Associateship program provides two-year term appointments for outstanding scientists and engineers chosen through a national competition. 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 Associateship 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.

The NIST 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 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).

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 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.

The program is a highly cost-effective recruitment tool for NIST. The NIST 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, ensuring selection of the best quality candidates. In recent years, about one third of the NIST 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.

Base Resource Assessment:

The NIST Postdoctoral Research Associateship Program provides two-year excepted term appointments for outstanding scientists and engineers chosen through a national competition. 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 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 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 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.

Schedule and Milestones:
(FY 12 – ongoing)

- Increased technology and knowledge transfer to NIST from universities;

  The NIST 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.

- Increased technology and knowledge 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.

- Expanded 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 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, ensuring selection of the best quality candidates at a minimal cost to NIST. In recent years, about one third of the postdoctoral 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.

- Enhanced 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 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.

- Enhanced opportunities for employment diversity.

  Additional funding for the NIST 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 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.

Deliverables:
(FY 12 – ongoing)

- Increased number of post-doctoral associates
- Peer-reviewed publications in scientific journals on measurement and standards related research in priority sectors

Performance Goals and Measurement Data

Performance Goal: New postdoctoral associates hired annually	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	23	23	23			
Without Increase	0	0	0			
Description:						

Performance Goal: Additional papers published by newly hired post-doctoral associates	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		23	23	23		
Without Increase		0	0	0		
Description:						

Performance Goal: Post-doctoral associates converted to NIST positions	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase			7	7	7	
Without Increase			0	0	0	
Description:						

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amount in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Chemist	Gaithersburg	ZP III	4	$74,872	$299,488
Physicist	Gaithersburg	ZP III	6	74,872	449,232
General engineer	Gaithersburg	ZP III	2	74,872	149,744
Electrical engineer	Gaithersburg	ZP III	3	74,872	224,616
Materials engineer	Gaithersburg	ZP III	5	74,872	374,360
Information technology specialist	Gaithersburg	ZP III	1	74,872	74,872
Administrative/technical support	Gaithersburg	ZA II	2	51,630	103,260
Total			23		1,675,572
less Lapse		25%	(6)		(418,893)
Total full-time permanent (FTE)			17		1,256,679
2011 Pay Adjustment (0.0%)					0
2012 Pay Adjustment 0.0%)					0
TOTAL					1,256,679

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	17
Other than full-time permanent	0
Total	17
Authorized Positions:	
Full-time permanent	23
Other than full-time permanent	0
Total	23

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

	Object Class	2012 Increase
11	Personnel compensation	
11.1	Full-time permanent	$1,257
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	1,257
12	Civilian personnel benefits	346
13	Benefits for former personnel	0
21	Travel and transportation of persons	55
22	Transportation of things	43
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	311
24	Printing and reproduction	0
25.1	Advisory and assistance services	3
25.2	Other services	1,014
25.3	Purchases of goods & services from Gov't accounts	62
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	0
25.6	Medical care	0
25.7	Operation and maintenance of equipment	41
25.8	Subsistence and support of persons	0
26	Supplies and materials	224
31	Equipment	44
32	Lands and structures	0
33	Investments and loans	0
41	Grants, subsidies and contributions	0
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Total obligations	3,400
	Less admin savings	(421)
	Total increase requested	2,979

11. Non-recurring Congressionally Directed Projects: (Base Funding: $ 0 million; Program Change; 0 FTE and -$10.5 million).

NIST requests a decrease of $10.5 million and 0 FTE for the Scientific and Technical Research and Services account for a total of 0 FTE and $0 million. In the Consolidated Appropriations Act, 2010, Congress provided additional funds for research activities related to a Center for Infrastructure Protection at the George Mason University, the LSU A&M Center for Digital Innovation, collaboration on nanoscale measurement strategies. the Hawaii Open Supercomputing Center, the University of Kentucky Firefighter Gear Safety Research Program, the Maryland Center of Excellence for Terahertz Science and Application, and the Rhode Island Consortium for Nanoscience and Nanotechnology. This additional amount is not required in FY 2012, as these research projects will be completed with the awarded funds.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Measurement Science, Services, and Programs
Subactivity: Laboratory Programs

	Object Class	2012 Decrease
11	Personnel compensation	
11.1	Full-time permanent	0
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	0
12	Civilian personnel benefits	0
13	Benefits for former personnel	0
21	Travel and transportation of persons	0
22	Transportation of things	0
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	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 & services from Gov't accounts	0
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	0
25.6	Medical care	0
25.7	Operation and maintenance of equipment	0
25.8	Subsistence and support of persons	0
26	Supplies and materials	0
31	Equipment	0
32	Lands and structures	0
33	Investments and loans	0
41	Grants, subsidies and contributions	($10,500)
42	Insurance claims and indemnities	0
43	Interest and dividends	0
99	Total obligations	0
	Total increase/decrease requested	(10,500)

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

	FY 2010 Actual	FY 2011 CR Level	FY 2012 Estimate
Department of Defense			
Air Force	$9,490	$12,942	$12,474
Army	3,523	3,590	3,400
Navy	1,501	1,888	1,650
Other	12,364	15,496	13,419
Subtotal, Department of Defense	26,878	33,916	30,943
Department of Agriculture	123	120	120
Department of Commerce	11,411	16,624	17,640
Department of Energy	5,647	7,825	7,647
Dept. of Health & Human Services	4,500	4,819	4,297
Dept. of Homeland Security	24,373	25,249	23,468
Department of the Interior	150	155	156
Department of Justice	8,744	13,214	13,123
Department of State	1	0	0
Department of Transportation	242	250	280
Department of the Treasury	76	50	50
Department of Veterans Affairs	165	170	170
Environmental Protection Agency	203	63	80
General Services Administration	837	200	200
National Aeronautics & Space Admin.	4,990	5,763	5,568
National Science Foundation	2,887	5,844	3,860
Nuclear Regulatory Commission	909	850	850
Other	6,326	8,735	7,474
Subtotal, Federal Agencies	98,462	123,847	115,926
Calibrations & Testing	8,908	8,905	9,084
Technical & Advisory Services	23,012	22,549	22,615
Standard Reference Materials	14,256	13,343	13,282
Subtotal, Other Reimbursables	46,176	44,797	44,981
Total, Reimbursable Program	144,638	168,644	160,907
Equipment Transfers	1,443	0	8,434
SRM Transfers	0	0	400
Subtotal, WCF transfer	1,443	0	8,834
Equipment Investments	16,141	21,655	18,853
IE Amortization	(19,105)	(19,429)	(18,853)
Excess Amortizations over Equipment Investments	1,521	0	0
WCF Operating Adjustments	3,307	0	0
Total, WCF Investments	1,864	2,226	0
Total, Reimbursable Program and WCF Investments	147,945	170,870	169,741

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Baldrige Performance
Excellence Program

Exhibit 10

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: Measurement science, services, and programs
Subactivity: Baldrige performance excellence program

		2010 Actual		2011 Annualized CR Level		2012 Base		2012 Estimate		Increase/ (Decrease) over 2012Base	
Line Item		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Baldrige performance excellence	Pos./Approp	51	$9,627		1/		1/		1/		
program	FTE/Obl.	48	9,906		1/		1/		1/		

[1/] Baldrige Performance Excellence Program became part of ITS, rather than STRS, after Congressional approval on NIST's proposal to realign laboratory structure.

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Corporate Services

Exhibit 10

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: Measurement science, services, and programs
Subactivity: Corporate services

		2010 Actual		2011 Annualized CR Level		2012 Base		2012 Estimate		Increase/ (Decrease) over 2012Base	
Line Item		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Computer support	Pos./Approp	7	$6,149	7	$6,149	7	$6,431	7	$6,431	0	0
	FTE/Obl.	7	9,166	7	6,627	7	6,467	7	6,467	0	0
Business systems	Pos./Approp	35	10,628	35	10,628	35	10,709	35	10,709	0	0
	FTE/Obl.	32	10,638	34	11,076	34	10,767	34	10,767	0	0
Research Support Services	Pos./Approp	10	2,103	10	2,103	10	2,370	10	2,370	0	0
	FTE/Obl.	10	2,302	11	2,119	11	2,379	11	2,379	0	0
Total	Pos./Approp	52	18,880	52	18,880	52	19,510	52	19,510	0	0
	FTE/Obl.	49	22,106	52	19,822	52	19,613	52	19,613	0	0

SUBACTIVITY: CORPORATE SERVICES

This subactivity includes the NIST central IT support for NIST's technical programs which 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 subactivity 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

Program Description:

The scope of this program includes: securely deploying and managing computing, software, and networking resources as well as distributed, redundant storage for NIST data; and, 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.

Examples of Accomplishments:

- Migrated website to geographically redundant, load-balanced, and cost-effective production architecture and a Content Management System.

- Established an Enterprise Agreement with Microsoft to reduce support costs and improve security of its Windows desktops.

- Began upgrades to the Central Computer Facility that will reduce and improve the management of power usage.

Priority Objectives for FY 2012:

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

- 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

Program Description:

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.

Example Accomplishments:

- Used incremental upgrades and performance tuning to keep the financial system operating smoothly.

Priority Objectives for FY 2012:

- Implement, operate, and maintain administrative management systems that support the delivery of administrative services to NIST and its cross service customers.

- Operate and maintain CBS and the NIST CBS Portal that supports delivery of services to NIST and its cross-service customers.

3. Research Support Services

Program Description:

The primary function of Research Support Services is to collaborate with the NIST Laboratories and Offices to provide software applications which enable and manage the dissemination of NIST scientific data to the public. The major focus of the work is custom application development but various Corporate Off-the-Shelf products are also supported. Major development projects are managed using industry standard project management practices and all projects are designed to meet Federal IT security and accessibility requirements.

Priority Objectives for FY 2012:

- Operate, host, update and maintain existing applications.

- Develop applications to meet newly identified requirements from the NIST Laboratories and Offices.

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

	FY 2010 Actual	FY 2011 CR Level	FY 2012 Estimate
Department of Commerce	$3,192	$2,503	$2,502
General Services Administration	20	21	21
Other	0	181	88
Subtotal, Federal Agencies	3,212	2,705	2,611
Technical & Advisory Services	38	836	866
Subtotal, Other Reimbursables	38	836	866
Total, Reimbursable Program	3,250	3,541	3,477
SRM Transfers	0	0	0
Subtotal, WCF transfer	0	0	0
Equipment Investments	969	2,321	2,321
IE Amortization	(1,335)	(2,380)	(2,321)
Excess Amortizations over Equipment Investments	366	0	0
Total, WCF Investments	0	(59)	0
Total, Reimbursable Program and WCF Investments	3,250	3,482	3,477

Standards Coordination
and Special Programs

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: Measurement science, services, and programs
Subactivity: Standards coordination and special programs

		2010 Actual		2011 Annualized CR Level		2012 Base		2012 Estimate		Increase/ (Decrease) over 2012Base	
Line Item		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Standards coordination	Pos./Approp	56	$15,377	56	$15,377	56	$15,512	112	$29,213	56	13,701
and special programs	FTE/Obl.	52	18,811	56	18,542	56	15,549	98	29,098	42	13,549
External projects	Pos./Approp	0	10,500	0	10,500	0	10,500	0	0	0	(10,500)
	FTE/Obl.	0	10,500	0	10,500	0	10,500	0	0	0	(10,500)
Total	Pos./Approp	56	25,877	56	25,877	56	26,012	112	29,213	56	3,201
	FTE/Obl.	52	29,311	56	29,042	56	26,049	98	29,098	42	3,049

SUBACTIVITY: STANDARDS COORDINATION AND SPECIAL PROGRAMS

Program Description:

Special Programs Office (SPO)/Standards Coordination Office (SCO): The SPO serves as the project and program management office for the Associate Director for Laboratory Programs, enhancing management oversight, planning, and resource coordination for high-profile programs that critically depend on the expertise and capabilities of two or more NIST laboratories. The SCO will be a normative standards and conformity assessment related multi-functional resource for NIST and U.S. government staff. This office will help NIST address normative standards related statutory responsibilities delegated to NIST, and will also serve to act as a unique resource of standards and conformity assessment related information addressing issues at the intersection of technology, standards, trade and innovation.

The SPO currently consists of the following four programs:

- Law Enforcement Standards: Develops performance standards, measurement tools, operating procedures and equipment guidelines that help criminal justice, public safety, emergency responder, and homeland security agencies make informed procurement, deployment, applications, operating, and training decisions. Provides unique expertise on performance standards for critical technologies such as ballistic body armor, metal detectors, protective equipment, computer forensics, DNA analysis, and public safety communication interoperability. Works with law enforcement, public safety and public security practitioners, universities, government agencies, professional and scientific organizations to solve difficult technical public safety and national security challenges.

- Smart Grid Interoperability Standards Project: Expedites development and promotes widespread adoption of Smart Grid interoperability and cyber security standards by: (1) engaging stakeholders in a public-private partnership to identify applicable standards, gaps in currently available standards, and coordinating development of new standards; and, (2) developing and implementing a framework for testing and certification. Provides measurement capabilities to ensure effective monitoring and real-time control and stability of Smart Grids.

- Greenhouse Gas Measurements and Climate Research Program: Provides the measurement science basis for accurate and comparable quantitative measurements of greenhouse gas emissions. Ensures measurement capabilities for accurate and reliable assessment of current greenhouse gas baselines, validation of greenhouse gas emission sources, and quantification of greenhouse gas sinks through improved quantitative measurements. Enables development of international measurement standards to ensure the accuracy of global assessments of greenhouse gas emissions.

- Coordinated National Security Standards Program: In cooperation with the Department of Homeland Security, develops and improves the effectiveness of measurement methods, standards, and technologies to address critical challenges in many areas relevant to homeland security, such as chemical and biological agent detection, biometrics, and first responder communications.

The Standards Coordination Office will provide the following programmatic functions:

- Standards and Information Dissemination and Outreach: Operates the National Center for Standards and Certification Information, and the World Trade Organization, Technical Barriers to Trade related Inquiry Point and Notification Authority providing unique standards, conformity assessment and technical regulations related information to NIST staff, U.S. govt. employees, U.S. exporters, and foreign trading partners. Provides standards and conformity assessment related outreach and training to stakeholders. Analyzes impact and effectiveness of NIST participation in standards and conformity assessment related activities.

- Standards Coordination: Provides secretarial support for the Interagency Committee on Standards Policy, and meet statutory responsibilities under the National Technology Transfer Advancement Act, and coordinate and produce annual reports about use of voluntary consensus standards by Federal agencies per Office of Management and Budget Circular A-119. Provides standards and conformity assessment related staff support to the NIST Director, and the Associate Director for Laboratories. Provides secretarial functions and support for the National Science and Technology Council's Sub-Committee on Standards, which is co-chaired by the NIST Director. Assists NIST operating units with participation in standards development committees, and assist in coordinating NIST participation in standards development activities.

- Standards Guidance: Provides standards and conformity assessment related technical support to other U.S. govt. agencies to assist with both technical and policy issues. Provides early warning about emerging standards and conformity assessment related issues that can help NIST managers make decisions about preparing for and addressing these issues. Assists NIST staff in bridging the technical, standards and trade policy aspects in issues with the potential to impact U.S. competitiveness and ability to innovate. Provides unique standards and conformity assessment policy expertise relating to key trading partners. Assists U.S. government agencies and private sector organizations with the implementation of Mutual Recognition Agreements (MRAs) such as the APEC Tel and CITEL MRAs.

Examples of Accomplishments:

- Law Enforcement Standards: Created a standard reference material that has globally standardized forensic firearms examinations and propelled the next generation of ballistic imaging software and instrumentation. The standard bullet was pivotal in the creation of algorithms for data collection and is the basis of uniform image capture for the National Integrated Ballistics Information Network, a national system utilized to associate firearms used in crimes to evidentiary fired bullets and casings. Developed repeatable, easy-to-use, low cost test materials and methods using inkjet printing technology and made these materials available to Department of Homeland Security's Transportation Security Administration. Explosive material solutions are printed onto calibration tabs that are then used for testing the functionality and accuracy of explosive detectors.

- Smart Grid Interoperability Standards Project: Issued Release 1.0 Framework and Roadmap for Smart Grid. Issued Release 1.0 Cyber Security Guidelines for the Smart Grid. Established the Smart Grid Interoperability Panel.

- Greenhouse Gas Measurements and Climate Research Program: Completed the development of the spectral reference data for carbon dioxide at unprecedented levels of accuracy that directly support the observing instruments to be employed in NASA's Orbiting

Carbon Observatory. Demonstrated a robust, low component cost, observing instrument technology prototype for carbon dioxide and methane intended for widespread use in surface-based observing networks.

Priority Objectives for FY 2012:

- Law Enforcement Standards: Utilize lessons learned from the 700MHz Public Safety Broadband Demonstration Network (a FY2011 project) to create a smaller, permanent network for testing key features of the evolving nationwide public safety network, including mission critical voice, priority access, roaming, and quality of service—all of which are critical to the vision of a nationwide interoperable network. Establish a Forensic Program Management Office that will be responsible for managing eighteen Federal scientific working groups to promulgate national standards, guidelines, and best practices throughout the forensic science community.

