United States General Accounting Office

GAO

Report to the Committee on Science, House of Representatives

April 2000

FEDERAL RESEARCH

DOE Is Providing Independent Review of the Scientific Merit of Its Research

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Abbreviations

DOE	Department of Energy
GAO	General Accounting Office

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United States General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

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April 25, 2000

The Honorable F. James Sensenbrenner, Jr.
Chairman
The Honorable Ralph M. Hall
Ranking Minority Member
Committee on Science
House of Representatives

Like the scientific community as a whole, federal agencies normally subject their research programs to a peer review process. While there is no precise definition, federal officials have characterized peer review as "a process that includes an independent assessment of the technical, scientific merit of research by peers who are scientists with knowledge and expertise equal to that of the researchers whose work they review." Individual agencies vary in their approach to peer review.

In March 1999, we reported on peer review procedures in 12 federal science agencies, finding that all of them were using peer review to assess research proposals.[1] One of these agencies was the Department of Energy (DOE), which referred to its process as "merit review with peer evaluation." You subsequently asked that we conduct a follow-up study to determine whether DOE had implemented the "merit review" procedures the agency said it had established. You requested that we determine (1) what procedures DOE has established for performing merit reviews and (2) whether DOE could document that it has followed the merit review procedures it has established. As agreed with your offices, the scope of our work was limited to DOE's Office of Basic Energy Sciences in the Office of Science and the Office of Power Technologies in the Office of Energy Efficiency and Renewable Energy. We reviewed the merit review procedures and practices of these two offices and analyzed the merit review files for selected projects and programs at headquarters, one DOE operations office, one DOE field office, and two DOE laboratories.

[1] *Federal Research: Peer Review Practices at Federal Science Agencies Vary* (GAO/RCED-99-99, Mar. 17, 1999).

Results in Brief

Both the Office of Basic Energy Sciences and the Office of Power Technologies have established procedures for merit reviews, setting out what types of review will be performed, who will perform the reviews, what criteria will be used in the evaluations, and how individual reviewers' comments will be used by those making award decisions. The offices differ in the specifics, however, reflecting DOE's belief that a "one size fits all" approach is not appropriate in an agency with components that have such varying research objectives. For example, since the Office of Basic Energy Sciences conducts basic research, it focuses its reviews on the merits of the science and the qualifications of the researchers. In contrast, since the Office of Power Technologies conducts applied research, it focuses its merit reviews on research outcomes and management of the projects and programs. These approaches are consistent with the Office of Science and Technology Policy's view that peer review practices should be flexible and tailored to agencies' missions and types of research.[2]

On the basis of our analysis of programs and more than 150 specific projects funded by the two offices in fiscal years 1998 and 1999, the Office of Basic Energy Sciences and the Office of Power Technologies documented that they were following the procedures they had established for merit reviews. Currently, all projects are reviewed except those that are provided project-specific funding through congressional mandates.

Background

The federal government is a primary source of funding for research and development, which accounted for about $80 billion in the fiscal year 1999 budget. This research is performed by the government's own scientists as well as by external organizations receiving federal financial assistance.

DOE is one of the largest federal agencies funding research, accounting for $7.0 billion in research and development funds in the fiscal year 1999 budget. Research is carried out by universities, nonprofit organizations, and industry through financial assistance awards or by the contractors that operate DOE's national laboratory system. Non-DOE organizations submit proposals for financial assistance in response to solicitations by DOE or

[2]In 1976, the Congress established the Office of Science and Technology Policy to serve as a source of scientific, engineering, and technological analysis and judgment for the President and to assist him in providing leadership and coordination for federal research and development programs.

because they have identified areas of research they wish to pursue and believe are compatible with DOE's research objectives. For the laboratory projects, the laboratory contractors identify the projects they believe need to be carried out by their respective laboratories and combine them into "field work proposals" to DOE for funding consideration.

