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MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

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SUBJECT: FY 2005 Interagency Research and Development Priorities

Science and technology contribute significantly to the highest priorities of this Administration: winning the war on terrorism, securing the homeland, and strengthening the economy. The President's FY 2004 Budget sets forth a research and development (R&D) agenda for the forthcoming fiscal year that reflects these priorities and seizes important opportunities for discovery and development while sustaining the basic R&D machinery needed for continued U.S. leadership in science and technology (S&T).

This memorandum provides guidance on R&D priorities for FY 2005, and establishes expectations for program evaluation based on the R&D Investment Criteria.

General R&D Program Guidance

The combination of limited resources and a multitude of opportunities requires careful attention to funding priorities and wise choices by agency managers. New programs must be justified with rigorous analysis demonstrating importance, consistency with national priorities, and likelihood of success. Existing programs also need to be reevaluated, modified, redirected, or terminated, in keeping with national needs and priorities. Agencies should fund new, high-priority activities by reallocating resources from lower-priority or recently completed activities. Requests for funding above guidance levels will require a compelling case that the agency is the best one to conduct the activity, and that funds from lower priority or recently completed programs cannot be substituted within the agency's guidance level.

In general, the Administration will favor investments in federal R&D programs that:

- sustain and nurture America's science and technology enterprise through the pursuit of specific agency missions and stewardship of critical research fields and their enabling infrastructure;
- strengthen science, mathematics, and engineering education by enhancing access and broad availability of excellent educational programs, establishing and encouraging best educational practices, and integrating research and education;
- focus on long-term, potentially high-payoff activities that require a federal presence to attain national goals, including homeland and national security, environmental quality, economic prosperity, human health and well being, and fundamental discovery;

- maximize efficiency and effectiveness of federal R&D investments through means such as competitive, peer-reviewed processes and phase-out of programs that are neither productive nor important to an agency's mission;
- promote collaborations among agencies, industry, academia and states to advance common S&T goals; and
- strengthen international partnerships that foster advancement of scientific frontiers and accelerate the progress of science across borders.

This memo does not set forth every Administration S&T priority. In particular, it does not include all priorities that fall within the purview of a single agency.

Some agencies operate *programs or facilities whose capabilities are important to the missions of other agencies*. Such programs and facilities will be given special consideration in budget preparations. Consistent with the President's Management Agenda, it is imperative that, where appropriate, federal R&D investments be managed as a portfolio of potentially interconnected activities to *optimize scientific discovery through interagency coordination of related research areas.* OSTP informs the budget process regarding the availability of instrumentation and facilities for S&T priorities and the need for coordination of related research programs based on information generated through the National Science and Technology Council (NSTC) and other interagency mechanisms.

The President's Council of Advisors on Science and Technology has urged increased investment in certain areas of physical science, citing opportunities for continued scientific discovery and the fact that such discoveries often drive advances in other areas of science. Budgetary proposals for these or any other area must be specific regarding how the programs will expand scientific frontiers in a manner consistent with stated agency missions and national goals and demonstrate coordination with similar programs in other agencies. The desire to achieve parity in funding levels among disciplines does not by itself suffice to justify funding increases.

Education and workforce development are essential components of all federal R&D activities and continue to be high priorities for this Administration. Effective interagency collaboration will promote the implementation of research-based programs and practices addressing priorities established in the *No Child Left Behind Act of 2002*. In addition to promoting effective educational outreach, a high priority will be given to research addressing math and science learning and achievement, including best practices for improving the quality of math and science education. Federal agencies also are expected to coordinate their ongoing efforts to maintain the adequacy of the supply and capacity of the R&D workforce.

Interagency Priorities for R&D Budgets

The President's R&D agenda includes existing and emerging priorities that require significant levels of interagency coordination and planning. During preparation of the FY 2005 Budget, the priority areas listed below will receive particular attention.

Agencies that receive funding for the following activities are expected to participate in applicable interagency coordination groups to produce: 1) a clear and concise definition of

program activities and priorities within the overall priority title; 2) an inventory of the programs in the baseline budget; and 3) an interagency implementation plan.