- Smart Grid Interoperability Standards Project: Issue new releases of the NIST Smart Grid Framework and Roadmap and NIST Smart Grid Cyber Security documents. Ongoing oversight of Smart Grid Interoperability Panel, including completion of an additional 12 standards for use by the Smart Grid eco-system, completion of 18 Priority Action Plans, finalization of the Testing and Certification Framework, and identification of the list of recognized Smart Grid Test Programs based on completed standards.

- Greenhouse Gas Measurements and Climate Research Program: Establish the first 25 percent of a high-spatial-density regional monitoring network as a test bed for investigating the performance of dense observing networks having significantly improved spatial resolution for greenhouse gas source and sink identification and quantification at local and regional scales.

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

	FY 2010 Actual	FY 2011 CR Level	FY 2012 Estimate
Department of Defense			
Other	$174	0	0
Subtotal, Department of Defense	174	0	0
Department of Agriculture	0	$60	0
Dept. of Homeland Security	112	4,426	$4,351
Department of Justice	2,244	4,276	4,261
Environmental Protection Agency	0	50	0
National Science Foundation	46	0	0
Subtotal, Federal Agencies	2,576	8,812	8,612
Technical & Advisory Services	2,053	2,555	2,555
Subtotal, Other Reimbursables	2,053	2,555	2,555
Total, Reimbursable Program	4,629	11,367	11,167
SRM Transfers	0	0	0
Subtotal, WCF transfer	0	0	0
Equipment Investments	54	35	35
IE Amortization	(184)	(22)	(35)
Excess Amortizations over Equipment Investments	131	0	0
Total, WCF Investments	1	13	0
Total, Reimbursable Program and WCF Investments	4,630	11,380	11,167

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Object Class

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	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
11	Personnel compensation					
11.1	Full-time permanent	$188,988	$192,658	$193,586	$224,700	$31,114
11.3	Other than full-time permanent	25,638	23,205	23,284	23,284	0
11.5	Other personnel compensation	7,583	7,428	7,428	7,428	0
11.9	Total personnel compensation	222,209	223,291	224,298	255,412	31,114
12.1	Civilian personnel benefits	59,049	58,993	62,841	71,399	8,558
13	Benefits for former personnel	28	28	28	28	0
21	Travel and transportation of persons	11,924	11,703	12,210	15,902	3,692
22	Transportation of things	863	776	801	1,511	710
23.1	Rental payments to GSA	16	39	43	43	0
23.2	Rental payments to others	1,846	1,924	1,993	1,993	0
23.3	Communications, utilities, and miscellaneous charges	17,430	17,080	12,187	20,080	7,893
24	Printing and reproduction	390	367	375	616	241
25.1	Advisory and assistance services	3,103	2,106	2,171	2,171	0
25.2	Other services	72,139	61,734	37,150	51,177	14,027
25.3	Purchases of goods and services from Government accounts	21,354	21,180	23,085	36,328	13,243
25.5	Research and development contracts	1,559	1,554	1,667	29,786	28,119
25.7	Operation and maintenance of equipment	14,737	9,863	10,092	12,301	2,209
26	Supplies and materials	37,999	24,787	25,835	32,330	6,495
31	Equipment	115,535	35,963	38,283	50,770	12,487
32	Land and structures	104	104	104	2,636	2,532
41	Grants, subsidies, and contributions	117,421	58,812	58,812	89,876	31,064
42	Insurance claims and indemnities	10	0	0	0	0
43	Interest and dividends	2	0	0	0	0
99	Total Obligations	697,718	530,304	511,975	674,359	162,384

	Object Class	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
99	Total Obligations	697,718	530,304	511,975	674,359	162,384
	Less Prior Year Recoveries	(9,273)	(1,000)	(1,000)	(1,000)	0
	Less Prior Year Refunds	(49)	0			
	Less Prior Year Unobligated Balance	(191,907)	(18,931)	0	0	0
	Plus Unobligated Balance, End of Year	18,931	0			
	Plus Unobligated Balance, Expired	3,137	0			
	Total Budget Authority	518,557	510,373	510,975	673,359	162,384
	Unobligated Balance Rescission					
	Transfer to NIST Working Capital Fund	1,443	0	0	8,834	8,834
	Transfer from Election Assistance Commission	(3,500)	(3,500)	0	(3,250)	(3,250)
	Transfer from Community Oriented Policing Services, DoJ	(1,500)	(1,500)	0	0	0
	Appropriation	515,000	505,373	510,975	678,943	167,968

Personnel Data	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
Full-time equivalent employment:					
Full-time permanent	1,821	1,833	1,837	2,186	349
Other than full-time permanent	243	239	235	235	0
Total	2,064	2,072	2,072	2,421	349
Authorized Positions:					
Full-time permanent	2,065	2,018	2,018	2,485	467
Other than full-time permanent	52	48	48	48	0
Total	2,117	2,066	2,066	2,533	467

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. $678,943,000, to remain available until expended,

no specific authority

3. of which not to exceed $9,234,000 may be transferred to the "Working Capital Fund." 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. Public Law 111-358, America Competes Reauthorization Act, 2010, 124 Stat 3982, passed January 4, 2011 reauthorized the Scientific and Technical Research and Standards appropriation through 2013. In addition, an Emergency Communication and Tracking Technologies Research initiative and a Green Manufacturing and Construction initiative were authorized to develop advanced technologies in these areas.

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 2010 Actual	FY 2011 Estimate	FY 2012 Estimate
Management and professional support services	$1,731	$1,372	$1,020
Studies, analyses, and evaluations	253	230	230
Engineering and technical services	719	504	504
Total	2,703	2,106	1,754

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.

Industrial
Technology Services

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
2011 Annualized CR Level	202	210	$204,227	$239,775	$194,600
plus: Reorganization from STRS					$9,627
less: 2011 Unobligated balance from prior year	0	0	0	(31,748)	0
Restoration of FY 2011 ATBs	0	0	434	434	434
2012 Adjustments to base:					
plus: Restoration of 2011 deobligation offset	0	0	3,800		3,800
plus: Uncontrollable cost changes	0	0	(63)	(63)	(63)
less: Estimated recoveries 2012	0	0	(3,800)		(3,800)
2012 Base Request	202	210	204,598	208,398	204,598
plus: 2012 Program changes	(9)	(11)	33,024	33,024	33,024
2012 Estimate	193	199	237,622	241,422	237,622

		2010 Actual		2011 Annualized CR Level		2012 Base		2012 Estimate		Increase/ (Decrease) Over 2012 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	78	$69,900	78	$69,900	78	$69,787	78	$74,973	0	$5,186
	FTE/Obl.	80	77,236	80	104,479	80	73,587	80	78,773	0	5,186
Advanced manufacturing technology consortia											
Advanced manufacturing technology consortia	Pos./Approp	0	0	0	0	0	0	2	12,306	2	$12,306
	FTE/Obl.	0	0	0	0	0	0	1	12,306	1	12,306
Hollings manufacturing extension partnership											
Hollings manufacturing extension partnership	Pos./Approp	70	124,700	73	124,700	73	124,967	76	142,616	3	17,649
	FTE/Obl.	78	124,913	78	125,669	78	124,967	80	142,616	2	17,649
Baldrige performance excellence program											
Baldrige performance excellence program	Pos./Approp	0	0	51	9,627	51	9,844	37	7,727	(14)	(2,117)
	FTE/Obl.	0	0	52	9,627	52	9,844	38	7,727	(14)	(2,117)
TOTALS	Pos./Approp	148	194,600	202	204,227	202	204,598	193	237,622	(9)	33,024
	FTE/Obl.	158	202,149	210	239,775	210	208,398	199	241,422	(11)	33,024

	2010 Actual		2011 Annualized CR Level		2012 Base		2012 Estimate		Increase/ (Decrease) Over 2012 Base	
Comparison by activity/subactivity:	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Adjustments for:										
Recoveries		(1,560)		(3,800)		(3,800)		(3,800)		0
Refunds		(194)		0		0		0		0
Unobligated balance, start of year		(37,543)		(31,748)		0		0		0
Unobligated balance, end of year		31,748		0		0		0		0
Budget Authority		194,600		204,227		204,598		237,622		33,024
Financing from transfers:										
Reorganization		0		(9,627)		0		0		0
Appropriation		194,600		194,600		204,598		237,622		33,024

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 2011 adjustments to base	0	434

In FY 2011, NIST's ITS adjustments to base increase of $434,000 was not applied. This adjustment restores the increase in FY 2012

	FTE	Amount
Restoration of FY 2011 deobligation offset		$3,800

In FY 2011, 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 2012.

	FTE	Amount
Subtotal, Adjustments	0	4,234
Financing:		
Recoveries of prior year obligations		(3,800)

This reduction is the estimated level of TIP prior year deobligations in FY 2012.

<u>Other Changes</u>:

Personnel benefits.		0	120

Civil Service Retirement System (CSRS)	(26)
Federal Employees' Retirement System (FERS)	43
Thrift Savings Plan (TSP)	18
Federal Insurance Contribution Act (FICA) – OASDI	(18)
Health Insurance	103

Civil Service Retirement System (-$26,000) – 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 11.8 percent in FY 2011 to 10.2 percent in FY 2012. The contribution rate will remain at 7.0 percent in FY 2012.

Payroll subject to retirement systems ($23,191,524)	
Cost of CSRS contributions in FY 2012 ($23,191,524 x .102 x .07)	$165,587
Cost of CSRS contributions in FY 2011 ($23,191,524 x .118 x .07)	191,562
Total adjustment to base	(25,975)

Federal Employees' Retirement System ($43,000) – 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 88.2 percent in FY 2011 to 89.8 percent in FY 2012. The contribution rate increased from 11.2 percent in FY 2011 to 11.7 percent in FY 2012.

Payroll subject to retirement systems ($23,191,524)	
Basic benefit cost in FY 2012 ($23,191,524 x .898 x .117)	$2,436,641
Basic benefit cost in FY 2011 ($23,191,524 x .882 x .117)	2,393,226
Total adjustment to base	43,415

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 remained at 4.56 percent for both FY 2011 and FY 2012.

Thrift plan cost in FY 2012 ($23,191,524 x .898 x .0456)	$949,764
Thrift plan cost in FY 2011 ($23,191,524 x .882 x .0456)	932,245
Total adjustment to base	17,519

Federal Insurance Contributions Act (FICA) - OASDI (-$18,000) – As the percentage of payroll covered by FERS increases, the cost of OASDI contributions will increase. However, in FY 2012, the maximum salary subject to OASDI tax decreased from $114,975 in FY 2011 to $110,175 in FY 2012. The OASDI tax rate will remain 6.2 percent in FY 2012.

FERS payroll subject to FICA tax in 2012 ($23,191,524 x .898 x .873 x .062)	$1,127,327
FERS payroll subject to FICA tax in 2011 ($23,191,524 x .882 x .903 x .062)	1,145,189
Increase (FY 2011-FY 2012)	(17,862)
OTP payroll subject to FICA tax in 2012 ($764,476 x .898 x .873 x .062)	37,157
OTP payroll subject to FICA tax in 2011 ($764,476 x .882 x .903 x .062)	37,750
Increase (FY 2010-2011)	(593)
Total adjustment to base	(18,455)

Health insurance ($103,000) – Effective January 2010, NIST's contribution to Federal employees' health insurance premiums increased by 6.9 percent. Applied against the FY 2011 estimate of $1,488,000, the additional amount required is $102,672.

Travel and transportation of persons	0	27

The GSA standard per diem rate of 6.4% for destinations within the Continental United States (CONUS) was applied to the FY 2011 estimate of $421,888 for an increase of $27,001.

Communications, utilities, and miscellaneous charges		0	(392)
Electricity rate decrease	(180)		
Natural Gas rate decrease	(212)		

The electricity ATB amount was derived using a year to year comparison of the cost per kilowatt hour. In analyzing the 12 months ended March 2010 and 2009, the per kilowatt hour rate decreased 17.9 percent (from 11.5 cents to .94 cents) for Gaithersburg, Maryland; decreased 17.9 percent (from 36.9 cents to 30.3 cents) for Kauai, Hawaii; decreased 1.5 percent (from 6.7 cents to 6.6 cents) for Boulder, Colorado; and increased 5.3 percent (from 8.6 cents to 9.1 cents) for Ft. Collins, Colorado for a net decrease of $180,000.

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 2010 and 2009, the per therm rate decreased 36.0 percent (from 1.329 to .851) and decreased 1.73 percent (from 7.370 to 5.637) for Gaithersburg and Boulder respectively resulting in a net decrease of $212,000.

General pricing level adjustment	0	182

This request applies the OMB economic assumptions of 1.2 percent for FY 2012 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 $912; rental payments to others $2,328 communications, utilities, and miscellaneous charges $5,508; other services $151,120; supplies $8,748; and equipment $13,010.

Subtotal Other changes	0	(63)
Total Adjustments to base	0	371

ITS

APPROPRIATION ACCOUNT: INDUSTRIAL TECHNOLOGY SERVICES (ITS)

The ITS appropriation funds the following budget activities/subactivities: Technology Innovation Program (TIP), Hollings Manufacturing Extension Partnership (MEP) program, and Baldrige Performance Excellence Program (BPEP). The request proposes to fund a new program, the Advanced Manufacturing Technology Consortia (AMTech), under this appropriation. The ITS request totals $237.6 million and 199 FTE, a $43.0 million increase and 41 FTE increase above the FY 2010 enacted level. This increase includes $371 thousand in inflationary adjustments.

Significant Adjustments-to-Base (ATBs):

NIST requests a net increase of 0 FTE and $371 thousand to fund adjustments to current programs for the ITS appropriation. The increase will provide inflationary increases for non-labor activities, including service contracts and utilities.

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Technology Innovation Program

Exhibit 10

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

Activity: Technology innovation program
Subactivity: Technology innovation program

Line Item		2010 Actual Personnel	2010 Actual Amount	2011 Annualized CR Level Personnel	2011 Annualized CR Level Amount	2012 Base Personnel	2012 Base Amount	2012 Estimate Personnel	2012 Estimate Amount	Increase/(Decrease) Over 2012 Base Personnel	Increase/(Decrease) Over 2012 Base Amount
Technology innovation program	Pos./Approp	78	$69,900	78	$69,900	78	$69,787	78	$74,973	0	$5,186
	FTE/Obl.	80	77,236	80	104,479	80	73,587	80	78,773	0	5,186

BUDGET ACTIVITY AND SUBACTIVITY: TECHNOLOGY INNOVATION PROGRAM (TIP)

The Technology Innovation Program (TIP) at the National Institute of Standards and Technology was established to assist U.S. businesses and institutions of higher education or other organizations, such as national laboratories and nonprofit research institutions, to support, promote, and accelerate innovation in the U.S. through high-risk, high-reward research in areas of critical national need. These areas need government attention because the magnitude of the problem is large and societal challenges are not being sufficiently addressed. TIP is funded at $75.0 million, an increase of $5.1 million above the FY 2011 Continuing Resolution annualized level (an increase of $5.2 million from the FY 2012 base).

BASE JUSTIFICATION FOR FY 2012:

The TIP statute originated in the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Sciences (COMPETES) Act of 2007 (P.L. 110-69). The COMPETES Act was recently reauthorized as the America COMPETES Reauthorization Act of 2010 (P.L. 111-358). TIP was established to help U.S. businesses, institutions of higher education, and other organizations—such as national laboratories and nonprofit research institutes—to support, promote, and accelerate innovation in the United States through high-risk, high-reward research in areas of critical national need. Areas which TIP has supported include civil infrastructure, and Manufacturing and Biomanufacturing.

Evaluation of program impacts is part of TIP's statutory requirement. TIP is collecting and will continue to collect information and data that will serve as the basis for the performance measures listed below.

TIP aims to speed the development of high-risk, transformative research targeted to key societal challenges that are not being addressed elsewhere.

Key program activities have been in the following areas:

- Selection Activities: holding competitions for new awards in accordance with the TIP Rule (15 CFR Part 296),
- Project Management Activities: holding funding recipients accountable for their use of Federal funds and adherence to the objectives of their original proposal,
- Identification of New Areas for Investment: researching and identifying new critical national needs appropriate for TIP, and
- Evaluation and Information Dissemination Activities: evaluating the results of the funded research projects and publishing non-proprietary information about the outcomes of those projects.

Priority Objectives for FY 2012:

In FY 2012, TIP is planning to hold a competition for funding in one or more areas of critical national needs that include topic areas in: Advanced Robotics and Intelligent Automation, Energy, Healthcare, Water, Civil Infrastructure Technologies, and Manufacturing. 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 has held two competitions in the area of Civil Infrastructure and two competitions in the area of Manufacturing, and intends to hold a competitive funding opportunity that expands upon these areas in FY 2011. In FY 2012, TIP plans to further expand the Manufacturing topic and introduce new investment areas as well to meet additional and changing areas of critical national need.

PROGRAM CHANGES FOR FY 2012:

Technology Innovation Program (TIP) (Base Funding: 80 FTE and $69.787 million; Program Change: + 0 FTE and + $5.186 million).