Within DOE, two of the offices funding research are the Office of Basic Energy Sciences in the Office of Science and the Office of Power Technologies in the Office of Energy Efficiency and Renewable Energy.[3] The two offices differ in their research objectives, however, with the Office of Basic Energy Sciences focusing on basic research, while the Office of Power Technologies focuses on applied research. The purpose of basic research is to obtain greater knowledge of the fundamental aspects of phenomena and observable facts without specific applications toward processes or products. The purpose of applied research is to gain the knowledge or understanding necessary for determining the means by which a recognized and specific need may be met. Said another way, basic research aims at expanding knowledge, while applied research aims at solving practical problems.

The Office of Basic Energy Sciences' mission is to foster and support fundamental research in the natural sciences and engineering that will provide a basis for (1) developing new and improved energy technologies and (2) understanding and mitigating the environmental impacts of energy use. This research is subdivided into four broad subprograms—materials science, chemical science, engineering and geosciences, and energy biosciences. As part of its mission, the Office of Basic Energy Sciences plans, constructs, and operates major scientific user facilities to serve more than 2,400 researchers in universities, other nonprofit organizations, national laboratories, and industry. In fiscal year 1999, the Office of Basic Energy Sciences' research and development budget was $779.2 million. Approximately $639.2 million, or 82 percent, supported research at DOE laboratories, while $134.4 million, or 17.2 percent, went for financial assistance projects funded through grants, contracts, and cooperative agreements. The remaining $5.6 million, or 0.7 percent, went for all other types of projects.

[3]A number of other offices also fund research. Two examples are the Office of Fusion Energy Sciences within the Office of Science and the Office of Industrial Technologies within the Office of Energy Efficiency and Renewable Energy.

The Office of Power Technologies' mission is to work with electric service providers and related industries to advance clean, competitive, and reliable power technologies. The Office of Power Technologies develops renewable energy technologies that use solar, wind, hydropower, geothermal, and biomass energy resources and conducts research and development aimed at creating a hydrogen energy infrastructure. The Office of Power Technologies also develops advanced technologies—including high-temperature superconducting materials, real-time power system controls, and energy storage—that will improve the reliability, energy efficiency, and cost-effectiveness of the nation's electric transmission and distribution systems. Finally, the Office of Power Technologies facilitates the export of renewable energy power generation internationally. The Office of Power Technologies' research and development budget for fiscal year 1999 was $270.7 million. Approximately $181.4 million, or 67 percent, of the funding supported research at DOE laboratories, while the remainder was for financial assistance projects.

Like other federal research agencies and the scientific community in general, DOE supports the use of independent peer review of the research it sponsors. DOE practices peer review as "merit review with peer evaluation," which DOE officials say is a formal, competent, and objective evaluation process using specified criteria and the review and advice of qualified peers. DOE uses merit reviews to guide the direction of research and to assess its progress. DOE defines merit review in 10 C.F.R. 600.3 as "a thorough, consistent, and objective examination of applications based on pre-established criteria by persons who are independent of those submitting the applications and who are knowledgeable in the field of endeavor for which support is requested." These individuals may come from any source, including industry, academia, private and nongovernmental institutions, government agencies, and their associated laboratories.

DOE does not have a single agencywide set of policies and procedures for merit reviews. Rather, there are specific procedures set out for the agency's various programs and functions. According to the Deputy Secretary of Energy, DOE's research grants, cooperative research and development, and other financial programs supporting research and development are governed by policies—including guidance on merit reviews—set out in 10 C.F.R. parts 600 through 605. Similarly, for research and development programs conducted through contractual mechanisms and competitive procurements, policies and procedures requiring objective review are established by statute, regulation, practice, and culture. The laboratories

are expected to apply merit review procedures as set out in the agreements between DOE and the laboratory contractors.

Our March 1999 report on peer review practices in 12 federal science agencies contained an appendix on DOE. We have included the information on DOE in appendix I of this report.