1. R&D for Combating Terrorism

Winning the war on terrorism and securing the homeland are national priorities. As articulated in the President's *National Strategy for Homeland Security*, the nation's S&T enterprise provides a key advantage in the war against terrorism when applied to: 1) preventing terrorist attacks within the U.S.; 2) reducing America's vulnerability to terrorism; and 3) minimizing the damage and recovering from attacks that do occur. The aim of this priority is to harness and focus America's substantial R&D capability to achieve these strategic objectives. Agencies are encouraged to promote R&D efforts, with emphasis on applied technologies, to address our nation's ability to detect, prevent, treat, remediate, and attribute acts of terrorism. Research and development, testing, evaluation and validation strategies should be elicited for both medical and non-medical countermeasures to weapons of mass destruction.

Research priority areas include:

(1) enhancing detection, treatment, and remediation of chemical, biological, and radiological threats;
(2) developing and transitioning technology to support first responders;
(3) exploiting the significant advances in human and microbial genetic sequencing to promote the development of novel or next-generation vaccines, therapeutics and diagnostics to counter biological threat agents;
(4) converting the vast amount of intelligence data into actionable knowledge;
(5) assessing the social and behavioral aspects of terrorism to help anticipate, counter, and diffuse threats to our homeland security;
(6) facilitating inspection of cargo and people at ports-of-entry; and
(7) securing critical infrastructure including information infrastructure.

The NSTC is actively shaping more specific R&D priorities within each of these categories. This is an ongoing process requiring intensive interagency planning and coordination.

2. Nanotechnology

The National Nanotechnology Initiative (NNI) continues to offer great promise broadly across many scientific fields and most sectors of the economy, and remains an Administration priority. The NNI supports both fundamental and applied R&D in nanotechnology and nanoscience across a broad range of areas, development of nanoscale instrumentation and metrology, and the dissemination of new technical capabilities to industry. Nanoscale R&D priority areas continue to include material science and research relevant to medical care and homeland security. Though research at the nanoscale offers natural bridges to interdisciplinary collaboration, especially at the intersection of the life and physical sciences, the Administration encourages novel approaches to accelerating interdisciplinary and interagency collaborations. Activities such as joint programs utilizing shared resources, as well as support for interdisciplinary activities at centers and user facilities, are encouraged.

3. Networking and Information Technology R&D

The interagency Networking and Information Technology R&D (NITRD) Program continues to be an Administration priority. Efforts that contribute to other interagency R&D priorities (research related to critical infrastructure protection and cybersecurity, for example) are

especially important, and may also require broader coordination with other NSTC entities. Research on networking is another high priority area. In addition, while the overall importance of each of the NITRD Program Component Areas remains undiminished, high-end computing is the subject of increased attention through coordinated multi-agency planning activities that are underway. These activities are focused on developing coordinated, multi-agency investment plans for R&D for core high-end computing technology, and will also address high-end computing capability, capacity and accessibility issues. Because of the emphasis on leveraging efforts and providing benefit to multiple agencies through these planning activities, agency plans and requests should reflect full consideration of the results of this planning activity.

4. Molecular-level Understanding of Life Processes

Methods for characterizing plants, animals and microorganisms have evolved from observation at the level of the whole organism, to deconstruction and manipulation at the cellular and molecular levels. New computer algorithms permit the synthesis of sequence data with experimental evidence of function across species to enable greater understanding of normal development and processes associated with disease, including the role of individual proteins and their interactions (proteomics). The NSTC coordination process (including efforts on Plant Genomes, Domestic Animal Genomes, and the Microbe Project) will assist in identifying R&D opportunities and needs to most effectively utilize federal resources and take better advantage of current biological, computational and bioinformatics technologies.

5. Environment and Energy

The Administration's environment and energy research initiatives are critical for achieving sustained economic growth while ensuring national energy security and a healthy environment.

- Climate Change: The Administration's R&D investments responding to the challenge of global climate change will increase our understanding of climate change science to provide sound climate policy decision-making. Agencies should implement strategic plans being developed for the Climate Change Science Program and the National Climate Change Technology Initiative, and should then move forward in prioritizing areas identified in the strategic plans and in establishing program-wide performance metrics.
- Environmental Observations: A key goal of the Administration's R&D investments is to enhance capabilities to assess and predict key environmental systems. Assessment and prediction are important in improving our understanding of and ability to model climate change, but they also affect many other aspects of society, such as health, resource management, weather prediction, sustainable development, and economic prosperity. To this end, integrated, comprehensive, global observation systems are required for understanding, monitoring, and predicting changes to the Earth system (atmosphere, land, fresh water, ocean, and ecosystems). Through the NSTC, the responsible agencies will develop and implement a coordinated, multi-year plan to enhance data time series, minimize data gaps, and maximize the quality, integrity, and utility of the data for short-term and long-term applications.
- Hydrogen Fuel R&D: President Bush's Hydrogen Fuel Initiative will work through partnerships with industry to develop the technologies and infrastructure needed to produce, store, and distribute hydrogen, and to use it in stationary, portable, and vehicular applications. Agency research efforts should address key technology barriers such as lowering the cost of hydrogen production, creating effective hydrogen storage, and developing affordable hydrogen fuel cells. OSTP will coordinate agency efforts, which

should support basic research in materials, electrochemistry, and advanced hydrogen production methods; development of components and manufacturing technologies; and, as appropriate, demonstration of systems and end-use applications and development of safety codes and interface standards.

