Senate Deliberates Civilian and Defense R&D Authorization

The prospects for increased research and development (R&D) funding in Congress depend on whether they involve civilian or defense applications. While federal civilian R&D spending is likely to double within the next decade, defense R&D money most likely will not increase for at least the next couple of years.

On the civilian side, a vigorous, bipartisan legislative authorization effort is afoot in the Senate with the Federal Research Investment Act (S. 2217), introduced by Sen. William H. Frist (R-Tenn.) and Sen. John D. Rockefeller (D-W. Va.) with a growing list of co-sponsors. The bill would increase overall civilian spending for basic R&D by 2.5% per year above inflation, which would amount to about $68 billion—or double current levels—by Fiscal Year 2010. It would establish a federal policy goal of expanding the civilian-side's share of the federal budget to 2.6% by FY 2010, compared with 2.1% in FY 1999. And it would establish a new set of accountability standards for federal agencies with R&D responsibilities.

The Frist-Rockefeller bill, as it is known, is a manifestation of a genuine and growing sense among legislators that federal R&D spending is a key component in maintaining the economic health of the country. It is a major stimulator of overall economic expansion. As stated in the legislation, "Federal investment in research has been effective in creating technology that has enhanced the American quality of life." The bill cites economic research showing that "about half of all United States post-World War II economic growth is a direct result of technical innovation," which is "the principal driving force behind the long-term economic growth and increased standards of living of the world's modern industrial societies."

A new concept emerging with this growing support for expanded R&D appropriations is that R&D spending levels should keep pace with overall economic expansion. That is a critical distinction, because while the civilian R&D budget has been increasing as a percentage of the federal government's discretionary spending, discretionary spending has been shrinking in relative terms. So if federal R&D support is linked to future economic growth, the reasoning goes, that support must be tied to the growth resulting from it—it must be tied to a constant percentage of the economy. That is what Frist-Rockefeller is intended to do.

According to Senate staffers, the legislation also aims to avoid some of the problems that surrounded an earlier effort to boost R&D authorization. That was bill S. 1305, sponsored by Sens. Phil Gramm (R-Texas), Lieberman (D-Conn.), and 17 others. Similarly titled the National Research Investment Act, it would have doubled R&D spending by FY 2008, but did not specify goals for overall policy or accountability.

The problem, staffers said, is that Gramm-Lieberman was assigned to the Senate Labor Committee, where it languished in competition with other legislation deemed more important to committee members. Frist-Rockefeller is under consideration in the Commerce, Science, and Transportation Committee, chaired by Sen. John McCain (R-Ariz.). "We've taken the next step from Gramm-Lieberman," one staffer said. Frist-Rockefeller "lays out a lot more [R&D] policy and provides kind of a business plan for U.S. government-funded research."

That "plan" consists of a directive that the White House Office of Management and Budget (OMB) determine how the overall civilian R&D budget should be distributed each year among the agencies and departments covered by the bill, such as the Departments of Energy and of Commerce, and the National Science Foundation. It also requires OMB to devise an unprecedented set of accountability standards for R&D-funding agencies, and programs falling below acceptable performance levels must be reviewed by their supervising agencies, OMB, and the White House Office of Science and Technology Policy.

Meanwhile, said staffers, the defense science and technology (S&T) budget is "a different problem." Legislators are debating about a range of issues, from procurement to readiness to veterans affairs. Basic S&T funding undoubtedly lacks top priority. The Department of Defense's (DoD) section 6.1 (basic research) budget for FY 1999 is expected to remain unchanged, as it did this year. Recent analyses show that purchasing power of the defense S&T budget in FY 1998 is the lowest it has been in 20 years.

In June, Sens. Jeff Bingaman (D-NM), Rick Santorum (R-Pa.), and Lieberman introduced S. 2081, the National Defense Science and Technology Investment Act of 1998, as the counterpart to Frist-Rockefeller. The bill seeks "for each year from FY00 until FY08, it shall be an objective of the Secretary of Defense to increase the Defense Science and Technology Program budget by no less than 2.0 percent over inflation greater than the previous fiscal year's budget request." Similar language encourages the Secretary of Energy to do likewise for nonproliferation S&T activities.

Senate staffers are blunt about the bill's chances, "If Frist-Rockefeller had included defense spending, it would have been dead in the water." Chances of passage of defense R&D appropriations may be enhanced by packaging essential parts of S. 2081 as amendments to the National Defense Authorization Act for FY 1999.

Sen. Strom Thurmond (R-SC), chair of the Armed Services Committee, had voted against a provision much like S. 2081 when the committee wrote the new authorization bill last May. The problem, staffers said, is that all segments of the DoD budget are strained, which has created a highly competitive situation among committee members. Bingaman-Santorum-Lieberman is viewed as giving the S&T portion of the budget special treatment.

PHIL BERARDELLI

NRC Report Recommends Future R&D for High-Temp Ceramic Matrix Composites

At the request of the Department of Defense (DoD) and the National Aeronautics and Space Administration (NASA), the National Research Council (NRC) conducted a study on the future research and development (R&D) needs to improve the performance of advanced ceramic fibers and fiber coatings for high-temperature ceramic matrix composites (CMCs) with attention limited to fibers and their coatings or interfaces, independent of CMC processing and matrix materials.