DOE Offices Have Established Differing Procedures for Performing Merit Reviews

Both the Office of Basic Energy Sciences and the Office of Power Technologies have established merit review procedures for their research programs. The specific procedures vary between the two offices, however, reflecting DOE's view that merit reviews should be tailored to the specific office or program involved rather than having a "one size fits all" policy agencywide. This view is consistent with the Office of Science and Technology Policy's belief—as discussed in our earlier report—that peer review practices should be flexible and tailored to agencies' missions and types of research.

Office of Basic Energy Sciences

The Office of Basic Energy Sciences requires that all of its research—except for projects mandated by the Congress—be subjected to merit review prior to being funded. The Office of Basic Energy Sciences' primary objective in these merit reviews is to "provide an independent assessment of the scientific and/or technical merit of research by peers having knowledge and expertise equal to that of the researchers whose work they review."

The Office of Basic Energy Sciences' merit reviews are project-specific. The reviewers normally are persons familiar with the science required by the project but not closely associated with the particular research or organizations involved in the research. The criteria used by the reviewers in evaluating the proposals are set out in the regulations and DOE's published procedures and are essentially the same for each review. The reviewers normally provide independent evaluations in narrative form.

Reviews Are Project-Specific

The Office of Basic Energy Sciences' policy is to perform a project-specific merit review prior to awarding funds for any financial assistance or laboratory project unless that project was mandated by the Congress. In fiscal year 1998, there were no congressionally mandated projects in the Office of Basic Energy Sciences' research budget of $645 million. In fiscal year 1999, the Office of Basic Energy Sciences' research budget of $779.2

million included only one congressionally mandated project, accounting for $487,000, or 0.06 percent of the overall budget.

According to procedures issued by the Office of Science, financial assistance awards—which typically are awarded for multiple years—are to be merit-reviewed before original approval and at every renewal. While the merit review on a renewal can be waived, no financial assistance project may be renewed for more than 6 years without a review. The Office of Basic Energy Sciences provides that laboratory projects funded through field work proposals are to be merit-reviewed prior to approval and generally every 3 to 4 years thereafter. Under certain circumstances, the Office of Basic Energy Sciences may allow laboratory projects to be extended up to 6 years without additional merit reviews.

Officials from the Office of Basic Energy Sciences noted that the office's research projects are often subject to other types of external review. One of these is the peer review process to which scientific papers are subjected before they can be included in scientific journals. These constitute peer reviews in their own right and also are made available to the merit reviewers selected by the Office of Basic Energy Sciences for their use in evaluating the projects in question.

Reviewers Have Expertise in the Science Rather Than in the Specific Area of Research

An Office of Basic Energy Sciences merit review team must comprise three or more professionally and technically qualified persons, and the reviewers themselves must be free from conflict of interest.[4] Office of Basic Energy Sciences officials told us that program managers—who typically choose the reviewers—must keep their knowledge current in the fields in which they work. This would include knowing who is qualified to serve as a merit reviewer and being familiar with their previous reviews. Over time, the Office of Basic Energy Sciences has developed a cadre of reviewers that it can call on to carry out specific reviews. The reviewers receive no additional pay but may be reimbursed for travel expenses.

The Office of Basic Energy Sciences prefers to use merit reviewers from outside DOE. While they did not have a precise definition of what constitutes a conflict of interest for outside reviewers, Office of Basic Energy Sciences officials said that they would not use any persons who

[4]According to 10 C.F.R. 605.10, reviewers are to be selected "on the basis of their professional qualifications and expertise" and are "to comply with all applicable DOE rules or directives concerning the use of outside evaluators."

themselves were submitting a grant proposal for the project under review. However, they might choose another employee of the same organization if he or she was sufficiently removed from the project. For example, if a university submits a proposal for a grant, a reviewer could be from the same university but not from the same department that would be performing the research.