NIST requests an increase of $5.186 million and 0 FTE for a total of $74.973 million and 80 FTE to support, promote, and accelerate innovation in the United States by funding high-risk, high-reward research in areas of critical national need.

The Technology Innovation Program (TIP) was 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 recognized the value of both the intramural and extramural programs at NIST in response to the National Academies report *Rising Above the Gathering Storm*. TIP recognizes the importance of rich teaming among small- and mid-sized businesses, universities and other research institutions in supporting technological development and innovation to increase U.S. competitiveness in the global marketplace. TIP was explicitly established within NIST to fund research that has the potential for yielding transformational results with wide-reaching implications, and that is within NIST's areas of technical competence. TIP aims to speed the development of high-risk, transformative research targeted to key societal challenges that are not being addressed elsewhere.

Proposed Actions: For FY 2012, NIST requests $74.973 million consisting of base funding of $69.787 million and an initiative increase of $5.186 million. The $5.186 million increase will enhance TIP's capability to fund additional projects in new areas of critical national need while funding remaining mortgage commitments from previous competitions. In FY 2012, TIP is planning to hold a competition for funding in one or more areas of critical national need as described below.

TIP is designed to fund high-risk, high-reward R&D projects that address critical national needs and societal challenges in any area that is important to the Nation but is not being addressed by others. TIP has the agility to make targeted, high impact investments that are within NIST's areas of technical competence and are not possible by other mission-oriented agencies or programs. 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 Administration guidance, the TIP Advisory Board, science advisory bodies, collaborations with other Federal agencies, national or state science policy reports, academic reports and organizations, industry roadmaps and the public.

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 has held two competitions in the area of Civil Infrastructure and two competitions in the area of Manufacturing, and intends to hold a competitive funding opportunity that expands upon these areas in FY2011. In FY2012, TIP plans to further expand the Manufacturing topic and introduce new investment areas as well to meet additional and changing areas of critical national need.

New topic areas under development for FY 2012 may include one or more of the following:

Advanced Robotics and Intelligent Automation: Advanced Robotics focuses on an area of critical national need in manufacturing. It also potentially impacts other application areas such as healthcare and homeland security. Manufacturing is an area of critical importance to the Nation and its economy. The manufacturing sector represents the largest of the United States' private industry sectors, supporting more than 14 million jobs and accounting for almost 12 percent of GDP in 2007. Potential next generation solutions for use in automation and robotics under consideration include new techniques for dexterous manipulation and handling objects; concurrency (parallel activities, networking and cross-communications); new approaches for navigation and 3-D planning in unstructured environments; new strategies for monitoring and controlling groups of robots; new technologies and approaches for the seamless integration of the various subsystems that make up a robot or intelligent automation system; new technical approaches for power and energy storage; new approaches to communications; and new methods for ensuring safe interactions between robots and humans

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. Innovation in new technologies will be required to enable a reliable Smart Grid approach to electric power distribution, demand, and response control, grid connectivity, and the integration of renewable energy sources into the grid. TIP specifically aims to fund research in energy storage systems and the integration of stored energy into the grid system, advanced sensors and their energy sources to be deployed along the grid, and communication and control technologies (high voltage power electronics).

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 regiments. 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. TIP first incorporated the biomanufacturing element of this topic into its manufacturing solicitation in FY 2010.

Water: Increasing population growth, climate variability, new demands from industry and a multitude of other factors exert increasing stress on fresh water supplies. These stresses manifest themselves in societal challenges of a technical nature that, if not addressed, have the potential to spread disease through fresh water distribution systems, distribution system failures that disrupt services and/or flood residences and businesses. The desired outcome is to have improved means for better managing the quality and quantity of delivered-water supplies and for protecting the public from waterborne disease sources. Better tools are required for environmentally benign disposition of brines and waste streams from desalination and water reclamation projects, for low-cost methods for removal of emerging contaminants from wastewater streams and from water distribution systems, for resource recovery from wastewater, and for transformative improvements in the energy costs of producing water from non-freshwater sources. Environmental issues of concentrated brine discharge from reverse osmosis plants limit deployment as permitting is a major constituent of the fixed costs of current desalination projects. The energy costs of new means of producing water and also for treating wastewater must be reduced to decouple water prices from energy prices and to provide cost-effective availability.

TIP may also offer continued solicitations in topics previously funded. By extending topics over multiple years, TIP can optimize the research potential of the technology community and respond to changing national priorities. Previous investment areas include:

Civil Infrastructure Technologies: (funded by TIP in FY 2008 and FY 2009 and planned for FY 2011) 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 2012 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.

Manufacturing (funded by TIP in FY 2009 and FY 2010 and planned for FY 2011): 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, or 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 advanced materials, with applications in areas ranging from therapeutics to batteries to flexible electronics.

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.

Statement of Need and Economic Benefits:

TIP only funds high-risk, high-reward projects that have the potential to address the Nation's most pressing needs. These areas justify TIP investment because the magnitude of the problem is national in scope and the scientific and technical challenges that need to be overcome are not being addressed by other funding sources. If not addressed, these societal challenges could negatively impact the overall function and quality of life of the Nation.

Evaluation of program impacts is part of TIP's statutory requirement. TIP is collecting and will continue to collect information and data that will serve as the basis for performance measures. A broader portfolio-level analysis will help the program better assess the benefits from program funding. Because TIP funds early-stage, transformative research, many of the project outcomes will not be realized until three to five years after the project is awarded, at the earliest. TIP continues to monitor and provides metrics regarding meeting intermediate benchmarks along this process including the creation of scientific knowledge, leveraging additional research investments in the technology, and adoption of the technology by early users.

Ultimately, the impact of TIP investments is expected to:

- Address some of the Nation's most pressing needs through science and technology
- Stimulate additional investments in research targeted at the Nation's long-run societal needs

- Advance the state-of-the-art and increase the Nation's return on its scientific investment
- Enhance U.S. competitiveness

Base Resource Assessment: TIP assists U.S. businesses and institutions of higher education or other organizations, such as national laboratories and nonprofit research institutions, to support, promote, and accelerate innovation in the U.S. through high-risk, high-reward research in areas of critical national need. As of December, 2010, TIP has completed three competitive funding opportunities addressing two areas of critical national need: *Civil Infrastructure and Manufacturing.*

TIP has awarded 38 projects (includes 16 joint ventures, 22 single applicants (small and medium businesses and 132 participants). These awarded projects involve a commitment of over $135.7 million in NIST funds and $144 million in cost-share funding provided by the awardees, for a total of $279.7 million in high-risk, high-reward research to be conducted over the three to five year life of the projects.

Schedule and Milestones:

FY12 –

- Award up to 22 new cooperative agreements – that funds high-risk, high-reward research in the identified critical national need.
- Continue managing existing awards in accordance with project-specific milestones.
- Continue evaluating the impact of the TIP program.
- Continue identifying, assessing and prioritizing new areas of critical national need for future TIP investment.

FY13 –

- Award up to 12 new cooperative agreements – that funds high-risk, high-reward research in an identified critical national need.
- Continue managing existing awards in accordance with project-specific milestones.
- Continue evaluating the impact of the TIP program.
- Continue identifying, assessing and prioritizing new areas of critical national need for future TIP investment.

Deliverables:

Each new competitive funding opportunity will enable TIP to initiate cost-shared research in high-risk, high-reward technologies that address the Nation's most pressing needs. Outputs, as captured in the performance indicators shown below, include:

- Initiation of new R&D projects conducted by small and medium companies, large companies (do not receive TIP funds but may participate), institutions of higher education, non-profit R&D organizations, national laboratories, government laboratories, and other organizations performing high-risk, high-reward R&D.
- The creation of new scientific knowledge and advancement of the state-of-the-art, as evidenced through publications (lagged measure).
- The creation of intellectual property vesting in a U.S. entity, as evidenced through patent applications (lagged measure).

- Creation of transformative R&D that continues to leverage non-TIP funds, as evidenced through projects with continued R&D after the completion of the TIP-funded project (lagged measure).
- The value of the TIP-funded R&D to end-users, as evidenced by a variety of indicators including licensing, beta testing, or commercialization (lagged measure).

Performance Goals and Measurement Data

Performance Goal:						
Cumulative number of TIP projects funded	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	38	60	72	96	106	120
Without Increase	38	56	68	92	102	116
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.						
Cumulative number of publications	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		24	60	105	114	114
Without Increase		*	*	*	*	*
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.						
Cumulative number of patent applications	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		12	30	35	38	38
Without Increase		*	*	*	*	*
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.						

Cumulative number of projects generating continued R&D	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		4	10	18	19	19
Without Increase		*	*	*	*	*

Description: This measure reflects the creation of transformative research whose value is demonstrated by continued R&D investment by the original researchers or 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).

Cumulative number of projects with technologies under adoption	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase		2	5	9	10	10
Without Increase		*	*	*	*	*

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).

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Technology Innovation Program
Subactivity: Technology Innovation Program

	Object Class	2012 Increase
11	Personnel compensation	
11.1	Full-time permanent	0
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	0
12	Civilian personnel benefits	0
13	Benefits for former personnel	0
21	Travel and transportation of persons	0
22	Transportation of things	0
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	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	$147
25.3	Purchases of goods & services from Gov't accounts	0
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	123
25.6	Medical care	0
25.7	Operation and maintenance of equipment	0
25.8	Subsistence and support of persons	0
26	Supplies and materials	0
31	Equipment	0
32	Lands and structures	0
33	Investments and loans	0
41	Grants, subsidies and contributions	4,916
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Total obligations	5,186

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

	FY 2010 Actual	FY 2011 CR Level	FY 2012 Estimate
Total, Reimbursable Program	0	0	0
SRM Transfers	0	0	0
Subtotal, WCF transfer	0	0	0
Equipment Investments	$19	$30	$30
IE Amortization	(32)	(18)	(30)
Excess Amortizations over Equipment Investments	13	0	0
Total, WCF Investments	0	12	0
Total, Reimbursable Program and WCF Investments	0	12	0

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

Activity: Advanced manufacturing technology consortia
Subactivity: Advanced manufacturing technology consortia

		2010 Actual		2011 Annualized CR Level		2012 Base		2012 Estimate		Increase/ (Decrease) Over 2012 Base	
Line Item		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Advanced manufacturing technology consortia	Pos./Approp	0	0	0	0	0	0	2	$12,306	2	$12,306
	FTE/Obl.	0	0	0	0	0	0	1	12,306	1	12,306

BUDGET ACTIVITY AND SUBACTIVITY: ADVANCED MANUFACTURING TECHNOLOGY CONSORTIA (AMTech)

BASE JUSTIFICATION FOR FY 2012:

AMTech is a new program proposed in FY 2012. This initiative provides grants to leverage existing consortia or establish critical new industry-led consortia. These consortia will develop road-maps of critical long-term industrial research needs, fund facilities, equipment and research at leading universities and government laboratories directed at meeting these needs.

PROGRAM CHANGES FOR FY 2012:

Advanced Manufacturing Technology Consortia (AMTech) (Base Funding: 0 FTE and $0 million; Program Change: +1 FTE and +$12.306 million)

This new initiative provides grants to leverage existing consortia or establish critical new industry-led consortia. These consortia will develop road-maps of critical long-term industrial research needs and fund research at leading universities, government laboratories and small business directed at meeting these needs. Since these consortia will be composed of private industry, government laboratories, and universities as well as regional governments and private sector financiers, the members will span the innovation lifecycle from idea to discovery, invention, and ultimately commercialization. The partnerships supported by this initiative will leverage the unique capabilities of each partner and depend critically on the open dissemination and sharing of methods and results. Through the advanced planning and road mapping, this initiative will increase the productivity of all research institutions that participate in this effort. By convening the key players across the innovation lifecycle, this initiative will eliminate critical barriers to innovation, increase the efficiency of domestic innovation efforts and collapse the timescale to deliver new products and services based on scientific and technological advance. This strategy has the potential to drive economic growth, enhance competitiveness and spur the creation of jobs in high value sectors.

Proposed actions:

U.S. R&D intensity is lagging other Nations and the composition of U.S. R&D has shifted toward short-term research. This leaves industry's long-term needs unmet and ultimately undermines our Nation's competitiveness. Currently, public institutions support curiosity driven academic research and private enterprise responds efficiently and effectively to current global competitive pressures. However, neither public institutions nor private enterprise are taking adequate actions to support transformational 21st century innovation.

- NIST will develop the AMTech program by building upon and leveraging critical synergies between:
    - NIST's successful partnership with the Nanoelectronics Research Initiative (NRI)
    - and draw on NIST's experience with awarding grants to industry-led consortia to perform the transformational research in areas of critical national need.

- This initiative provides grants to existing or critical new industry-led consortia. Grants will be competitively awarded to consortia composed of industry, Federal, university, regional, and other private sector partners. Criteria for award potentially include:
  - a demonstration of the innovative and high risk nature of the research to be supported;
  - a demonstration of the potential high impact of the research results and likelihood that these research results will transform industrial competitiveness;
  - a demonstrated need for NIST support of the consortia research agenda;
  - a demonstration that the consortium members span the innovation life cycle from idea to discovery, invention, and ultimately commercialization;
  - and a demonstration of how the proposed consortia builds upon existing regional assets and advantages.

- This initiative is built on the success of NIST's partnership with the industry-led Nanoelectronics Research Initiative (NRI). Modeled on the NIST/NRI partnership the AMTech program represents a new class of public-private partnerships that addresses certain weakness identified by evaluations of prior government/university/industry partnership efforts. A key Federal role in this new class of public private partnership will be to act as an honest broker to ensure the integrity of the research agenda and project selection. Additionally, these partnerships are built on open access to the pre-competitive intellectual property generated by university research performed through this collaboration. Finally, these partnerships leverage location economies and facilitate the transfer of knowledge by minimizing the cost associated with the transfer of academic research results to the industrial environment.

- The research progress of the AMTech partnership will be evaluated annually.

- NIST operates at the intersection of three assets critical to the Nation's innovative capacity and competitiveness: private industry, the university science base, and Federal research labs. To meet certain critical, cross-cutting and transformational challenges, this approach, which leverages the unique capabilities of each asset, was deemed more appropriate for achieving the program's objectives compared to alternative approaches that focused on individual assets (e.g., grants to private enterprise, grants to university researchers, or NIST intramural research).

- The AMTech program will complement other NIST programs and operating units. The programs in this initiative will strengthen the connections between NIST, industry and academia. To further enhance these benefits, NIST will coordinate these programs with NIST laboratories, user facilities, measurement services and standards. NIST extramural programs such as the Manufacturing Extension Partnership program can further aid technology development, dissemination and adoption.

Statement of Need and Economic Benefits:

- NIST has a long history of performing rigorous cost benefit studies of its programs and this program will be treated identically. NIST evaluations have demonstrated that programs have expedited the introduction of new technology, increased research efficiency, increased productivity, reduce transactions and adoption costs.

- Increase the Nation's return on its scientific investment.

  - Increase the efficiency of private and public research institutions.

- Stimulate investments in research targeted at long-run industry need.
- Collapse the timescale of technological innovation.
- Increase the efficiency of the U.S. innovation ecosystem
    - Increase productivity.
    - Lower transaction and adoption costs.
- Stimulate the economy and enhance competitiveness.

Base Resources Assessment:

- No base funding currently exists for this program.

Schedule & Milestones:

Note that in order to promote competition among regions and sectors, starting in FY2013 the number of planning grants exceed the potential partnership awards.

- FY 2012
    - Award up to two grants to establish or develop new consortia to identify critical long-term industry research needs ($500,000/award).
    - Award 1-2 grants to established consortia with clearly identified long-term industry research needs identified in and explicit technology roadmap. Grant will be for up to $5 - 10 million annually. All research will be directly traceable to the technology roadmap. Consortia grant will be renewable up to five years.

Deliverables:

Metrics

- Creation of Industry roadmaps
- Construction of facilities and provision of equipment
- Attraction of industry and state funding of directed basic research
- Attraction of state and venture funds to support commercialization
- Funding research activities and support graduate and post-doctoral researchers
- Production of new scientific knowledge and marketable inventions
- Creation of new companies and jobs in high value added sectors

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amount in thousands)

Activity: Advanced Manufacturing Technology Consortia
Subactivity: Advanced Manufacturing Technology Consortia

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Assesment Panel Member	Gaithersburg	ZP IV	1	$105,211	$105,211
Technical Project Manager	Gaithersburg	ZP IV	1	105,211	105,211
Total			2		210,422
Less Lapse		25%	(1)		(52,606)
Total full-time permanent (FTE)			1		157,817
2011 Pay Adjustment (0%)					0
2012 Pay Adjustment (0%)					0
TOTAL					157,817

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	1
Other than full-time permanent	0
Total	1
Authorized Positions:	
Full-time permanent	2
Other than full-time permanent	0
Total	2

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Advanced Manufacturing Technology Consortia
Subactivity: Advanced Manufacturing Technology Consortia

	Object Class	2012 Increase
11	Personnel compensation	
11.1	Full-time permanent	$158
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	158
12	Civilian personnel benefits	42
13	Benefits for former personnel	0
21	Travel and transportation of persons	2
22	Transportation of things	0
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	48
24	Printing and reproduction	0
25.1	Advisory and assistance services	0
25.2	Other services	25
25.3	Purchases of goods & services from Gov't accounts	9
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	293
25.6	Medical care	0
25.7	Operation and maintenance of equipment	6
25.8	Subsistence and support of persons	0
26	Supplies and materials	5
31	Equipment	11
32	Lands and structures	0
33	Investments and loans	0
41	Grants, subsidies and contributions	11,707
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Total obligations	12,306

Hollings Manufacturing
Extension Partnership

Exhibit 10

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

		2010 Actual		2011 Annualized CR Level		2012 Base		2012 Estimate		Increase/ (Decrease) Over 2012 Base	
Line Item		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Hollings manufacturing extension partnership	Pos./Approp	70	$124,700	73	$124,700	73	$124,967	76	$142,616	3	$17,649
	FTE/Obl.	78	124,913	78	125,669	78	124,967	80	142,616	2	17,649

BUDGET ACTIVITY AND SUBACTIVITY: HOLLINGS MANUFACTURING EXTENSION PARTNERSHIP (MEP)

The request funds MEP at $142.6 million, an increase of $17.9 million above the FY 2011 Continuing Resolution annualized level (a $17.6 million increase above the FY 2012 base).