Research and Development Investment Criteria

As an initiative of the President's Management Agenda, the development of explicit R&D investment criteria builds on the best of the planning and assessment practices that R&D program managers use to plan and assess their programs. The Administration has worked with experts and stakeholders over the past two years to build upon lessons learned from previous and ongoing practice.

This year, the content of the R&D investment criteria has not changed from last year, but OMB has worked to clarify their implementation, especially in relation to OMB's Program Assessment Rating Tool (PART). Specifically, agencies should use the criteria as broad guidelines that apply at all levels of federally funded R&D efforts, and they should use the PART as the instrument to periodically evaluate compliance with the criteria at the program level. To make this possible, the R&D PART has been modified to clarify its alignment with the R&D criteria.

The R&D criteria address not only planning, management, and prospective assessment but also retrospective assessment. Retrospective review of whether investments have been well-directed, efficient, and productive is essential for validating program design and instilling confidence that future investments will be wisely invested. Retrospective reviews should address continuing program relevance, quality, and successful performance to date.

While the criteria are intended to apply to all types of R&D, the Administration is aware that predicting and assessing the outcomes of *basic* research in particular is never easy. Serendipitous results are often the most interesting and ultimately may have the most value. Taking risks and working towards difficult-to-attain goals are important aspects of good research management, and innovation and breakthroughs are among the results. However, there is no inherent conflict between these facts and a call for clearer information about program goals and performance towards achieving those goals. The Administration expects agencies to focus on improving the management of their research programs and adopting effective practices, and not on predicting the unpredictable.

The R&D investment criteria have several potential benefits:

- Use of the criteria allows policy makers to make decisions about programs based on information beyond anecdotes, prior-year funding levels, and lobbying of special interests.
- Improving the process for selecting, planning, and managing R&D programs helps increase the productivity of the federal R&D portfolio and the return on taxpayer investment.
- The R&D investment criteria will help communicate the Administration's expectations for proper program management.
- The criteria and implementation guidance set standards for information to be provided in program plans and budget justifications.
- The processes and collected information promoted under the criteria will improve public understanding of the possible benefits and effectiveness of the federal investment in R&D.

To facilitate interagency discussion, dissemination and implementation of the R&D investment criteria, OSTP has commissioned a series of case studies that document and explain existing effective management practices in various research agencies. These documented management practices illustrate how agencies may be able to satisfy the investment criteria. The interagency working group convened under the NSTC will meet again in early June to critique the first case studies and select further good management practices for documentation.

The Investment Criteria

The Relevance, Quality, and Performance criteria apply to all R&D programs. Industry-relevant applied R&D must meet additional criteria. Together, these criteria can be used to assess the need, relevance, appropriateness, quality, and performance of federal R&D programs.

I. Relevance

R&D investments must have clear plans, must be relevant to national priorities, agency missions, relevant fields, and "customer" needs, and must justify their claim on taxpayer resources. Review committees should assess program objectives and goals on their relevance to national needs, "customer" needs, agency missions, and the field(s) of study the program strives to address. For example, the Joint DOE/NSF Nuclear Sciences Advisory Committee's Long Range Plan and the Astronomy Decadal Surveys are the products of good planning processes because they articulate goals and priorities for research opportunities within and across their respective fields. Programs that directly address Presidential priorities may receive special consideration for support, with adequate documentation of their relevance to those priorities.

OMB will work with some programs to identify quantitative metrics to estimate and compare potential benefits across programs with similar goals. Such comparisons may be within an agency or among agencies.

A. Programs must have complete plans, with clear goals and priorities.
Programs must provide complete plans, which include explicit statements of:
- specific issues motivating the program;
- broad goals and more specific tasks meant to address the issues;
- priorities among goals and activities within the program;
- human and capital resources anticipated; and
- intended program outcomes, against which success may later be assessed.