For both financial assistance and laboratory projects, procedures issued by the Office of Science and the Office of Basic Energy Sciences would exclude as reviewers DOE or laboratory contractor personnel from the same laboratory or from another laboratory working on the research in question. DOE employees could not be reviewers if they were the contracting officer or were responsible for managing, auditing, or providing technical assistance on the project in question.

The Office of Basic Energy Sciences conducts each merit review using one of four basic methods:

- *Field readers*. Under this method, Office of Basic Energy Sciences program managers send project packages to three or more reviewers. The reviewers then return written comments to the program manager. The readers do not have contact with one another. This method can be used for both financial assistance proposals and laboratory projects.
- *On-site or off-site panel reviews*. The Office of Basic Energy Sciences may request three or more reviewers to meet as a panel to evaluate laboratory projects. The reviewers are required to document their findings to the program manager.
- *Standing committees*. The Office of Science has the authority to establish and use a standing committee to review financial assistance projects. The choice of a standing committee is appropriate when required by legislation or when (1) there are enough applications on specific topics received on a regular basis, (2) there are persons available on the committee to serve as reviewers, or (3) the legislative authority for the project involved extends beyond 1 year.
- *Ad hoc committees*. The Office of Basic Energy Sciences may use ad hoc committees when it determines that a proposal for either a financial assistance or laboratory project has special review requirements. Such requirements might include construction or facility operation; subject matter complexity involving several areas of expertise; consideration of several projects on a similar topic; or a subject matter of a special nonrecurring nature.

Review Criteria Are Standardized

The Office of Basic Energy Sciences uses standardized criteria for its merit reviews. The criteria that reviewers are to consider for financial assistance proposals are set out in 10 C.F.R. 605.10, in descending order of importance, as follows:

- scientific and/or technical merit or the educational benefits of the project,
- appropriateness of the proposed method or approach,
- competency of applicant's personnel and adequacy of proposed resources,
- reasonableness and appropriateness of the proposed budget, and
- other appropriate factors established and set forth by the Office of Science in a notice of availability or a special solicitation.

The criteria for performing merit reviews on laboratory projects are set out in Office of Basic Energy Sciences procedures and mirror those set out for financial assistance projects. The only differences are that (1) the first criterion for laboratory projects omits the terminology "educational benefits of the project," (2) the final criterion is worded "other appropriate factors established and set forth by the Office of Basic Energy Sciences," and (3) the criteria do not specify their order of importance.

Office of Basic Energy Sciences officials said that the use of standardized criteria is essential because each proposal involves basic research and is evaluated on its own merit. The Office of Basic Energy Sciences' concern is that each project is "good science," that an organization submitting a proposal is qualified and capable, and that merit reviewers look at each project in the same manner.

Reviewers Provide Independent Narrative Assessments

Office of Basic Energy Sciences merit reviewers are required to provide a written evaluation or analysis to the program manager. Reviewers are independent and, in preparing their narrative comments, are not required to follow any particular format or even comment on each of the individual criteria. Reviewers normally do not assign numerical scores or rank proposals against one another. Also, reviewers normally do not provide a consensus analysis of the proposals. In the case of field readers, the reviewers do not even know who the other reviewers were or what they reported. In the case of panels, there may be a summary of the individual reviewers' reports.

The program manager is responsible for providing a narrative analysis and funding recommendation on each proposal to the selecting official. While

the program manager uses the merit reviewers' comments in making his or her own decision and includes a summary of the comments in the narrative, he or she does not show a consensus of the reviewers' views. Instead, according to Office of Basic Energy Sciences officials, the program manager considers the quality of the technical insights in each reviewer's comments. The program manager also considers the reviewer's reputation and expertise as well as the program manager's previous experience with the reviewer. For example, a short paragraph from a highly respected expert in the area might carry more weight than several pages from a less experienced scientist. In addition, the program manager must consider the reviewers' reports in comparison with one another.