BASE JUSTIFICATION FOR FY 2012:

The Hollings Manufacturing Extension Partnership (MEP) is a Federal-state-industry partnership that provides U.S. manufacturers with access to technologies, resources, and industry experts. The MEP program consists of 60 Manufacturing Extension Partnership Centers that work directly with their local manufacturing communities to strengthen the competitiveness of our Nation's domestic manufacturing base. Funding for the MEP Centers is a cost-sharing arrangement consisting of support from the Federal government, state and local government/entities, and fees charged to the manufacturing clients for services provided by the MEP Centers.

MEP's mission is to act as a strategic advisor to promote business growth and connect manufacturers to public and private resources essential for increased competitiveness and profitability. In doing so, MEP supports the mission of NIST of promoting U.S. innovation and industrial competitiveness, while also advancing the goals of the U.S. Department of Commerce to maximize U.S. competitiveness and enable economic growth for America industries, workers, and consumers.

A strong domestic manufacturing base is essential to supporting our Nation's middle class, our national security, and our growing renewable energy economy. Now more than ever, we need strong manufacturing businesses to create good jobs and help the U.S. economy regain its momentum. With Centers in every state and in Puerto Rico, MEP is positioned to connect manufacturers with the opportunities being made available through Federal and state governments to invest in environmentally sustainable manufacturing practices, develop innovative products, and diversify into new markets. MEP Centers know their communities and understand their local manufacturing industries. Across the country, they serve as trusted advisors to their manufacturing clients and help them navigate economic and business challenges, capitalize on opportunities and develop pathways leading to profitable growth.

- In FY 2012, 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 client company growth through new product development and market expansion. MEP will leverage the knowledge, information and deliverables achieved from the strategic programmatic competitions that began in FY 2010 as a critical mechanism for further implementation of the MEP Next Generation Strategy. Technology acceleration, supplier development and environmental sustainability strategies represent the next logical steps toward generating increased profit, creating jobs, and bolstering a long-term competitive position. MEP will work to create the tools, services and trained MEP Center field staff that are equipped to help firms innovate and create new sales, enter into new markets and adopt new technologies that build competitive advantage.

- The MEP program has a strong culture of partnership. At the state and local level, MEP Centers are often closely tied to state universities, community colleges, government economic development offices, as well as workforce development organizations. MEP Centers collaborate with third parties resources and partner organizations to ensure clients receive the most effective assistance. At the Federal level, MEP has ongoing partnerships with several agencies including the Department of Energy, the Environmental Protection Agency, Department of Defense, National Aeronautics and Space Administration, the Small Business Administration and the Department of Labor. Within the Department of Commerce, MEP works with the International Trade Administration, the Economic Development Agency and the U.S. Patent and Trademark Office.

Examples of Accomplishments:

Each year the program tracks the impact of the MEP system. The most recent data based on services provided in FY 2009 have MEP clients reporting significant impacts, including:

- New Sales $3.5 billion
- Retained Sales $4.9 billion
- Cost Savings $1.3 billion
- New Client Investment $1.9 billion
- Jobs Created 17,721
- Jobs Retained 54,354

Recently, when businesses struggled under challenging economic conditions, the MEP network used its partnerships and connections to work with companies to stabilize operations, diversify their customers, and create new business plans for moving towards a stronger future – saving jobs and helping firms identify new strategies for innovation and growth. The MEP program has the support of the Administration as evidenced in the President's Framework for Revitalizing American Manufacturing that outlines a path to increasing MEP program funding with a focus on expanding MEP Center efforts to bolster the competitiveness.

Priority Objectives for FY 2012:

The broad reach and extensive manufacturing knowledge of the MEP network puts the program in the position to strategically disseminate and implement Federal level initiatives and priorities throughout the country. While MEP has a connection and reach to the U.S. manufacturing community that is unmatched by any other government program, the current Federal investment only allows the program to serve a fraction of the domestic manufacturing base. With increased resources at the national scale, MEP could better leverage its network of Centers to focus on innovation and export opportunities for manufacturers, connect U.S. manufacturers to new technologies and commercialization opportunities, and to lay the foundation for a clean energy economy that would keep jobs in the U.S., strengthen national security, and revitalize American communities.

- Environmental Sustainability: MEP will continue to support its partnership with the Department of Energy and the Environmental Protection Agency in addressing the Secretary of Commerce's High Priority Performance Goals focused on implementing sustainable manufacturing business practices through the Economy, Energy, and Environment (E3) community activities and the Green Supplier Network program. E3 is a partnership between five Federal agencies that supports the Administration and Secretarial priority for interagency cooperation.

- Technology acceleration and deployment:

  - MEP program's strategic focus on technology acceleration and technology scouting through universities and Federal labs enables MEP Centers to work with manufacturing firms to innovate and increase business opportunities in green products and services.

  - Identifying and accelerating technology development and deployment for and with manufacturing firms is a key element of MEP's innovation strategy. It is anticipated that these efforts will expand to the smart grid and the work being done to enable interoperability among smart grid devices and systems. Given the role of NIST in developing and deploying smart grid technology, the MEP network is well positioned to advance this important Administration priority by working with manufacturing firms to understand, deploy, and continuously innovate smart grid technologies.

- Export: Through its ExporTech program and partnership with the International Trade Administration, MEP has been working with manufacturers to help them expand into overseas markets. This addresses a high priority of the Administration as demonstrated by the recently announced National Export Initiative.

- Partnerships: MEP will continue to identify partnership opportunities – at all levels of government – to leverage the Federal investment in support of the tools, services, and information needed by the manufacturing industry. While these existing partnership arrangements help align resources and program capabilities, they do not replace the need for an expanded investment in the program.

The MEP network has proved, through client reported impact metrics and long-standing Federal, state, and local partnerships, to be a valuable resource to America's manufacturers. As investments are being made in renewable energy, technology innovation, and export programs initiatives; investments in MEP programmatic resources will ensure that these initiatives reach the targeted manufacturing community and that these firms are connected with the opportunities at the Federal and state level. In a number of ways, investing in MEP increases the effectiveness of multiple Federal initiatives, programs, investments, and priorities.

PROGRAM CHANGES FOR FY 2012:

Hollings Manufacturing Extension Partnership Program (MEP) (Base Funding: 78 FTE and $124.967 million; Program Change: +2 FTE and +$17.649 million).

The broad reach and extensive manufacturing knowledge of the MEP network, puts the program in the position to strategically disseminate and implement Federal level initiatives and priorities throughout the country. This initiative would further support MEP's current partnership with the U.S. Department of Energy and U.S. Environmental Protection Agency addressing the Secretary of Commerce's High Priority Performance goals focused on implementing sustainable manufacturing business practices through its E3 (Economy, Energy, and Environment) community activities and the Green Supplier Network program. E3 is a partnership between five Federal agencies that supports the Administrative and Secretarial priority for interagency cooperation. Additionally, the MEP network's focus on technology acceleration and technology scouting through universities and Federal labs enables MEP Centers to work with manufacturing firms to innovate and increase business opportunities in green products and services. Identifying and accelerating technology development and deployment for and with manufacturing firms is a key element of MEP's innovation strategy. It is anticipated that these efforts will expand to the Smart Grid and the work being done to enable interoperability among Smart Grid devices and systems. Given the role of NIST in developing and deploying Smart grid technology, the MEP network will be well positioned to advance this important priority by working with manufacturing firms to understand, deploy, and continuously innovate Smart Grid technologies.

In addition, through its ExporTech program and a partnership with the International Trade Administration, MEP has been working with manufacturers to help them expand into overseas markets. This addresses a high priority of the Administration as demonstrated by the recently announced National Export Initiative.

Recently, when businesses struggled under challenging economic conditions, the MEP network used its partnerships and connections to work with companies to stabilize their operations, diversify their customers, and create new business plans for moving towards a stronger future – saving jobs and helping firms identify new strategies for innovation and growth. The initiative has the support of the Administration as evidenced in the President's *Framework for Revitalizing American Manufacturing* that outlines a path to increasing MEP program funding with a focus on expanding MEP center efforts to bolster the competitiveness of U.S. manufacturers.

A strong manufacturing base is critical to the financial and national security of the United States. Now more than ever, manufacturers are facing new and significant challenges. Technology and globalization have fundamentally changed many manufacturing companies and products. Manufacturing increasingly depends on access to customers and the infrastructure needed to support the constant reinvention of the manufacturers' products and processes. The challenge is clear: increasing global competition, coupled with the changing nature of innovation and exacerbated by the economic downturn of late, demands that the U.S. proactively support its domestic manufacturing base.

Sustaining and strengthening the U.S. manufacturing industry requires an efficient and progressive Federal role, partnering with state and local governments, to supply high-quality unbiased information, advice, and assistance that help firms respond to new challenges. For over 20 years MEP has successfully provided services that reduce manufacturers' bottom-line expenses, increase efficiencies, and build capacity. The Next Generation MEP strategy builds upon these core competencies and works to expand capabilities and service offerings in the areas of technology acceleration, supplier development, workforce and environmentally sustainable manufacturing.

Proposed Actions:

With an increase in its Federal resources, MEP will work to expand the elements of its Next Generation Strategy by building on the investments made in FY 2010 and FY 2011 that focused on national program development initiatives that support the priorities of the Administration, and by competitively allocating funds to innovatively address national needs. These investments would particularly target technology innovation and commercialization; environmentally sustainable business practices; renewable energy initiatives; market diversification; supplier development; and export opportunities for domestic manufacturers.

Specifically, this initiative supports Department of Commerce Strategic Objective to "provide services to improve the competitiveness of small and medium size firms in manufacturing and service industries" under the Market Development and Commercialization goal. This investment supports a robust MEP system that is positioned to:

- 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;
- Provide manufacturers with the information and tools needed to explore global market opportunities through strengthened partnerships and the ExporTech program;
- Accelerate the adoption of advanced and clean technologies into commercialized products,
- Improve manufacturers' competitive advantage through reduced environmental costs and impact, and facilitate the development of new environmentally focused products and processes through expanded service offerings and GSN and E3 partnerships;
- Help manufacturers build strong, stable businesses that provide good, middle class jobs; and
- Foster innovative partnerships with industry, academia, and local, state, and Federal governments that are focused on meeting the increased challenges facing U.S. manufacturers.

Statement of Need and Economic Benefits:

In FY 2012, MEP will continue to support the nationwide system of MEP Centers and build on the knowledge, information and deliverables achieved in the FY 2010 and FY 2011 programmatic competitions. Additional funding requested in this initiative is necessary to further the implementation of the MEP Next Generation Strategy with the development of new tools, services and partnerships in the areas of technology innovation and commercialization, environmentally sustainable business practices, renewable energy initiatives, market diversification, supplier development, and export opportunities for domestic manufacturers.

Investment in the MEP has resulted in a positive return. Each year the MEP measures the impact of the system and the most recent data provided in FY 2009 have MEP clients reporting significant impacts, including:

New Sales:	$3.5 billion
Retained Sales:	$4.9 billion
Cost Savings:	$1.34 billion
New Client Investment:	$1.9 billion
Jobs Created:	17,721
Jobs Retained:	54,354

With additional Federal resources, the MEP network could broaden the reach and increase the effectiveness of our MEP centers, creating stronger companies and more middle-class jobs. As investments are being made in renewable energy, technology innovation, and export programs, MEP programmatic resources will ensure that these initiatives reach the manufacturing community and that businesses are connected with market opportunities. The existing and expanding partnership increases the effectiveness and leverage of a number of Federal initiatives, programs, investments, and priorities.

Schedule and Milestones/ Deliverables:

Hold a grant competition in FY 2012 to expand MEP service capabilities in the areas of: technology innovation and commercialization, environmentally sustainable business practices, renewable energy initiatives, market diversification, supplier development, and export opportunities for domestic manufacturers.

Performance Goals and Measurement Data:

Note: The targets listed below are only rough estimates for the incremental funding received. MEP measures total client impact as a result of the services but this is not divided in terms of service offerings or financial investment in a particular service area. The additional investment in FY 2012 will primarily be used to expand activities and pilot efforts focused on the Next Generation MEP strategic areas.

As the pilot efforts are completed and the new and expanded projects become standard service offerings provided by more of the MEP system, the target impacts will be reflected in the MEP base performance targets. The performance targets for the MEP program (reflecting all levels of service offerings) is on an upward trajectory.

Performance Goal Performance Measure: Number of additional Clients served by Hollings MEP Centers receiving Federal funding.	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With increase	N/A	34,000	34,500	35,200	35,500	35,500
Without increase	30,000	32,000	33,500	34,500	35,000	35,500

Performance Goal Performance Measure: Increased sales attributed to Hollings MEP Centers receiving Federal funding.	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With increase	N/A	$3.3B	$3.3B	$3.35B	$3.25B	$3.2B
Without increase	$2.0B	$2.8B	$3.0B	$3.2B	$3.2B	$3.2B

Performance Goal Performance Measure: Capital investment attributed to Hollings MEP Centers receiving Federal funding.	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With increase	**N/A**	**$1.8B**	**$1.8B**	**$1.8B**	**$2.0B**	**$2.0B**
Without increase	**$1.1B**	**$1.5B**	**$1.6B**	**$1.7B**	**$1.9B**	**$2.0B**

Performance Goal Performance Measure: Cost savings attributed to Hollings MEP Centers receiving Federal funding.	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With increase	**N/A**	**$1.7B**	**$1.65B**	**$1.55B**	**$1.55B**	**$1.5B**
Without increase	**$1.1B**	**$1.3B**	**$1.4B**	**$1.4B**	**$1.5B**	**$1.5B**

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amount in thousands)

Activity: Hollings Manufacturing Extension Partnership
Subactivity: Hollings Manufacturing Extension Partnership

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Account manager	Gaithersburg, I	ZA IV	1	$105,211	$105,211
Acquisition advisor	Gaithersburg, I	ZA IV	1	105,211	105,211
Federal project officer	Gaithersburg, I	ZA IV	1	105,211	105,211
Total			3		315,633
Less Lapse		25%	(1)		(78,908)
Total full-time permanent (FTE			2		236,725
2011 Pay Adjustment (1.4%)					0
2012 Pay Adjustment (2.3%)					0
TOTAL					236,725

Personnel Data	Number
Full-Time Equivalent Employm	
Full-time permanent	2
Other than full-time permanent	0
Total	2
Authorized Positions:	
Full-time permanent	3
Other than full-time permanent	0
Total	3

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Hollings Manufacturing Extension Partnership
Subactivity: Hollings Manufacturing Extension Partnership

	Object Class	2012 Increase
11	Personnel compensation	
11.1	Full-time permanent	$237
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	237
12	Civilian personnel benefits	65
13	Benefits for former personnel	0
21	Travel and transportation of persons	60
22	Transportation of things	5
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	236
24	Printing and reproduction	6
25.1	Advisory and assistance services	0
25.2	Other services	4,446
25.3	Purchases of goods & services from Gov't accounts	990
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	0
25.6	Medical care	0
25.7	Operation and maintenance of equipment	50
25.8	Subsistence and support of persons	0
26	Supplies and materials	272
31	Equipment	282
32	Lands and structures	0
33	Investments and loans	0
41	Grants, subsidies and contributions	11,000
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Total obligations	17,649

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 2010 Actual	FY 2011 CR Level	FY 2012 Estimate
Department of Defense			
Air Force	0	$16	0
Navy	$12	0	0
Other	100	0	0
Subtotal, Department of Defense	112	16	0
Department of Energy	0	200	$200
Dept. of Homeland Security	51	0	0
Department of Veterans Affairs	1,603	0	0
Subtotal, Federal Agencies	1,766	216	200
Technical & Advisory Services	75	0	0
Subtotal, Other Reimbursables	75	0	0
Total, Reimbursable Program	1,841	216	200
SRM Transfers	0	0	0
Subtotal, WCF transfer	0	0	0
Equipment Investments	22	34	34
IE Amortization	(36)	(21)	(34)
Excess Amortizations over Equipment Investments	14	0	0
Total, WCF Investments	0	13	0
Total, Reimbursable Program and WCF Investments	1,841	229	200

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Baldrige Performance Excellence Program

Exhibit 10

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

Activity: Baldrige performance excellence program
Subactivity: Baldrige performance excellence program

		2010 Actual		2011 Annualized CR Level		2012 Base		2012 Estimate		Increase/ (Decrease) Over 2012 Base	
Line Item		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Baldrige performance	Pos./Approp	0	0	51	$9,627	51	$9,844	37	$7,727	(14)	($2,117)
excellence program	FTE/Obl.	0	0	52	9,627	52	9,844	38	7,727	(14)	(2,117)

BUDGET ACTIVITY: BALDRIGE PERFORMANCE EXCELLENCE PROGRAM

For FY 2012, NIST requests a decrease of $1.9 million from the FY 2011 Continuing Resolution annualized level ($2.1 million and 14 FTE below the FY 2012 base program) for a total of $7.7 million and 38 FTE for the Baldrige Performance Excellence Program.