B. Programs must articulate the potential public benefits of the program.
Programs must identify potential benefits, including added benefits beyond those of any similar efforts that have been or are being funded by the government or others. R&D benefits may include technologies and methods that could provide new options in the future, if the landscape of today's needs and capabilities changes dramatically. Some programs and sub-program units may be required to quantitatively estimate expected benefits, which would include metrics to permit meaningful comparisons among programs that promise similar benefits. While all programs should try to articulate potential benefits, OMB and OSTP recognize the difficulty in predicting the outcomes of basic research. Discovery is a legitimate object of basic research, and some basic

research investments may be justified on external judgments of the opportunity for discovery**.**

C. **Programs must document their relevance to specific Presidential priorities to receive special consideration.**
Many areas of research warrant some level of federal funding. Nonetheless, the President has identified a few specific areas of research that are particularly important. To the extent a proposed project can document how it directly addresses one of these areas, it may be given preferential treatment.

D. **Program relevance to the needs of the Nation, of fields of science and technology, and of program "customers" must be assessed through prospective external review.**
Programs must be assessed on their relevance to agency missions, fields of science or technology, or other "customer" needs. A customer may be another program at the same or another agency, an interagency initiative or partnership, or a firm or other organization from another sector or country. As appropriate, programs must define a plan for regular reviews by primary customers of the program's relevance to their needs. These programs must provide a plan for addressing the conclusions of external reviews.

E. **Program relevance to the needs of the Nation, of fields of science and technology, and of program "customers" must be assessed periodically through retrospective external review.**
Programs must periodically assess the need for the program and its relevance to customers against the original justifications. Programs must provide a plan for addressing the conclusions of external reviews.

II. Quality

Programs should maximize the quality of the R&D they fund through the use of a clearly stated, defensible method for awarding a significant majority of their funding. A customary method for promoting R&D quality is the use of a competitive, merit-based process. NSF's process for the peer-reviewed, competitive award of its R&D grants is a good example. Justifications for processes other than competitive merit review may include "outside-the-box" thinking, a need for timeliness (e.g., R&D grants for rapid studies in response to an emergency), unique skills or facilities, or a proven record of outstanding performance (e.g., performance-based renewals).

Programs must assess and report on the quality of current and past R&D. For example, NSF's use of Committees of Visitors, which review NSF directorates, is an example of a good quality-assessment tool. OMB and OSTP encourage agencies to provide the means by which their programs may be benchmarked internationally or across agencies, which provides one indicator of program quality.

A. **Programs allocating funds through means other than a competitive, merit-based process must justify funding methods and document how quality is maintained.**
Programs must clearly describe how much of the requested funding will be broadly competitive based on merit, providing compelling justifications for R&D funding allocated through other means. (See OMB Circular A-11 for definitions of competitive merit review and other means of allocating federal research funding.) All program funds allocated through means other than unlimited competition must document the processes

they will use to distribute funds to each type of R&D performer (e.g., federal laboratories, federally funded R&D centers, universities). Programs are encouraged to use external assessment of the methods they use to allocate R&D and maintain program quality.

B. **Program quality must be assessed periodically through retrospective expert review.** Programs must institute a plan for regular, external reviews of the quality of the program's research and research performers, including a plan to use the results from these reviews to guide future program decisions. Rolling reviews performed every 3-5 years by advisory committees can satisfy this requirement. Benchmarking of scientific leadership and other factors provides an effective means of assessing program quality relative to other programs, other agencies, and other countries.

III. Performance

R&D programs should maintain a set of high priority, multi-year R&D objectives with annual performance measures and milestones that show how one or more outcomes will be reached. Metrics should be defined not only to encourage individual program performance but also to promote, as appropriate, broader goals, such as innovation, cooperation, education, and dissemination of knowledge, applications, or tools.

OMB encourages agencies to make the processes they use to satisfy the Government Performance and Results Act (GRPA) consistent with the goals and metrics they use to satisfy these R&D criteria. Satisfying the R&D performance criteria for a given program should serve to set and evaluate R&D performance goals for the purposes of GPRA. OMB expects goals and performance measures that satisfy the R&D criteria to be reflected in agency performance plans.

Programs must demonstrate an ability to manage in a manner that produces identifiable results. At the same time, taking risks and working towards difficult-to-attain goals are important aspects of good research management, especially for basic research. The intent of the investment criteria is not to drive basic research programs to pursue less risky research that has a greater chance of success. Instead, the Administration will focus on improving the management of basic research programs.