Office of Power Technologies

As with the Office of Basic Energy Sciences, Office of Power Technologies research projects—other than those mandated by the Congress—are subjected to merit review prior to being funded. Generally, Office of Power Technologies projects and programs are reviewed annually as a part of the individual program reviews used to formulate annual operating plans. In addition, financial assistance projects and competitively bid laboratory subcontracts are subjected to their own merit reviews.

The Office of Power Technologies differs from the Office of Basic Energy Sciences in its approach to merit reviews. Office of Power Technologies officials said that because they focus on applied rather than basic research, the scientific merit of a program or project normally has already been established. They are more concerned with whether the research will achieve the desired objectives and thus concentrate merit reviews on the anticipated results of the research and management of the program or project. To this end, the reviews tend to be program-oriented, rely on persons and panels with specific knowledge in the particular field of research, use review criteria that are designed specifically for the project or program under review, and make use of numerical scoring and consensus reporting.

Reviews Are Program-Oriented and Multilevel

The Office of Power Technologies takes an integrated programmatic approach to merit review, and research projects are subjected to merit review at multiple points in the planning process. These include the long-range plan for determining where the technology is headed, multiyear and annual plans for establishing DOE program direction, and the award process for individual projects.

As a part of its long-range planning efforts, the Office of Power Technologies develops "technology road maps" for individual programs to define how the technology is expected to develop over some period. The driving force for the road map is the industry—for example, wind, photovoltaics, superconductivity—behind the particular technology. Generally, the road map is put together by persons in the top echelons of the industry with input and assistance from the Office of Power Technologies. The period covered by the road map depends on the technology and the window for its development. In the photovoltaics area, for example, the road map covers 20 to 25 years, as the technology is still being refined and developed. The road map in the superconductivity area is much shorter—about 5 years—as there is a better idea of the end result and what is needed to get there.

In addition to the technology road maps, the Office of Power Technologies develops multiyear plans that set out goals, objectives, and strategies over a shorter period of about 5 years. The multiyear plan is developed by the office with industry input and review. Office of Power Technologies officials said that both the technology road maps and the multiyear plans are a form of peer or merit review—although not labeled as such—because they involve outside experts helping the office determine its research priorities and objectives.

Because of its focus on applied research, the Office of Power Technologies' merit review process includes annual programmatic reviews as well as individual project reviews. In addition, peer review of various long-range planning documents for each of these programs is also considered part of the merit review process.

The Office of Power Technologies has 12 programs—solar buildings, photovoltaics, concentrating solar power, wind energy, geothermal, hydropower, biopower, high-temperature superconductivity, hydrogen, energy storage, transmission reliability, and distributed power—funding research by DOE laboratories and external organizations. The Office of Power Technologies develops annual operating plans for each program that, among other things, set out particular research projects that are to be added, modified, or dropped. Prior to developing the plan, the officials' practice is to conduct program reviews of the individual programs and their projects. While these reviews vary in format among the programs, the general approach is to assemble cognizant DOE, DOE laboratory contractor, and industry personnel at a common location and have the individuals responsible for the various projects make presentations and

answer questions raised by the persons in attendance. As part of this process, the Office of Power Technologies puts together a panel charged with rating each project on its own merits and in comparison with the other projects. This review—which in effect constitutes merit review for the individual projects as well as the entire program—is then made available to the Office of Power Technologies management to develop the annual operating plan and decide the budget for various projects.

For financial assistance awards, the Office of Power Technologies in the Office of Energy Efficiency and Renewable Energy requires a merit review on each specific project. Prior to May 1998, this often was the case only for competitive awards. However, in response to congressional concerns about the number of noncompetitive awards it was making, the Office of Energy Efficiency and Renewable Energy changed its procedures to encourage more competitive awards. This change resulted in the Office of Power Technologies' reducing the level of noncompetitive awards from 14 percent in fiscal year 1998 to 5.9 percent in fiscal year 1999. Also, in May 1998, the Office of Energy Efficiency and Renewable Energy reemphasized, through a *Federal Register* notice, the requirement that all discretionary financial assistance awards are to be subjected to merit reviews regardless of whether they are competitive or noncompetitive.