BASE JUSTIFICATION FOR FY 2012:

Baldrige Performance Excellence Program Overview

The Baldrige Performance Excellence Program budget is organized into one subactivity under the Industrial Technology Services account. The program was previously funded out of the Scientific and Technical Research and Services account.

NIST's Baldrige Performance Excellence Program (BPEP) provides global leadership in the learning and sharing of successful strategies and performance practices, principles, and methodologies to strengthen U.S. organizations. The program promotes organizational excellence through education, outreach, and an annual Presidential awards program. The Baldrige Award is given to organizations in six categories: manufacturing, service, small business, health care, education, and nonprofit. BPEP works closely with these organizations to recognize and disseminate proven best practices for management and operation, leading to organizations that are more strategic, innovative, competitive, and effective. BPEP also takes advantage of more than 20 years' worth of learning's from Baldrige Award recipients to identify strategies and practices that are most likely to strengthen the performance and competitiveness of U.S. industry and other organizations.

The program has, as its foundation, the Malcolm Baldrige National Quality Award, created by P.L. 100-107 in August 1987. In 1999, the award was expanded to include categories for 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).

NIST responsibilities under P.L. 100-107, P.L. 105-309, and P.L. 108-320 are carried out by the Baldrige Performance Excellence Program. The program continues to build key linkages with other organizations and provide educational outreach services. U.S. businesses and nonprofit organizations throughout the country are now turning to NIST for leadership in performance improvement. The BPEP 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 objectives of the Baldrige Performance Excellence Program subactivity are to:

- Develop the Criteria for Performance Excellence. This body of knowledge is considered the de facto standard for assessment and improvement of organizational management systems. The impact of the Criteria is substantial and includes:
  - over 2 million copies downloaded annually;
  - forming the basis for selection of the Malcolm Baldrige National Quality Award (MBNQA) Recipients;
  - providing the core of nearly 40 state quality award programs around the country; and

- o being utilized by internal business excellence programs at major corporations such as Cargill, Eaton, and Cisco, as well as government agencies such as the Veterans Administration, Department of the Army and the Coast Guard.

- Implement the MBNQA competition; including examiner selection, examiner training, application review, and overseeing the activities of over 600 volunteers annually.

- Conduct the annual Presidential Award Ceremony, which features the President or Vice-President, the Secretary of Commerce, the Chair of the Baldrige Foundation, and the highest ranking official and other representatives from the Award Recipient organizations.

- Provide web-based self assessment tools for all organizations to accelerate their improvement and innovation potential.

- Conduct the Quest for Excellence Conference and Baldrige Regional Conferences where MBNQA recipients share their performance excellence strategies.

- Collaborate and share information 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.

- Use online learning, collaboration, and other technologies to educate and provide outreach to Baldrige stakeholders and the broader community.

- Evaluate the BPEP's performance through a combination of methods, including independent expert review, analysis of input from all key stakeholder groups, and review of output and outcome measures focused on the program's operational strategy, participation in the MBNQA competition, increasing utilization and recognition of the Criteria for Performance Excellence, promoting awareness of performance excellence throughout the U.S., and improving the efficiency and effectiveness of all key program processes.

To align with the reorganization approved by the Congress on July 14, 2010, NIST also requests the following transfer for a net change of $0:

From (Appropriation, Activity, Subactivity, Line Item, Program, or Office)	Activity, Subactivity, Line Item, Program, or Office	To (Appropriation, Activity, Subactivity, Line Item, Program, or Office)	Activity, Subactivity, Line Item, Program, or Office	Amount
STRS Appropriation	Baldrige Performance Excellence Program	ITS Appropriation	Baldrige Performance Excellence Program	$9,627,000 52 FTE

In conjunction with the NIST reorganization of the Laboratory Programs approved by the Commerce, Justice, Science, and Related Agencies Committee on Appropriations on July 14, 2010, NIST requests a technical adjustment of $9,627,000 from the STRS Appropriation to the ITS Appropriation.

PROGRAM CHANGES FOR FY 2012:

Baldrige Performance Excellence Program (Base Funding: 52 FTE and $9.844 million; Program Change: -14 FTE and - $2.117 million).

NIST requests a decrease of $2.117 million and 14 FTE leaving a total of $7.727 million and 38 FTE. NIST will evaluate alternative sources of funding, alternative cost models, and reforms to the program that would generate efficiencies and reduce program overhead consistent with the Administration's goal of transitioning the program out of Federal funding.

Proposed Actions:

At the proposed funding level, the program will evaluate alternative sources of funding, alternative cost models, and reforms to the program that would generate efficiencies and reduce program overhead. The program will continue to meet the objectives outlined in the base justification, but with limited resources allocated to providing self-assessment tools, developing online learning, and conducting performance evaluation.

Statement of Need and Economic Benefits:

The BPEP 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. Thousands of U.S. organizations in every industry use the Baldrige criteria to improve their performance and competitive standing. The BPEP has invigorated improvement efforts in sectors such as healthcare and education that are especially important to the Nation's economic performance and the quality of life enjoyed by its citizens. For example, using the Baldrige approach, health care providers are demonstrating improved quality and reduced costs, with many achieving some of these results through enhanced use of health information technologies. Four recent Baldrige health care recipients are among the 100 most wired hospitals/systems in the United States.[1] The value of the BPEP is also recognized worldwide: nearly 40 states and 100 countries participate in programs modeled after the BPEP.

Deliverables:

The request includes funding for criteria development, best practices dissemination, and the annual awards process. Additionally, the BPEP will evaluate alternative sources of funding, consistent with the Administration's goal of transitioning the program out of Federal funding.

1 http://www.hhnmostwired.com/hhnmostwired/html/previouswinners.html

PROGRAM CHANGE PERSONNEL DETAIL

Activity: Baldrige Performance Excellence Program
Subactivity: Baldrige Performance Excellence Program

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Administrative/Technical Support	Gaithersburg, MD	ZA IV	(8)	($105,211)	($841,688)
Administrative/Technical Support	Gaithersburg, MD	ZA III	(6)	(74,872)	(449,232)
Total			(14)		(1,290,920)
Less Lapse		0%	0		0
Total full-time permanent (FTE)			(14)		(1,290,920)
2012 Pay Adjustment (2.3%)					0
TOTAL					(1,290,920)

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	(14)
Other than full-time permanent	0
Total	(14)
Authorized Positions:	
Full-time permanent	(14)
Other than full-time permanent	0
Total	(14)

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Baldrige Performance Excellence Program
Subactivity: Baldrige Performance Excellence Program

	Object Class	2012 Decrease
11	Personnel compensation	
11.1	Full-time permanent	($1,291)
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	(15)
11.8	Special personnel services payments	0
11.9	Total personnel compensation	(1,306)
12	Civilian personnel benefits	(353)
13	Benefits for former personnel	0
21	Travel and transportation of persons	(14)
22	Transportation of things	(21)
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	(150)
24	Printing and reproduction	(6)
25.1	Advisory and assistance services	0
25.2	Other services	(58)
25.3	Purchases of goods & services from Gov't accounts	(62)
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	0
25.6	Medical care	0
25.7	Operation and maintenance of equipment	0
25.8	Subsistence and support of persons	0
26	Supplies and materials	(68)
31	Equipment	(79)
32	Lands and structures	0
33	Investments and loans	0
41	Grants, subsidies and contributions	0
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Total obligations	(2,117)

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

	FY 2010 Actual	FY 2011 CR Level	FY 2012 Estimate
Technical & Advisory Services	$915	$426	$510
Subtotal, Other Reimbursables	915	426	510
Total, Reimbursable Program	915	426	510
SRM Transfers	0	0	0
Subtotal, WCF transfer	0	0	0
Equipment Investments	0	10	10
IE Amortization	0	(6)	(10)
Excess Amortizations over Equipment Investments	0	0	0
Total, WCF Investments	0	4	0
Total, Reimbursable Program and WCF Investments	915	430	510

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Exhibit 16

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

	Object Class	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
11	Personnel compensation					
11.1	Full-time permanent	$16,704	$21,688	$21,739	$20,843	($896)
11.3	Other than full-time permanent	1,446	1,492	1,499	1,499	0
11.5	Other personnel compensation	613	762	762	747	(15)
11.9	Total personnel compensation	18,763	23,942	24,000	23,089	(911)
12.1	Civilian personnel benefits	4,940	6,377	6,640	6,394	(246)
13	Benefits for former personnel	2	2	2	2	0
21	Travel and transportation of persons	920	1,124	1,163	1,212	49
22	Transportation of things	13	76	77	61	(16)
23.1	Rental payments to GSA	2	4	4	4	0
23.2	Rental payments to others	290	194	200	200	0
23.3	Communications, utilities, and miscellaneous charges	2,377	2,726	2,395	2,529	134
24	Printing and reproduction	14	37	38	38	0
25.1	Advisory and assistance services	568	80	233	233	0
25.2	Other services	7,847	14,779	13,950	18,509	4,559
25.3	Purchases of goods and services from government accounts	1,336	1,509	1,497	2,434	937
25.5	Research and development contracts	1,500	2,080	1,329	1,745	416
25.7	Operation and maintenance of equipment	716	876	893	949	56
26	Supplies and materials	491	725	738	947	209
31	Equipment	837	1,167	1,190	1,404	214
32	Land and structures	0	0	0	0	0
41	Grants, subsidies, and contributions	161,531	184,077	154,049	181,672	27,623
42	Insurance claims and indemnities	2	0	0	0	0
99	Total Obligations	202,149	239,775	208,398	241,422	33,024

	Object Class	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
99	Total Obligations	202,149	239,775	208,398	241,422	33,024
	Less Prior Year Recoveries	(1,560)	(3,800)	(3,800)	(3,800)	0
	Less Prior Year Refunds	(194)	0	0	0	0
	Less Prior Year Unobligated Balance	(37,543)	(31,748)	0	0	0
	Plus Unobligated Balance End of Year	31,748	0	0	0	0
	Total Budget Authority/Appropriation	194,600	204,227	204,598	237,622	33,024

Personnel Data

	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
Full-time equivalent employment:					
Full-time permanent	142	193	193	182	(11)
Other than full-time permanent	16	17	17	17	0
Total	158	210	210	199	(11)
Authorized Positions:					
Full-time permanent	137	190	190	181	(9)
Other than full-time permanent	11	12	12	12	0
Total	148	202	202	193	(9)

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. $142,616,000, is provided for the Hollings Manufacturing Extension Partnership to remain available until expended.

   $74,973,000, is provided for the Technology Innovation Program to remain available until expended.

   $7,727,000, is provided for the Baldrige Performance Excellence Program to remain available until expended.

   $12,306,000, is provided for the Advanced Manufacturing Technology Consortia Program to remain available until expended.

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".

Public Law 111-358, America Competes Reauthorization Act, 2010, 124 Stat 3982, passed January 4, 2011 reauthorized the Industrial Technology Services appropriation through 2013 to include the Manufacturing Extension Partnership Program (MEP) and the Malcolm Baldrige National Quality Award program. In addition, authorization is provided for an Innovative Services Initiative to assist small and medium-sized manufacturers within the MEP program.

Exhibit 34

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

	FY 2010 Actual	FY 2011 Estimate	FY 2012 Estimate
Management and professional support services	$118	$30	$33
Studies, analyses, and evaluations	450	50	200
Engineering and technical services	0	0	0
Total	568	80	233

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 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
2011 Annualized CR Level	114	119	$147,000	$180,004	$147,000
less: Unobligated balance from prior year	0	0	0	(33,004)	0
Restoration of FY 2011 ATBs			574	574	574
less: Non-recurring construction and major renovations cost		0	(22,000)	(22,000)	(22,000)
2012 Adjustments to base:					
plus: Uncontrollable cost changes	0	0	610	610	610
2012 Base Request	114	119	126,184	126,184	126,184
2012 Program changes	0	0	(41,619)	(41,619)	(41,619)
2012 Estimate	114	119	84,565	84,565	84,565

Comparison by activity/subactivity:		2010 Actual Per-sonnel	2010 Actual Amount	2011 Annualized CR Level Per-sonnel	2011 Annualized CR Level Amount	2012 Base Per-sonnel	2012 Base Amount	2012 Estimate Per-sonnel	2012 Estimate Amount	Increase/ (Decrease) Over 2012 Base Per-sonnel	Increase/ (Decrease) Over 2012 Base Amount
Construction and major renovations											
Construction and major	Pos/Approp	89	$147,000	114	$147,000	114	$126,184	114	$84,565	0	($41,619)
renovations	FTE/Obl.	119	459,076 *	119	180,004	119	126,184	119	84,565	0	(41,619)
Adjustments for:											
Prior year recoveries			(2,571) *		0		0		0		0
Prior year refunds			(1)		0		0		0		0
Unobligated balance, start of year			(342,546) *		(33,004)		0		0		0
Unobligated balance, end of year			33,004		0		0		0		0
Unobligated balance, expired account			38 *		0		0		0		0
Financing from transfers:											
Transfers to other accounts (+)			0		0		0		0		0
Appropriation			147,000		147,000		126,184		84,565		(41,619)

* Reflects American Recovery and Reinvestment Act (ARRA) obligations of $290,147K. (Note: FY 2009 appropriation of $360M; FY 2009 obligations $70,019K, FY 2010 recoveries of prior-year obligations $204K, FY 2010 obligations of $290,147K, unobligated balance of $38K available for upward adjustments on prior-year activities.)

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

	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
Total Obligations	$459,956	$180,957	$126,184	$84,565	($41,619)
Financing:					
Offsetting collections from:					
Federal funds	0	0	0	0	0
Non-Federal sources	(953)	0	0	0	0
Total offsetting collections	(953)	0	0	0	0
Adjustments for:					
Prior year recoveries	(2,571)	0	0	0	0
Prior year refunds	(1)	0	0	0	0
Unobligated balance, start of year (Direct)	(342,546) *	(33,004)	0	0	0
Unobligated balance, start of year (Reimbursable)	(880)	(953)	0	0	0
Unobligated balance, end of year (Direct)	33,004	0	0	0	0
Unobligated balance, end of year (Reimbursable)	953	0	0	0	0
Unobligated balance, expired (ARRA)	38	0	0	0	0
Budget Authority	147,000	147,000	126,184	84,565	(41,619)
Financing:					
Transfer to other accounts	0	0	0	0	0
Transfer from other accounts	0	0	0	0	0
Appropriation	147,000	147,000	126,184	84,565	(41,619)

* Reflects American Recovery and Reinvestment Act (ARRA) obligations of $290,147K. (Note: FY 2009 appropriation of $360M; FY 2009 obligations $70,019K, FY 2010 recoveries of prior-year obligations $204K, FY 2010 obligations of $290,147K, unobligated balance of $38K available for upward adjustments on prior-year activities.)

Adjustments
to Base

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:			
Restoration of FY 2011 adjustments to base		0	($21,426)

In FY 2011, NIST's CRF adjustments to base reduction of $21,426,000. was not applied. This adjustment restores the decrease in FY 2012

		FTE	Amount
Other Changes:			
Personnel benefits		0	69
Civil Service Retirement System (CSRS)	($11)		
Federal Employees' Retirement System (FERS)	18		
Thrift Savings Plan (TSP)	0		
Federal Insurance Contribution Act (FICA) - OASDI	(8)		
Health Insurance	48		
Employees' Compensation Fund	22		

Civil Service Retirement System (-$11,000) – 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 11.8 percent in FY 2011 to 10.2 percent in FY 2012. The contribution rate will remain at 7.0 percent in FY 2012.

Payroll subject to retirement systems ($9,617,726)	
Cost of CSRS contributions in FY 2012 ($9,617,726 x .102 x .07)	$68,671
Cost of CSRS contributions in FY 2011 ($9,617,726 x .118 x .07)	79,442
Total adjustment to base	(10,771)

Federal Employees' Retirement System ($18,000) – 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 88.2 percent in FY 2011 to 89.8 percent FY 2012. The contribution rate increased from 11.2 percent in FY 2010 to 11.7 percent in FY 2011.