OMB will work with some programs to identify quantitative metrics to compare performance across programs with similar goals. Such comparisons may be within an agency or among agencies.

Construction projects and facility operations will require additional performance metrics. Cost and schedule earned-value metrics for the construction of R&D facilities must be tracked and reported. Within DOE, the Office of Science's formalized independent reviews of technical cost, scope, and schedule baselines and project management of construction projects ("Lehman Reviews") are widely recognized as an effective practice for discovering and correcting problems involved with complex, one-of-a-kind construction projects.

A. **Programs may be required to track and report relevant program inputs annually.** Programs may be expected to report relevant program inputs, which could include statistics on overhead, intramural/extramural spending, infrastructure, and human capital. These inputs should be discussed with OMB.

B. **Programs must define appropriate output and outcome measures, schedules, and decision points.**
Programs must provide single- and multi-year R&D objectives, with annual performance measures, to track how the program will improve scientific understanding and its application. Programs must provide schedules with annual milestones for future competitions, decisions, and termination points, highlighting changes from previous schedules. Program proposals must define what would be a minimally effective program and a successful program. Agencies should define appropriate output and outcome measures for all R&D programs, but agencies should not expect fundamental basic research to be able to identify outcomes and measure performance in the same way that applied research or development are able to. Highlighting the results of basic research is important, but it should not come at the expense of risk-taking and innovation. For some basic research programs, OMB may accept the use of qualitative outcome measures and quantitative process metrics. Facilities programs must define metrics and methods (e.g., earned-value reporting) to track development costs and to assess the use and needs of operational facilities over time. If leadership in a particular field is a goal for a program or agency, OMB and OSTP encourage the use of benchmarks to assess the processes and outcomes of the program with respect to leadership. OMB encourages agencies to make the processes they use to satisfy GPRA consistent with the goals and metrics they use to satisfy these R&D criteria.

C. **Program performance must be retrospectively documented annually**
Programs must document performance against previously defined output and outcome metrics, including progress towards objectives, decisions, and termination points or other transitions. Programs with similar goals may be compared on the basis of their performance. OMB will work with agencies to identify such programs and appropriate metrics to enable such comparisons.

IV. Criteria for R&D Programs Developing Technologies That Address Industry Issues

The purpose of some R&D and technology demonstration programs and projects is to introduce some product or concept into the marketplace. However, some of these efforts engage in activities that industry is capable of doing and may discourage or even displace industry investment that would occur otherwise. Programs should avoid duplicating research in areas that are receiving funding from the private sector, especially for evolutionary advances and incremental improvements. For the purposes of assessing federal R&D investments, the following criteria should be used to assess industry-relevant R&D and demonstration projects, including, at OMB discretion, associated construction activities.

OMB will work with programs to identify appropriate measures to compare potential benefits and performance across programs with similar goals, as well as ways to assess market relevance.

A. **Programs and projects must articulate public benefits of the program using uniform benefit indicators across programs and projects with similar goals.**
In addition to the public benefits required in the general criteria, *all* industry-relevant programs and projects must identify and use uniform benefit indicators (including benefit-cost ratios) to enable comparisons of expected benefits across programs and projects. OMB will work with agencies to identify these indicators.

B. **Programs and projects must justify the appropriateness of federal investment.**
Programs and projects must demonstrate that industry investment is sub-optimal to develop a technology or system and explain why the development or acceleration of that technology or system is necessary to meet a federal mission or goals.

C. **Programs and projects must demonstrate that investment in R&D and demonstration activities is a more effective way to support the federal goals than other policy alternatives.**
When the federal government chooses to intervene to address market failures, there may be many policy alternatives to address those failures. Among other tools available to the government are legislation, tax policy, regulatory and enforcement efforts, and an integrated combination of these approaches. Agencies should consider that the legislation, tax policy or regulatory or enforcement mechanisms may already be in place to achieve a reasonable expectation of advancing the desired end.

D. **Programs and projects must document industry or market relevance, including readiness of the market to adopt technologies or other outputs.**
Programs must assess the likelihood that the target industry will be able to adopt the technology or other program outputs. The level of industry cost sharing or enforceable recoupment commitments in contracts are indicators of industry relevance. Agencies must be able to justify any demonstration activities with an economic analysis of the public and private returns on the public investment.

E. **Program performance plans and reports must include "off ramps" and transition points.**
In addition to the schedules and decision points defined in the general criteria, program plans should also identify whether, when, and how aspects of the program may be shifted to the private sector.