For research conducted by DOE laboratories, individual projects normally are not merit-reviewed separately because, according to Office of Power Technologies officials, they already have been subjected to the program review process. If the laboratory subcontracts part of the research, these subcontracts typically are subjected to merit reviews if the subcontracts are competitively bid. Noncompetitive subcontracts generally are subjected to reviews by the laboratory management team only.

Office of Power Technologies officials said that they did not require merit reviews of congressionally mandated projects. Such projects accounted for 9.4 percent of the office's research budget in fiscal year 1998 and 6.7 percent in fiscal year 1999.

Office of Power Technologies officials stressed that there are many other occasions on which programs or projects may be subjected to merit review on an ad hoc and postaward basis. In 1994, for example, a review team from what is now the Office of Science performed a review of 115 research projects sponsored by the photovoltaics program. Similarly, program or laboratory management may convene a special merit review team at any time they believe they need the assistance. Also, papers on research results

submitted for publication normally are subjected to a rigorous peer review process by the scientific journals to which they are submitted.

Reviewers Have Expertise in the Specific Area of Research

As with the Office of Basic Energy Sciences, an Office of Power Technologies merit review team must comprise three or more persons who are competent and free from any conflict of interest. Unlike the Office of Basic Energy Sciences, however, the Office of Power Technologies requires that its reviewers be more closely aligned with the field of research and makes greater use of DOE and laboratory contractor personnel.

Office of Power Technologies officials said they choose team members knowledgeable about the program or project in question because team members need to be familiar with the specific research and with the persons or organizations involved in the research. While they did not have a precise definition of what would constitute a conflict of interest, they said it did not mean that individuals who worked in a related area would be precluded from serving as reviewers. They said they would not use a person who worked for one of the organizations competing for the award nor would they use the selecting official, as these persons would not be sufficiently removed from the process and would have a potential conflict of interest. Each reviewer is required to sign a statement that he or she is free from conflicts of interest on the subject review.

Office of Power Technologies officials said they normally require that the merit review team members meet as a panel, regardless of whether the merit review is for a program or a project. The teams can vary in size, normally depending on the scope of work they are asked to perform and the complexity of the project or program. Except in limited instances, the team members receive no additional compensation but may be reimbursed for travel expenses. In general, the Office of Power Technologies attempts to group reviews and other meetings in such a way that the additional expense of a particular merit review is kept to a minimum.

Review Criteria Vary by Program and Project

Unlike the Office of Basic Energy Sciences, the Office of Power Technologies does not require its reviewers to apply standardized criteria in evaluating programs and projects. Rather, Office of Power Technologies or laboratory officials set criteria tailored to their needs on the particular merit review. Office of Power Technologies officials said that each program and project is different and that the flexible criteria are consistent with having reviews aimed at evaluating projects for their ability to achieve the desired results. However, they noted that typical evaluation criteria

frequently focus on the project's approach, the technical merit of the project, and the capabilities of the applicant and key personnel.

Panels Provide Numerical Scores and Consensus Views

Unlike the Office of Basic Energy Sciences, the Office of Power Technologies generally requires that its merit reviewers use numerical scoring sheets and that the panels tabulate the results and reach consensus opinions. The results are to be summarized by the leader of the team and provided to the selecting officials, who then use them in making the final selections.

Office of Power Technologies officials said that they believe numerical scoring and consensus opinions add consistency to the reviews. Otherwise, someone else has to interpret how the reviewers rated the project. By using numerical scoring, the reviewers are better able to identify their differences, both in perception of the applicant's qualifications and the relative scale used by each reviewer. This is helpful in discussions and reaching consensus opinions.

The summary prepared by the team for a program review or a competitively bid award typically ranks the various applicants in comparison with each other. In some cases, the reviewers may be asked to set cutoff points to show which applicants the reviewers thought were qualified to receive an award.