Payroll subject to retirement systems ($9,617,726)	
Basic benefit cost in FY 2012 ($9,617,726 x .898 x .117)	$1,010,496
Basic benefit cost in FY 2011 ($9,617,726 x .882 x .117)	992,492
Total adjustment to base	18,004

Thrift Savings Plan ($0) – The cost of agency contributions to the Thrift Savings Plan will also rise as FERS participation increases. The contribution rate has decreased from 4.64 in FY 2011 to 4.56 in FY 2012.

Thrift plan cost in FY 2012 ($9,617,726 x .898 x .0456)	$393,834
Thrift plan cost in FY 2011 ($9,617,726 x .882 x .0464)	393,604
Total adjustment to base	230

Federal Insurance Contributions Act (FICA) - OASDI (-$8,000) – As the percentage of payroll covered by FERS increases, the cost of OASDI contributions will increase. However, in FY 2012, the maximum salary subject to OASDI tax will decrease from $114,975 in FY 2011 to $110,175 in FY 2012. The OASDI tax rate will remain 6.2 percent in FY 2012.

FERS payroll subject to FICA tax in 2012 ($9,617,726 x .898 x .873 x .062)	$467,471
FERS payroll subject to FICA tax in 2010 ($9,617,726 x .882 x .903 x .062)	474,920
Increase (FY 2011-FY 2012)	(7,449)
OTP payroll subject to FICA tax in FY 2012 ($1,103,274 x .898 x .873 x .062)	53,625
OTP payroll subject to FICA tax in FY 2010 ($1,103,274 x .882 x .903 x .062)	54,479
Increase (FY 2010-FY 2011)	(854)
Total adjustment to base	(8,303)

Health insurance ($48,000) – Effective January 2010, NIST's contribution to Federal employees' health insurance premiums increased by 6.9 percent. Applied against the FY 2011 estimate of $693,000, the additional amount required is $47,817,000.

Employees' Compensation Fund ($22,000) – The total NIST Employees' Compensation Fund bill for the year ending June 30, 2010 is a net $56,000 lower than for the year ending June 30, 2009. CRF's share increased by $22,000.

Travel and transportation of persons	0	2

The General Services Administration (GSA) increased the standard per diem rate to 6.4% for destinations within the Continental United States (CONUS). This increase was applied to the FY 2011 estimate of $25,000 for an increase of $1,600.

General pricing level adjustment	0	539

This request applies the OMB economic assumptions of 1.2 percent for FY 2012 where the prices that the government pays are established through the market system. Factors are applied to sub-object classes that result in the following adjustments to base: communications, utilities, and miscellaneous charges $672; other services $495,624; supplies and materials $40,308; and equipment $1,668.

Subtotal, Other changes	0	610
Total adjustments to base	0	(20,816)

Program and
Performance

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

		2010 Actual		2011 Annualized CR Level		2012 Base		2012 Estimate		(Increase/ Decrease) Over 2012 Base	
Line Item		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Construction and major renovations	Pos/Approp	6	$22,000	0	$22,000	0	0	0	$25,381	0	$25,381
	FTE/Obl.	11	305,370 *	0	41,996	0	0	0	25,381	0	25,381
Safety, Capacity, Maintenance and Major Repairs	Pos/Approp	80	58,000	114	58,000	114	$59,184	114	59,184	0	0
	FTE/Obl.	104	55,008	119	67,508	119	59,184	119	59,184	0	0
External Projects	Pos/Approp	3	67,000	0	67,000	0	67,000	0	0	0	(67,000)
	FTE/Obl.	4	98,698	0	70,500	0	67,000	0	0	0	(67,000)
Total	Pos/Approp	89	147,000	114	147,000	114	126,184	114	84,565	0	(41,619)
	FTE/Obl.	119	459,076 *	119	180,004	119	126,184	119	84,565	0	(41,619)

* Reflects American Recovery and Reinvestment Act (ARRA) obligations of $290,147K. (Note: FY 2009 appropriation of $360M; FY 2009 obligations $70,019K, FY 2010 recoveries of prior-year obligations $204K, FY 2010 obligations of $290,147K, unobligated balance of $38K available for upward adjustments on prior-year activities.)

APPROPRIATION ACCOUNT: CONSTRUCTION OF RESEARCH FACILITIES

BUDGET ACTIVITY: CONSTRUCTION OF RESEARCH FACILITIES

For FY 2012, NIST requests an increase of $25.4 million over the FY 2012 base program. The Construction of Research Facilities appropriation request totals $84.6 million and 119 FTE.

BASE JUSTIFICATION FOR FY 2012:

Construction of Research Facilities Overview

The Safety, Capacity, Maintenance, and Major Repair (SCMMR) program within the NIST CRF appropriation funds 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 current and future measurement and research needs for the Nation.

State-of-the-art facilities are essential to the capabilities of NIST's laboratories. NIST measurement capabilities must be maintained at the highest levels of precision and accuracy to meet the increasingly stringent needs of their users. Also, facilities must be compliant with various health and safety regulations. Other major considerations for facilities are to increase the capacity of facilities, to improve access for people with disabilities, to safeguard the utility infrastructure of existing buildings, and to improve the performance and sustainability of the buildings in response to Executive mandates.

Aging and deteriorating buildings and infrastructure threaten NIST's ability to meet its mission. Failure to properly maintain, repair, improve, and construct facilities used by NIST will cause reductions in measurement capabilities, impairing NIST's ability to meet its measurement and standards missions, and thus reducing U.S. innovation and industrial competitiveness. Other negative impacts include possible damage to staff and visitor safety and health, and reductions in staff productivity.

NIST prioritizes its efforts to improve and upgrade its facilities so as to address its highest priority SCMMR projects. If major facilities-related emergency situations arise, previously planned facilities work is reprioritized as appropriate.

Primary activities being conducted with the SCMMR program's base resources include the following:

- continue the repair and 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 facilities 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 because they are over 40 to 50 years old,
- continue architectural and structural repairs as needed,
- accelerate energy conservation and other building performance improvements to meet mandated sustainability targets,
- 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.

Significant Adjustments-to-Base (ATBs):

NIST requests an increase in FY 2012 of $610 thousand to fund adjustments to the SCMMR program within the Construction of Research Facilities budget. The increase provides inflationary increases for non-labor activities, including service contracts, and utilities.

PROGRAM CHANGES FOR FY 2012:

1. Building 1 Renovation (Base Funding: $0 million; Program Change: 0 FTE and +$25.381 million):

NIST requests an increase of $25.381 million to complete the next phase of the Boulder Building 1 interior wing renovations. This initiative would enable NIST to continue the 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 completed the renovation design and construction documents for the renovation of Building 1 Wings 3, 5, 6 and the limited portion of the center spine, and perform the limited renovation of Building 3 for the relocation of the Instrument Shops. At the FY 2011 CR annualized level, NIST will complete exterior renovations in Building 1, Wings 3, 5, 6, and the center spine, which could include modified roof structures, service corridors, and mechanical equipment rooms. The FY 2011 CR annualized level of $22.0 million enables NIST to complete exterior renovations described above as well as a significant portion of the interior renovations at Building 1, Wing 3. The FY 2012 initiative for $25.381 million will complete the interior renovations of Wings 3, 5, and a portion of Wing 6. The remaining interior wing renovations will be completed with future funding requests.

Proposed Actions:

The 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[1] in 2006 to review the capabilities of the 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 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.

[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.*

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 (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 2012. 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, 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 the 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.

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 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.

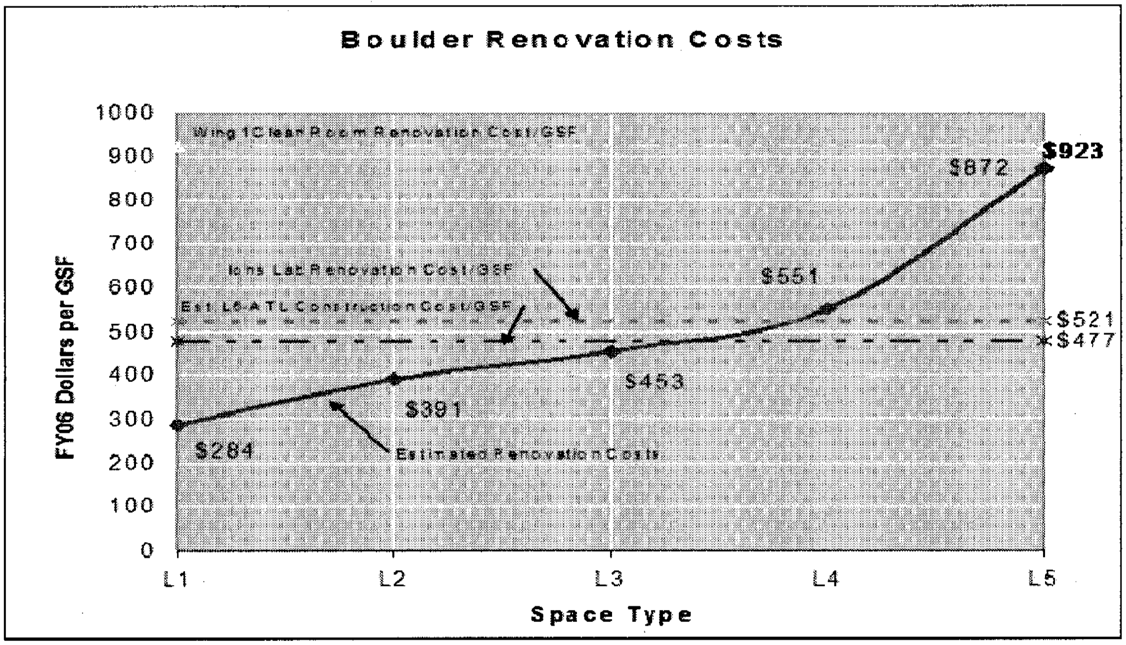

Table 2

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 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.

Statement of Need and Economic Benefits:

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[2], 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 may 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 condition of the lighting system 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. Much research and measurement planned for the future will not be possible without significantly upgraded facilities.

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 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.

Base Resource Assessment:

There are no base resources associated with the Construction and Major Renovations program. Funding is requested each year for useable segments of the renovation or construction project.

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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.*

Schedule and Milestones:

- FY 2011 – Award the construction of Building 1 exterior renovations for Wings 3, 5, 6, and center spine, and a significant portion of the interior renovations of Wing 3.
- FY 2012 – Complete the interior renovation of Wing 3. Award the construction of the interior renovations of Wing 5 and a significant portion of interior renovations of Wing 6.
- FY 2013 – Award the construction to renovate the remaining interior portion of Wing 6.

Deliverables:

- FY 2011 – Award the design of Building 1 renovation. Complete designs for exterior renovations and begin design for interior renovations. Award the construction to renovate Building 1 exterior Wings 3, 5, 6 and the limited portion of the center spine, and a significant portion of the interior renovations of Wing 3. This work will be finished in subsequent fiscal years due to the required period of performance.
- FY 2012 – Complete the interior renovation of Wing 3. Award the construction of the interior renovations of Wing 5 and a significant portion of interior renovations of Wing 6. This work will be finished in subsequent fiscal years due to the required period of performance.

Performance Goals and Measurement Data

Performance Goal: Percent of Renovations Complete	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target	FY 2016 Target
With Increase	100% of exterior renovations of Wings 3, 5, 6 and a limited portion of the center spine; and approximately 95% of the Wing 3 interior renovation.	100% of the Wing 3 interior renovation; 100% interior renovation of Wing 5; and approximately 60% of the interior renovation of Wing 6	**N/A**	**N/A**	**N/A**	**N/A**
Without Increase*	100% of exterior renovations of Wings 3, 5, 6 and a limited portion of the center spine; and approximately 95% of the Wing 3 interior renovation.	0%*	**N/A**	**N/A**	**N/A**	**N/A**
Description: With FY 2011 CR annualized funding, NIST can complete portions of the renovations to Building 1. Given that each year's appropriation for NIST major construction projects is non-base, funding is necessary each year to continue the project.						

**The design documents for internal renovations will not be used and they will need to be updated prior to a solicitation and award in the out years. The Building 1 Renovation program will be delayed and there will be the potential for cost increases due to inflation and changing renovation needs.*

MULTI-YEAR BUDGET INFORMATION
(Dollar amounts in thousands)

Major Cost Categories	FY 2010	FY 2011 CR (Annualized)	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Building 1 Renovation, Design and Renovation of Building 3	12,000						
Exterior Renovations		14,200					
Wing 3 Interior Renovation		7,800	300				
Wing 5 Interior Renovation			20,100				
Wing 6 Interior Renovation			4,981	3,419			
Total*:	12,000	22,000	25,381	3,419			
Delta from PB							
FTE's (Initiative)			0				

** Outyears subject to change with full year appropriation. The remaining interior wing renovations will be completed with future funding requests.*

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amounts in thousands)

Activity: Construction and Major Renovations
Subactivity: Construction and Major Renovations
Program Change: Building 1 Renovation

Existing staff will be used to manage the Building 1 Renovation project and therefore no new FTE are required for this initiative.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Construction and Major Renovations
Subactivity: Construction and Major Renovations
Program Change: Building 1 Renovation

	Object Class	2012 Increase
11	Personnel compensation	
11.1	Full-time permanent	0
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	0
12	Civilian personnel benefits	0
13	Benefits for former personnel	0
21	Travel and transportation of persons	0
22	Transportation of things	0
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	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 & services from Gov't accounts	0
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	0
25.6	Medical care	0
25.7	Operation and maintenance of equipment	0
25.8	Subsistence and support of persons	0
26	Supplies and materials	0
31	Equipment	0
32	Lands and structures	$25,381
33	Investments and loans	0
41	Grants, subsidies and contributions	0
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Total obligations	25,381

2. Non-recurring Congressionally Directed Projects: (Base Funding: 0 FTE and $ 0.0 million; Program Change: 0 FTE and -$47.0 million; Program Change 0 FTE and -$20.0 million).

NIST requests a decrease of $47.0 million and 0 FTE for one-time activities and a decrease of $20.0 million and 0 FTE for Competitive Construction Grants in the Construction of Research Facilities account for a total of 0 FTE and $67.0 million. In the Consolidated Appropriations Act, 2010, Congress provided $47.0 million in additional funds for construction activities related to the expansion of the Research, Technology and Economic Development Park at Mississippi State University, the Advanced Nanomaterials Research Facility and North Dakota State University, the Interdisciplinary Science and Engineering Teaching and Research Corridor at the University of Alabama, and the Mississippi Biotechnology Research Park at the University of Mississippi Medical Center. The funds awarded in FY 2010 are sufficient to complete these projects. Congress also directed that within the appropriation, $20.0 million and 0 FTE was provided for Competitive Construction Grants in the Construction of Research Facilities account. These additional amounts are not required in FY 2012, as all awarded projects are fully funded.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Construction and Major Renovations
Subactivity: External Projects
Program Change: Non-recurring congressionally directed projects

	Object Class	2012 Decrease
11	Personnel compensation	
11.1	Full-time permanent	0
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	0
12	Civilian personnel benefits	0
13	Benefits for former personnel	0
21	Travel and transportation of persons	0
22	Transportation of things	0
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	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 & services from Gov't accounts	0
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	0
25.6	Medical care	0
25.7	Operation and maintenance of equipment	0
25.8	Subsistence and support of persons	0
26	Supplies and materials	0
31	Equipment	0
32	Lands and structures	0
33	Investments and loans	0
41	Grants, subsidies and contributions	($67,000)
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Total obligations	(67,000)

Exhibit 16

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
SUMMARY OF REQUIREMENTS BY OBJECT CLASS

	Object Class	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
11	Personnel compensation					
11.1	Full-time permanent	$9,127	$9,127	$9,153	$9,153	0
11.3	Other than full-time permanent	484	484	484	484	0
11.5	Other personnel compensation	1,084	1,084	1,084	1,084	0
11.9	Total personnel compensation	10,695	10,695	10,721	10,721	0
12.1	Civilian personnel benefits	2,839	2,825	2,995	2,995	0
13	Benefits for former personnel	1	1	1	1	0
21	Travel and transportation of persons	41	41	44	44	0
22	Transportation of things	26	26	26	26	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	57	57	59	59	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	84,572	58,583	40,738	40,738	0
25.3	Purchases of goods and services from government accounts	63	63	65	65	0
25.5	Research and development contracts	0	0	0	0	0
25.7	Operation and maintenance of equipment	993	993	1,014	1,014	0
26	Supplies and materials	3,346	3,346	3,380	3,380	0
31	Equipment	138	138	141	141	0
32	Land and structures	135,353	35,718	0	25,381	$25,381
41	Grants, subsidies, and contributions	220,952	67,518	67,000	0	(67,000)
42	Insurance claims and indemnities	0	0	0	0	0
99	Total Obligations	459,076	180,004	126,184	84,565	(41,619)

	Object Class	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
99	Total Obligations	459,076	180,004	126,184	84,565	(41,619)
	Less Prior Year Recoveries	(2,571)	0	0	0	0
	Less Prior Year Refunds	(1)	0	0	0	0
	Less Prior Year Unobligated Balance	(342,546)	(33,004)	0	0	0
	Plus Unobligated Balance End of Year	33,004	0	0	0	0
	Plus Unobligated Balance - Expired	38	0	0	0	0
	Total Budget Authority	147,000	147,000	126,184	84,565	(41,619)
	Plus Transfers from Other Accounts	0	0	0	0	0
	Appropriation	147,000	147,000	126,184	84,565	(41,619)

Personnel Data

	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
Full-time equivalent employment:					
Full-time permanent	119	119	119	119	0
Other than full-time permanent	0	0	0	0	0
Total	119	119	119	119	0
Authorized Positions:					
Full-time permanent	89	114	114	114	0
Other than full-time permanent	0	0	0	0	0
Total	89	114	114	114	0

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. $84,700,000, to remain available until expended.