The NRC committee, chaired by David W. Johnson of Lucent Technologies/Bell Laboratories, recognizes that the following technical shortcomings of CMCs open research opportunities: Fiber coating needs to be demonstrated for long-life applications, fiber coatings for actual (versus model) oxide composite systems need to be demonstrated, a combination of oxidation resistant fiber coatings and matrix sealing concepts to protect the fiber from oxidation is needed to be tested for longer life non-oxide composites, and microstructural modifications are needed to enhance creep resistance.

The committee places a high priority on making available an engineering database for actual (versus model) CMCs to enable designers to make materials selection decisions. While CMC processing is expensive, and the committee recommends ways to reduce the costs such as developing less expensive fiber precursors, the report said that the current level of technical performance rather than costs has limited CMC applications.

To improve the materials performance, the report recommends investigations for

the development of oxidation-resistant coatings to "enable the development of CMCs suitable for applications that demand longer component lifetimes" such as thermally loaded gas turbine engine components; and the development of a viable interface for oxide CMCs, focusing on "weakly bonded, thermally stable oxide coatings (e.g., rare-earth phosphates of the general formula $M^{3+}PO_4$) [and] the development of oxide composites that do not require fiber coatings (e.g., porous matrices)." To enhance creep resistance, the committee recommends studies on "mechanism(s) by which SiC nanoparticle dispersions inhibit creep in bulk oxide ceramics," the mechanism by which "certain solutes lower the creep rate of bulk polycrystalline oxides (e.g., yttria in alumina)," and the use of "multiphase microstructures to promote increased high temperature microstructural stability (e.g., resistance to grain growth)." Of a lower priority, the committee recommends continued studies on Si-B-N-C amorphous fibers in the area of non-oxide fibers; according to the report, "for many applications, adequate properties have already been attained" in this area.

To obtain a copy of the report, *Ceramic Fibers and Coatings: Advanced Materials for the Twenty-First Century*, contact National Academy Press, Box 285, 2101 Constitution Ave., N.W., Washington DC 20055; 800-624-6242; website http://www.nap.edu. □

PUBLIC AFFAIRS FORUM

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FMS Meeting Addresses Materials R&D Role in the U.S. Scientific Innovation Process

The 15th Biennial Conference on National Materials Policy, held in Georgetown on May 17–19, 1998, addressed the topic, "Maximizing Return on U.S. Research and Development," with a focus on case studies in materials. The conference was sponsored by the Federation of Materials Societies (FMS), an umbrella organization whose members and affiliates represent the professional societies, universities, and National Research Council organizations which are involved with materials science, engineering, and technology.

The topic was chosen for its importance and timeliness. The end of the cold war and the globalization of science, technology, and the marketplace have placed new importance on federal sponsorship of research and development. These global currents have raised new questions about what R&D should be done and who should pay for it. They have already had a profound impact on materials R&D in the United States. They will continue to affect what materials researchers do, how they go about it, and how effective they can be in serving the national interest.

The conference began with overviews from Senator Jeff Bingaman (D-NM); Ray Kammer, Director, National Institute of Standards and Technology; and Joseph Bordogna, Acting Deputy Director, National Science Foundation. These talks stressed the importance of the innovation process and the special role of materials R&D in this process.

Bingaman spoke of his efforts to strengthen R&D overall, providing S. 1305 as an example, which is his co-sponsored bill that would double R&D expenditures over a period of years. He indicated his concern that although overall R&D spending would increase in the President's budget for the next fiscal year, much of that increase would go to the National Institute of Health, with other nondefense spending actually decreasing. He said that half of the U.S. productivity improvement is due to innovation and that the country needs to develop a stewardship model for innovation. He said that the federal government might best help innovation by doing so indirectly, by supporting institutions that foster innovation.

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Some of Bordogna's key points were that major advances in understanding, controlling, designing, and fabricating materials have been made in this century. Materials science and engineering (MSE) has led to exponential improvements in performance of machines and devices and is a basic engine for technologies creating new wealth. Nonetheless, society understands little of what goes into development of new materials and processes, and tends to take materials for granted. New and improved materials and processes will play a central role in improving the future well-being of the United States and the planet.

Arden L. Bement, Jr. (Purdue University) reported on the international MSE benchmarking study he chaired recently ("International Benchmarking of U.S. Materials Science and Engineering Research," National Academy Press, 1988). His study showed that the United States leads in some areas, although not all. He emphasized that the U.S. lead is threatened in several areas. The U.S. innovation process is a major determinant in the country's overall world pre-eminence. Kammer outlined the numerous NIST programs aimed at enhancing innovation in materials and other industries.

Following these introductory addresses, industrial speakers talked about present and projected economic impacts of materials R&D. Praveen Chaudhari (IBM) summarized the incredible and continuing advances in information technology through advances in materials and materials processing. Roger Heimbuch (General Motors) described the important impact of materials technologies on automotive performance and competitiveness of the industry, and discussed the problems encountered in the vital task of introducing new materials and processes into automobile manufacture.

The theme of the difficulty of introducing new materials and processes into the marketplace was echoed by Azusa Tomiura, who headed Nippon Steel's venture into the new materials area. It was further echoed by David Ragone (Ampersand Ventures) who spoke from a venture capitalist's point of view. New materials (and new processes) often take 20 years to successfully reach significant production levels. A simple "present value" calculation shows that a new business based solely on a new material or process is totally uninteresting to a ven-