DOE Is Following the Merit Review Procedures It Has Established

On the basis of our review of available documentation from program and project files for fiscal years 1998 and 1999, the Office of Basic Energy Sciences and the Office of Power Technologies are following the merit review procedures they have established. Both offices are performing merit reviews on projects or programs, are selecting reviewers with the requisite knowledge of the research, are requiring those reviewers to apply appropriate criteria in making their evaluations, and are using the merit review evaluations in making award decisions. The two offices vary, however, in the methods they employ to achieve these results.

Two recently issued internal studies—one by DOE's Inspector General and the other by DOE's Laboratory Operations Board[5]—agree with our findings that DOE is following its merit review procedures. The Board suggested ways for DOE to standardize and strengthen its management of the review process, but according to the Deputy Secretary of Energy, DOE has elected to maintain its policy of having flexible procedures that can be adapted to the needs of the particular offices.

Office of Basic Energy Sciences

In our analysis of documentation for 100 randomly selected projects funded in fiscal year 1998 by the Office of Basic Energy Sciences, we found that 96 had been subjected to a merit review. The remaining four were not reviewed because, according to office officials, the regulations would not have subjected these projects to merit reviews at the time they were awarded. Many of the projects we reviewed had been subjected to more than one merit review because they were ongoing projects and subject to additional reviews on a 3- to 4-year cycle. Overall, we identified 216 separate merit reviews on the 96 projects.

The merit review files on the projects we selected did not include specific information showing why the reviewers chosen were considered to have the proper technical qualifications. However, they generally did show the organizations with which the reviewers were affiliated, and these organizations—such as domestic and foreign research universities, DOE laboratories, other federal laboratories, and for-profit corporations—would have had expertise in the broad areas of science involved in the research. Overall, 48 of the 96 projects that were merit-reviewed included at least one reviewer from a DOE laboratory, 12 included at least one reviewer from another federal agency, and 91 included at least one reviewer from another organization, such as a university. In most cases, the project files we reviewed did not include conflict of interest statements from reviewers because the Office of Basic Energy Sciences did not require such documentation. However, the files did indicate that the reviewers were external to the organizations submitting the proposals and thus appeared to meet the Office of Basic Energy Sciences' requirements on conflict of interest.

[5]In April 1995, the Secretary of Energy established the Laboratory Operations Board to provide focused, regular attention to issues facing DOE's laboratory complex.

For each of the 96 projects in our sample for which the Office of Basic Energy Sciences performed a merit review, the project file included documentation indicating that at least three reviewers were involved in the evaluation. The files also generally included the reviewers' written evaluations of the proposals. In cases in which the individual written evaluations were not in the file, there was other documentation—such as the program manager's summary—indicating that individual written evaluations had been submitted. Even though the evaluations varied in form and content, the reviewers generally addressed the specific criteria established by DOE's regulations and procedures.

Office of Power Technologies

Like the Office of Basic Energy Sciences, the Office of Power Technologies was following its merit review procedures, based on our review of program and project files for projects funded in fiscal years 1998 and 1999. The primary mechanism was the program review. In fiscal year 1999, for example, the Office of Power Technologies performed program reviews on 10 of its 12 programs. The remaining two programs were not subjected to merit reviews because they were in the early stages of development. Each of the 10 program reviews used panels of experts that reviewed all of the projects in the particular program. Six of the panels assigned numerical scores.

The Office of Power Technologies also was performing separate, preaward merit reviews on all financial assistance projects we reviewed that were funded since May 1998. This was consistent with the Office of Energy Efficiency and Renewable Energy's publication of a notice in the *Federal Register*, as discussed earlier, requiring that all future awards for financial assistance be merit-reviewed, regardless of whether they were competitively bid.