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". Public Law 111-358, America Competes Reauthorization Act, 2010, 124 Stat 3982, passed January 4, 2011 reauthorized the Construction of Research Facilities appropriation through 2013.

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.

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Working
Capital Fund

Exhibit 5

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
2011 Annualized CR Level	667	741	0	0
Reduction in transfers from prior STRS program changes	0	0	0	0
2012 Base	667	741	0	0
Baldrige Performance Excellence Program reduction	14	14	0	0
Transfer from STRS program changes for equipment investments			8,834	8,834
2012 Estimate	681	755	8,834	8,834

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

	2010 Actual	2011 Annualized CR Level	2011 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
Total Obligations	$158,580	$186,403	$176,261	$185,095	$8,834
Offsetting collections from:					
Federal funds	(110,446)	(135,581)	(127,349)	(127,349)	0
Non-Federal sources	(42,259)	(50,822)	(48,912)	(48,912)	0
Total offsetting collections	(152,705)	(186,403)	(176,261)	(176,261)	0
Unobligated balance, start of year	(120,234)	(145,229)	(145,229)	(145,229)	0
Unobligated balance, end of year	145,229	145,229	145,229	145,229	0
Change in uncollected customer payments - Federal	(29,427)	0	0	0	0
Budget Authority	1,443	0	0	8,834	8,834
Financing:					
Transfer from other accounts	(1,443)	0	0	(8,834)	(8,834)
Appropriation	0	0	0	0	0

Program and
Performance

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund

This Working Capital Fund (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. 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.

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

	Object Class	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 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	$400	$400
31	Equipment	$1,443	0	0	8,434	8,434
32	Land and structures	0	0	0	0	0
41	Grants, subsidies, and contributions	0	0	0	0	0
99	Total Obligations	1,443	0	0	8,834	8,834

Personnel Data	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
Full-time equivalent employment:					
Full-time permanent	603	686	686	700	14
Other than full-time permanent	55	55	55	55	0
Total	658	741	741	755	14
Authorized Positions:					
Full-time permanent	665	637	637	651	14
Other than full-time permanent	30	30	30	30	0
Total	695	667	667	681	14

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

	FY 2010 Actual	FY 2011 Estimate	FY 2012 Estimate
Management and professional support services	$1,661	$1,260	$1,266
Studies, analyses, and evaluations	255	180	185
Engineering and technical services	109	0	0
Total	2,025	1,440	1,451

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.

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Public Safety
Innovation Fund

Department of Commerce
National Institute of Standards and Technology
Public Safety Innovation Fund
SUMMARY OF RESOURCE REQUIREMENTS - DIRECT MANDATORY
(Dollar amounts in thousands)

	Positions	FTE	Budget Authority	Direct Obligations	Appro-priation
2011 Annualized CR Level	0	0	0	0	0
less: Unobligated balance from prior year	0		0	0	0
Restoration of FY 2011 ATBs			0	0	0
less: Non-recurring cost		0	0	0	0
2012 Adjustments to base:					
plus: Uncontrollable cost changes			0	0	0
2012 Base Request	0	0	0	0	0
plus: 2012 Program changes	10	7	$100,000	$100,000	$100,000
2012 Estimate	10	7	100,000	100,000	100,000

Comparison by activity/subactivity:		2010 Actual Per-sonnel	2010 Actual Amount	2011 Annualized CR Level Per-sonnel	2011 Annualized CR Level Amount	2012 Base Per-sonnel	2012 Base Amount	2012 Estimate Per-sonnel	2012 Estimate Amount	Increase/ (Decrease) Over 2012 Base Per-sonnel	Increase/ (Decrease) Over 2012 Base Amount
Public Safety Innovation Fund											
Public Safety Innovation Fund	Pos/Approp	0	0	0	0	0	0	10	$100,000	10	$100,000
	FTE/Obl.	0	0	0	0	0	0	7	100,000	7	100,000
Total: Public Safety Innovation Fund	Pos/Approp	0	0	0	0	0	0	10	100,000	10	100,000
	FTE/Obl.	0	0	0	0	0	0	7	100,000	7	100,000

	2010 Actual		2011 Annualized CR Level		2012 Base		2012 Estimate		Increase/ (Decrease) Over 2012 Base	
	FTE	Amount	FTE	Amount	FTE	Amount	FTE	Amount	FTE	Amount
Direct Mandatory Obligation	0	0	0	0	0	0	7	$100,000	7	$100,000
Adjustments for:										
Prior year recoveries		0		0		0		0		0
Prior year refunds		0		0		0		0		0
Unobligated balance, start of year		0		0		0		0		0
Unobligated balance, end of year		0		0		0		0		0
Unobligated balance, expired account		0		0		0		0		0
Total Budget Authority	0	0	0	0	0	0	7	100,000	7	100,000
Financing from transfers:										
Transfers to other accounts (+)		0		0		0		0		0
Net Appropriation	0	0	0	0	0	0	7	100,000	7	100,000

Department of Commerce
National Institute of Standards and Technology
Public Safety Innovation Fund
SUMMARY OF FINANCING
(Dollar amounts in thousands)

	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
Total Obligations	0	0	0	$100,000	$100,000
Financing:					
Offsetting collections from:					
Federal funds	0	0	0	0	0
Non-Federal sources	0	0	0	0	0
Total offsetting collections	0	0	0	0	0
Adjustments for:					
Prior year recoveries	0	0	0	0	0
Prior year refunds	0	0	0	0	0
Unobligated balance, start of year (Mandatory)	0	0	0	0	0
Unobligated balance, end of year (Mandatory)	0	0	0	0	0
Budget Authority	0	0	0	100,000	100,000
Financing:					
Transfer to other accounts	0	0	0	0	0
Transfer from other accounts	0	0	0	0	0
Appropriation	0	0	0	100,000	100,000

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Department of Commerce
National Institute of Standards and Technology
Public Safety Innovation Fund
PROGRAM AND PERFORMANCE: DIRECT MANDATORY OBLIGATIONS
(Dollar amounts in thousands)

Activity: Public Safety Innovation Fund
Subactivity: Public Safety Innovation Fund

		2010 Actual		2011 Annualized CR Level		2012 Base		2012 Estimate		(Increase/ Decrease) Over 2012 Base	
Line Item		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Public Safety Innovation Fund	Pos/Approp	0	0	0	0	0	0	10	$100,000	10	$100,000
	FTE/Obl.	0	0	0	0	0	0	7	100,000	7	100,000
Total	Pos/Approp	0	0	0	0	0	0	10	100,000	10	100,000
	FTE/Obl.	0	0	0	0	0	0	7	100,000	7	100,000

MANDATORY APPROPRIATION ACCOUNT: PUBLIC SAFETY INNOVATION FUND

This new fund is established as part of the Administration's effort to spur wireless innovation.

BUDGET ACTIVITY: PUBLIC SAFETY INNOVATION FUND (PSIF)

This budget activity is new in FY 2012. Proposed authorizing legislation will be submitted after submission of the FY 2012 President's budget.

The President's Wireless Innovation and Infrastructure Initiative proposes to reallocate a total of 500 megahertz of Federal agency and commercial spectrum bands over the next ten years in order to increase Americans' access to wireless broadband. The auctions of reallocated spectrum licenses are expected to raise more than $27.0 billion by 2021. This effort will enhance America's public safety, infrastructure, and competitiveness by investing some of the expected receipts in the creation of a broadband network for public safety, expanding access to wireless broadband in rural America, and a Wireless Innovation (WIN) Fund to help develop cutting-edge wireless technologies. As part of this initiative, NIST will participate in the WIN Fund by working with industry and public safety organizations to conduct research and to develop new standards, technologies and applications to advance public safety communications.

SUBACTIVITY: PUBLIC SAFETY INNOVATION FUND

This newly proposed budget activity and subactivity is new in FY 2012. Proposed authorizing legislation will be submitted after submission of the FY 2012 President's budget.

BASE JUSTIFICATION FOR FY 2012:

The PSIF is a new program and no base funding exists.

PROGRAM CHANGES FOR FY 2012:

Public Safety Innovation Fund (Base Funding: 0 FTE and $0 million; Program Change: + 7 FTE and + $100.0 million).

The President's budget includes a request of $100.0 million in mandatory appropriations for the Public Safety Innovation Fund, NIST's component of the Wireless Innovation Fund, which will help spur the development of cutting-edge wireless technologies. As part of this initiative, NIST will work with industry and public safety organizations to conduct research and develop new standards, technologies and applications to advance public safety communications. Core components of this program will include documenting public safety requirements and driving the adoption of those requirements into the appropriate standards; developing the capability for communications between currently deployed public safety narrow band systems and the future nationwide broadband network; and establishing a roadmap that seeks to capture and address public safety's needs beyond what can be provided by the current generation of broadband technology and driving technological progress in that direction. NIST will accomplish these goals through directed research, development, applications, and demonstration projects. Where appropriate, NIST will cooperate with other government research agencies and transfer funding if particular agencies are better suited to sponsor and oversee relevant research, development, or demonstration projects.

The PSIF request totals $100.0 million in new mandatory appropriations in FY 2012. The Administration intends to continue the program at the $100.0 million level through FY 2016, for a total five-year program of $500.0 million.

Proposed Actions:

- NIST will develop the PSIF program by building upon and leveraging critical synergies between:
    - The Department of Commerce's Public Safety Communications Research (PSCR) program, a partnership of the NIST Office of Law Enforcement Standards (NIST/OLES), NTIA's Institute for Telecommunication Sciences (ITS), and various other NIST laboratories, based in Boulder, Colorado.
    - NIST and PSCR's strong relationships with public safety practitioners, agencies, and the Public Safety Broadband Licensee, which holds the license to the public safety spectrum.
    - NIST's successful partnerships with the Departments of Homeland Security and Justice, the National Telecommunications and Information Administration (NTIA), and the Federal Communications Commission (FCC).
    - NIST's experience in research, development, testing, and evaluation of critical public safety communications technologies, including broadband.

- The PSIF program will support and expand upon the ongoing work of the PSCR program, including:

    - The 700MHz Public Safety Broadband Demonstration Network, which will provide public safety practitioners access to information on how advanced communications technologies, such as video, mapping and GPS technologies, will perform over the demonstration network. The network will later be used as a public safety education center, where first responders can run emergency scenarios and develop advanced public safety specific applications. The effort will also result in integration opportunities for a variety of enhanced broadband communication technologies.
    - Helping to identify, articulate, and support public safety's requirements in national and international standards bodies, providing insight and direction to IT and wireless standards committees that are developing standards for voice, data, image, and video communications.

Statement of Need and Economic Benefits:

Public safety agencies have long struggled with effective cross-agency radio communications. Broadband has the potential to revolutionize the way public safety performs its mission, as newly available 700MHz spectrum will let public safety adopt technologies that support high-speed data transmission across long distances, creating access to video, mapping, GPS applications, and more. These new capabilities will undoubtedly help public safety personnel better perform their mission to protect lives and property. Additionally, these networks will supplement—and one day take the place of—the traditional land mobile radio networks that today handle mission critical voice communications.

This 700MHz spectrum, which will utilize commercial cellular technology, created a new nationwide spectrum block for public safety users, and potentially commercial users. There are an estimated maximum of 4 million public safety users in the U.S., including fire, police and EMS. Current nationwide cellular service providers cover 85 percent of the population. Public safety requires nearly 95 percent population and 90 percent geographic coverage with an inferred system availability of 90 percent. Besides stringent coverage and availability requirements, public safety also has additional requirements beyond those of the commercial market, including mission-critical voice, public safety specific applications, enhanced security requirements, and specialized testing needs. These are very difficult requirements to maintain, and there is currently little market force driving the research and development of these technologies critical for public safety.

Base Resources Assessment:

- The base year funding for this initiative is currently zero. Outyears are projected at $100.0 million per year, for five years.

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amount in thousands)

Activity: Public Safety Innovation Fund
Subactivity: Public Safety Innovation Fund

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Program manager	Gaithersburg	ZP V	1	$123,758	$123,758
Program leads	Gaithersburg	ZP IV	5	105,211	526,055
Grants specialist	Gaithersburg	ZP IV	2	105,211	210,422
Secretary	Gaithersburg	ZA III	1	74,872	74,872
Administrative/tech support	Gaithersburg	ZA II	1	51,630	51,630
Total			10		986,737
Less Lapse		25%	(3)		(246,684)
Total full-time permanent (FTE)			7		740,053
2011 Pay Adjustment (0%)					0
2012 Pay Adjustment (0%)					0
TOTAL					740,053

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	7
Other than full-time permanent	0
Total	7
Authorized Positions:	
Full-time permanent	10
Other than full-time permanent	0
Total	10

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Activity: Public Safety Innovation Fund
Subactivity: Public Safety Innovation Fund

	Object Class	2012 Increase
11	Personnel compensation	
11.1	Full-time permanent	$740
11.3	Other than full-time permanent	0
11.5	Other personnel compensation	0
11.8	Special personnel services payments	0
11.9	Total personnel compensation	740
12	Civilian personnel benefits	204
13	Benefits for former personnel	0
21	Travel and transportation of persons	46
22	Transportation of things	1
23.1	Rental payments to GSA	0
23.2	Rental Payments to others	0
23.3	Communications, utilities and miscellaneous charges	190
24	Printing and reproduction	1
25.1	Advisory and assistance services	0
25.2	Other services	2,611
25.3	Purchases of goods & services from Gov't accounts	69
25.4	Operation and maintenance of facilities	0
25.5	Research and development contracts	12,098
25.6	Medical care	0
25.7	Operation and maintenance of equipment	28
25.8	Subsistence and support of persons	0
26	Supplies and materials	30
31	Equipment	48
32	Lands and structures	0
33	Investments and loans	0
41	Grants, subsidies and contributions	83,934
42	Insurance claims and indemnities	0
43	Interest and dividends	0
44	Refunds	0
99	Total obligations	100,000

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Exhibit 16

Department of Commerce
National Institute of Standards and Technology
Public Safety Innovation Fund
SUMMARY OF REQUIREMENTS BY OBJECT CLASS

	Object Class	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
11	Personnel compensation					
11.1	Full-time permanent	0	0	0	$740	$740
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	740	740
12.1	Civilian personnel benefits	0	0	0	204	204
13	Benefits for former personnel	0	0	0	0	0
21	Travel and transportation of persons	0	0	0	46	46
22	Transportation of things	0	0	0	1	1
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	190	190
24	Printing and reproduction	0	0	0	1	1
25.1	Advisory and assistance services	0	0	0	0	0
25.2	Other services	0	0	0	2,611	2,611
25.3	Purchases of goods and services from government accounts	0	0	0	69	69
25.5	Research and development contracts	0	0	0	12,098	12,098
25.7	Operation and maintenance of equipment	0	0	0	28	28
26	Supplies and materials	0	0	0	30	30
31	Equipment	0	0	0	48	48
32	Land and structures	0	0	0	0	0
41	Grants, subsidies, and contributions	0	0	0	83,934	83,934
42	Insurance claims and indemnities	0	0	0	0	0
99	Total Mandatory Obligations	0	0	0	100,000	100,000

	Object Class	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
99	Total Mandatory Obligations	0	0	0	100,000	100,000
	Less Prior Year Recoveries	0	0	0	0	0
	Less Prior Year Refunds	0	0	0	0	0
	Less Prior Year Unobligated Balance	0	0	0	0	0
	Plus Unobligated Balance End of Year	0	0	0	0	0
	Plus Unobligated Balance - Expired	0	0	0	0	0
	Total Budget Authority	0	0	0	100,000	100,000
	Plus Transfers from Other Accounts	0	0	0	0	0
	Appropriation	0	0	0	100,000	100,000

Personnel Data

	2010 Actual	2011 Annualized CR Level	2012 Base	2012 Estimate	Increase/ (Decrease) Over 2012 Base
Full-time equivalent employment:					
Full-time permanent	0	0	0	7	7
Other than full-time permanent	0	0	0	0	0
Total	0	0	0	7	7
Authorized Positions:					
Full-time permanent	0	0	0	10	10
Other than full-time permanent	0	0	0	0	0
Total	0	0	0	10	10

Department of Commerce
National Institute of Standards and Technology
Public Safety Standards and Technology Research and Development
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. 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.

2. $500,000,000 in total, to be issued as an annual mandatory appropriation of $100,000,000 each year for five years (2012-2016)

    no specific authority

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Institute Material

Summary of 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)

Source and Use of Funds Spent	FY 2010 Perm. Pos. [1]	FY 2010 FTE	FY 2010 Oblig.	FY 2011 Perm. Pos. [1]	FY 2011 FTE	FY 2011 Oblig.	FY 2012 Perm. Pos. [1]	FY 2012 FTE	FY 2012 Oblig.	FY 2012 Approp. Requested
Direct Funding										
Discretionary										
Scientific and technical research and services	2,117	2,064	$697,718	2,066	2,072	$530,054	2,533	2,421	$674,359	$678,943
Industrial technology services	148	158	202,149	202	210	239,775	193	199	241,422	237,622
Construction of research facilities	89	119	459,076	114	119	180,004	114	119	84,565	84,565
Gifts and bequests	0	0	1,787	0	0	1,106	0	0	NA	0
Mandatory										
Public Safety Innovation Fund	0	0	0	0	0	0	10	7	100,000	100,000
Total, direct funding	2,354	2,341	1,360,730	2,382	2,401	950,939	2,850	2,746	1,100,346	1,101,130
Reimbursable Funding and WCF Investments										
Scientific and technical research and services - Smart Grid, DoE/ NTIA, DoC	0	0	11,375	0	0	827	0	0	0	
Construction of research facilities - building surcharge	0	0	880	0	0	953	0	0	0	
Research, development and supporting services:										
Federal government	477	451	106,016	457	508	135,580	467	518	127,349	
Calibrations and tests, technical and advisory services:										
Federal government	24	23	6,115	23	26	6,184	24	26	6,248	
Public and non-federal government	88	83	22,235	85	94	22,482	86	96	22,718	
Subtotal, Services	112	106	28,350	108	120	28,666	110	122	28,966	
National Voluntary Laboratory Accreditation Program	24	23	6,650	23	25	6,605	23	26	6,664	
Standard reference materials (SRMs):										
SRM Sales:										
Federal government	3	3	502	3	3	446	3	3	444	
Public and non-federal government	79	75	14,521	76	85	12,897	78	86	12,838	
Subtotal, SRM sales	82	78	15,023	79	88	13,343	81	89	13,282	
SRM investment adjustment	0	0	(767)	0	0	0	0	0	0	
Subtotal, SRM	82	78	14,256	79	88	13,343	81	89	13,282	
Total, Reimbursable program	695	658	167,527 [2]	667	741	185,974 [2]	681	755	176,261	
WCF Investments and Operating Adjustments										
WCF investments	0	0	17,205	0	0	24,085	0	0	21,283	
WCF transfers	0	0	1,443	0	0	0	0	0	8,834	
Excess Amortizations over Equipment Investments	0	0	2,045	0	0	0				
WCF operating adjustments	0	0	3,307	0	0	0	0	0	0	
Total, WCF Investments and operating adjustments	0	0	24,000	0	0	24,085	0	0	30,117	
Total, NIST program	3,049	2,999	1,552,257	3,049	3,142	1,160,998	3,531	3,501	1,306,724	
Offsetting adjustment for amortization of equipment	0	0	(20,692)	0	0	(21,876)	0	0	(21,283)	
Adjusted total, NIST program	3,049	2,999	1,531,565	3,049	3,142	1,139,122	3,531	3,501	1,285,441	

[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 obligations in FACTS II.

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

	FY 2010 Actual	FY 2011 CR Level	FY 2012 Estimate
Department of Defense			
Air Force	$9,490	$12,958	$12,474
Army	3,523	3,590	3,400
Navy	1,513	1,888	1,650
Other	12,638	15,496	13,419
Subtotal, Department of Defense	27,164	33,932	30,943
Department of Agriculture	123	180	120
Department of Commerce	14,603	19,127	20,142
Department of Energy	5,647	8,025	7,847
Dept. of Health & Human Services	4,500	4,819	4,297
Dept. of Homeland Security	24,536	29,675	27,819
Department of the Interior	150	155	156
Department of Justice	10,988	17,490	17,384
Department of State	1	0	0
Department of Transportation	242	250	280
Department of the Treasury	76	50	50
Department of Veterans Affairs	1,768	170	170
Environmental Protection Agency	203	113	80
General Services Administration	857	221	221
National Aeronautics & Space Admin.	4,990	5,763	5,568
National Science Foundation	2,933	5,844	3,860
Nuclear Regulatory Commission	909	850	850
Other	6,326	8,916	7,562
Subtotal, Federal Agencies	106,016	135,580	127,349
Calibrations & Testing	8,907	8,905	9,084
Technical & Advisory Services	26,093	26,366	26,546
Standard Reference Materials	14,256	13,343	13,282
Subtotal, Other Reimbursables	49,256	48,614	48,912
Total, Reimbursable Program	155,272	184,194	176,261
Equipment Transfers	1,443	0	8,434
SRM Transfers	0	0	400
Subtotal, WCF transfer	1,443	0	8,834
Equipment Investments	17,205	24,085	21,283
IE Amortization	(20,692)	(21,876)	(21,283)
Excess Amortizations over Equipment Investments	2,045	0	0
WCF Operating Adjustments	3,307	0	0
Total, WCF Investments	1,865	2,209	0
Total, Reimbursable Program and WCF Investments	158,580	186,403	185,095

Department of Commerce
National Institute of Standards and Technology
PERIODICALS, PAMPHLETS, AND AUDIOVISUAL SERVICES
(Obligations in thousands)

	2009 Actual	2010 Actual	2011 Estimate	2012 Estimate
Periodicals	$15	$15	$34	$34
Pamphlets	25	25	25	25
Audiovisuals	6	6	10	14
Total	46	46	69	73

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

	2010 Actual	2011 Estimate	2012 Estimate
Average ES salary	$168,715	$168,715	$168,715
Average scientific and professional	170,816	170,816	170,816
Average Career Path Salary	105,572	105,572	105,572
Average salary of ungraded positions	56,169	56,169	56,169

FY 2011 and FY 2012 average salaries reflect a freeze on federal employee pay schedules and rates.

DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
NTIS Revolving Fund
Budget Estimates, Fiscal Year 2012
President's Submission

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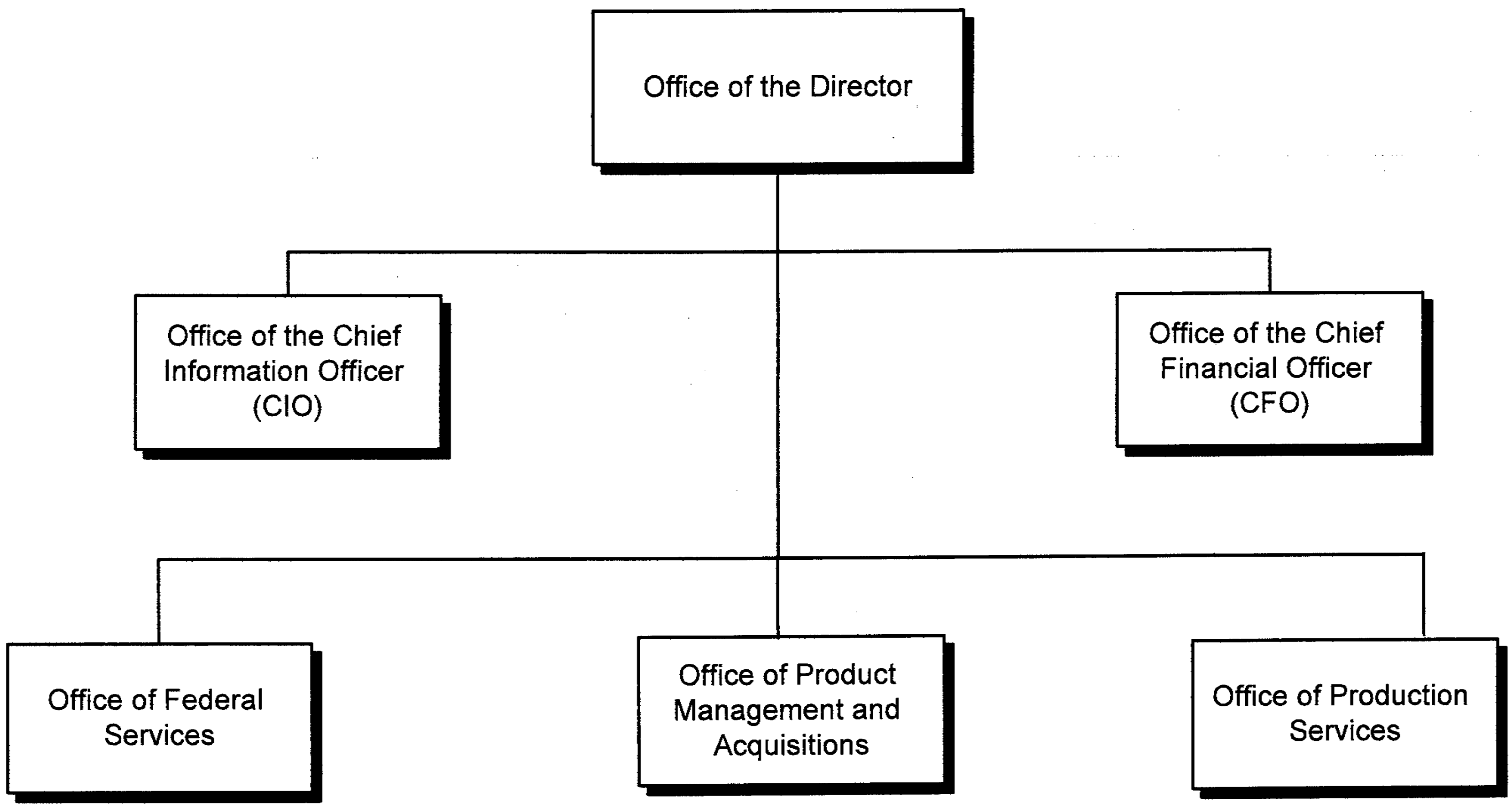
Exhibit 2

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 2012
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 2012 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 845,000 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 54.8 million information items to the public in FY 2012.

NTIS plans to obligate $65,500,000 of earned revenue in FY 2012.

(Dollar amounts in thousands)

	2010	2011	2012	2013	2014	2015	2016
National Technical Information Service:							
Reimbursement from offsetting collections:							
Information clearinghouse program	$45,984	$65,000	$65,500	$66,000	$66,500	$67,000	$67,500
Total, NTIS	$45,984	$65,000	$65,500	$66,000	$66,500	$67,000	$67,500

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
President's Budget, 2011	0	0	0	0
Plus 2012 Adjustments to Base	0	0	0	0
Less: Obligations from prior years	0	0	0	0
2012 Base Request	0	0	0	0
Plus 2012 program changes	0	0	0	0
2012 Estimate	0	0	0	0

		2010 Actual		2011 Currently Available		2012 Base		2012 Estimate		Increase/ (Decrease) over 2012 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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Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
SUMMARY OF FINANCING
(Dollar amounts in thousands)

	2010 Actual	2011 Currently Available	2012 Base	2012 Estimate	Increase (Decrease) over 2012 Base
Total Obligations	$45,984	$65,000	$65,500	$65,500	$0
Offsetting collections from:					
Federal funds	(36,905)	(51,350)	(51,700)	(51,700)	0
Trust funds	0	0	0	0	0
Non-Federal sources	(10,629)	(13,650)	(13,800)	(13,800)	0
Recoveries	0	0	0	0	0
Unobligated balance, start of year	(4,608)	(6,158)	(6,158)	(6,158)	0
Unobligated balance transferred	0	0	0	0	0
Unobligated balance, end of year	6,158	6,158	6,158	6,158	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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Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
JUSTIFICATION OF PROGRAM AND PERFORMANCE

APPROPRIATION ACCOUNT: NTIS Revolving Fund

BUDGET ACTIVITY: Organization, Preservation and Public Access to Technical Information

For FY 2012, the National Technical Information Service plans to continue to operate on a self-supporting reimbursable basis, which will include estimated obligations of $65,500,000 and 150 FTE.

BASE JUSTIFICATION FOR FY 2012:

NTIS' basic authority is to operate a permanent clearinghouse of scientific and technical information, codified as chapter 23 of Title 15 of the United States Code (15 U.S.C. 1151-1157). This chapter also established NTIS' authority to charge fees for its products and services and to recover all costs through such fees "to the extent feasible."

Operating on a reimbursable basis NTIS acquires information products; 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. These 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 also provides information management services to other federal agencies that help them interact with and better serve the information needs of their own constituents. These activities include: web hosting, e-Training, scanning, digitization, electronic archive, and managing a wide range of bibliographic and other types of databases.

All activities are funded through the NTIS Revolving Fund, without direct appropriation.

Significant Adjustments-to-Base (ATBs):

- None

ADMINISTRATIVE COST SAVINGS:

The Administration is pursuing an aggressive government-wide effort to curb non-essential administrative spending called the Accountable Government Initiative. In order to support this initiative, and improve the efficiency of programs without reducing their effectiveness, the National Technical Information Service has identified $129,000 in administrative savings, with an additional $9,000 in savings identified through the Department's Working Capital Fund (see the Departmental Management Working Capital Fund section for more details). Of these administrative savings, $91,000 is tied to the acquisition plans for FY 2012. In the area of human capital, NTIS expects to reduce its costs by $38,000 through a hiring slowdown and working to reduce its workers compensation costs.

The $138,000 in administrative savings will be reinvested in the activities of the NTIS Revolving Fund.

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
JUSTIFICATION OF PROGRAM AND PERFORMANCE

PROGRAM CHANGES FOR FY 2012:

None

Deliverables:

Performance Goals and Measurement Data

Performance Measure: Number of updated items available	FY 2010 Actual	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target
Total	969,473	825,000	875,000	892,500	910,350	928,500
Description: 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. Continually expanding and refining efforts to acquire new scientific and technical information products is reflected in future targets.						

Performance Measure: Number of information products disseminated (annual)	FY 2010 Actual	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target
Total	50.3M	52.8M	54.8M	55.0M	55.5M	56.0M
Description: 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 recently deployed its new Next Generation 2.0 website and has initiated the use of Social Media technology as part of its Outreach and Education activities to further the success of this goal.						

Performance Measure: Customer Satisfaction	FY 2010 Actual	FY 2011 Target	FY 2012 Target	FY 2013 Target	FY 2014 Target	FY 2015 Target
Total	98%	95%-98%	95%-98%	95%-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 they 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. Customer satisfaction is key to NTIS' successful operation.						

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund – Reimbursable Obligations
SUMMARY OF REQUIREMENTS BY OBJCT CLASS
(Dollar amounts in thousands)

Object Class		2010 Actual	2011 Currently Available	2012 Base	2012 Estimate	Increase/ (Decrease) over 2012 Base
11.1	Full-time permanent (Compensation)	$10,223	$11,285	$11,900	$11,900	0
11.3	Other than full-time permanent	59	150	150	150	0
11.5	Other personnel compensation	601	650	650	650	0
11.8	Special personnel services payments	0	0	0	0	0
11.9	Total personnel compensation	10,883	12,085	12,700	12,700	0
12.1	Civilian personnel benefits	3,042	3,990	4,200	4,200	0
13	Benefits for former personnel	0	0	0	0	0
21	Travel and transportation of persons	101	200	200	200	0
22	Transportation of things	2,373	2,500	2,500	2,500	0
23.1	Rental payments to GSA	1,634	1,891	1,905	1,905	0
23.2	Rental payments to others	98	1,000	1,000	1,000	0
23.3	Communications, utilities and miscellaneous charges	578	1,800	1,800	1,800	0
24	Printing and reproduction	0	4,000	4,000	4,000	0
25.1	Consulting services	67	100	100	100	0
25.2	Other services	24,084	30,434	30,095	30,095	0
25.3	Purchase of goods and services from Government accounts	732	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	155	500	500	500	0
26	Supplies and materials	607	3,000	3,000	3,000	0
31	Equipment	1,630	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		2010 Actual	2011 Currently Available	2012 Base	2012 Estimate	Increase/ (Decrease) over 2012 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	45,984	65,000	65,500	65,500	0
	Earned Revenue/Reimbursable Obligations.	45,984	65,000	65,500	65,500	0
	Total Obligations	45,984	65,000	65,500	65,500	0
Personnel Data						
Full-Time equivalent Employment:						
Full-time permanent		120	145	145	145	0
Other than full-time permanent		1	5	5	5	0
Total		121	150	150	150	0
Authorized Positions:						
Full-time permanent		117	190	190	190	0
Other than full-time permanent		1	10	10	10	0
Total		118	200	200	200	0

Exhibit 34

DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
NTIS Revolving Fund
CONSULTING AND RELATED SERVICES
(Obligations in thousands)

	2010 Actual	2011 Estimate	2012 Estimate
Consulting Services	$67	$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	$67	$100	$100

Exhibit 35

Department of Commerce
National Technical Information Service
NTIS Revolving Fund
PERIODICALS, PAMPHLETS, AND AUDIOVISUAL PRODUCTS
(obligations in thousands)

	2010 Actual	2011 Estimate	2012 Estimate
Periodicals	$4	$4	$5
Pamphlets	0	0	0
Audiovisuals	0	0	0
Total	$4	$4	$5

DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
NTIS Revolving Fund
AVERAGE GRADE AND SALARIES

	2010 Actual	2011 Estimate	2012 Estimate
Average GS/GM Grade	10.0	10.3	10.5
Average GS/GM Salary	$86,974	$93,062	$98,646

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