At the two DOE laboratories we visited, the laboratory contractors were conducting merit reviews of subcontracts only if they were competitively bid. Any reviews of noncompetitive subcontracts were carried out by laboratory management personnel in charge of the projects. The reasons given by officials from the Office of Power Technologies and the laboratory contractor for not having outside panels review noncompetitive subcontracts were that (1) the awards were normally small, (2) the projects had already been merit-reviewed in the program review of which the subcontract was a part, (3) the laboratory contract itself was competitively bid and subject to merit review, and (4) the laboratory contractor was charged with following "best practices" in making the award and was in the

best position to determine the merits of the project and the qualifications of the subcontractor.

The Office of Power Technologies is not required to include specific information in its files showing why particular reviewers were selected or why they were considered to have the requisite expertise. However, the files for the 52 projects we reviewed did show the organizations and DOE units from which the reviewers came, and we found that the panels were made up of individuals who had an association with, but not a direct involvement in, the research or organizations that were the subject of the reviews. We also found that the reviewers were required to sign statements showing they had no conflicts of interest and that these statements were included in the project files. The Office of Power Technologies used merit reviewers from diverse backgrounds. As would be expected for applied research, a larger proportion of the reviewers on the Office of Power Technologies projects we reviewed came from the DOE laboratories involved in the specific or related research.

The criteria used by the Office of Power Technologies' reviewers in evaluating proposals were more extensive than those used by the Office of Basic Energy Sciences, required reviewers to consider a range of ranking factors, and focused on anticipated results and management capabilities. For example, in one financial assistance solicitation for a photovoltaics research project in fiscal year 1998, the Office of Power Technologies set out 21 separate categories in which proposals were to be ranked by the merit reviewers. These were grouped into broader areas such as identification and description of the proposed project; statement of work for the proposed product and applications development; applicant and participant roles, capabilities, and organization; market potential; and commercialization.

The project files we analyzed included individual reviewers' evaluations as well as summaries of the panels' comments. An individual reviewer's evaluation typically showed the score the reviewer assigned to each dimension of the criteria as well as any narrative comments the reviewer believed were warranted. Similarly, the summary showed a consensus score for each proposal as well as a narrative showing the panel's overall assessment. Typically, the summary included a ranking of the projects, showing the recommended order of funding.

DOE's Internal Studies of Merit Review

Two internal DOE studies produced findings that are consistent with our own on the agency's use of merit reviews. Both the Inspector General and the Laboratory Operations Board have issued reports concluding that DOE has established merit review procedures and applied them consistently.

In April 1998, DOE's Inspector General issued a report on merit review programs at three DOE laboratories—the National Renewable Energy Laboratory, the Pacific Northwest National Laboratory, and the Los Alamos National Laboratory. The Inspector General concluded that DOE had established and was managing a peer review process for scientific and technical projects at the three laboratories.

In March 1999, DOE's Laboratory Operations Board issued a report on DOE's overall use of merit reviews. The report noted that DOE was making broad use of merit reviews in all areas of research and that these reviews appropriately use review mechanisms that match the specific objectives of individual programs and projects. The report supported DOE's practice of having different merit review procedures for individual offices and programs, stating that a "one-size-fits-all approach would undermine the legitimacy of the evaluation."

The report concluded that DOE should follow through on earlier commitments it made to strengthen its management of the review process. Some of these commitments were as follows:

- establishment of guidelines for conducting reviews at various levels of management,
- periodic and random sampling of the use and effectiveness of the reviews, and
- development of a process for linking review principles and methods to other evaluation activities.

The report also noted that the reestablishment of the Office of Program Analysis within the Undersecretary's Office would help institutionalize these commitments and serve as a resource for program offices and laboratories. The report said general agreement should be reached on how to characterize the different types of merit review, noting that having a common lexicon would help DOE better explain its extensive use of reviews.

In a February 18, 2000, letter responding to our request for information on DOE's response to the Laboratory Operations Board's report, the Deputy

Secretary of Energy stated that DOE was generally supportive of the report's findings that DOE was using merit reviews throughout the agency. He also said that the report underscores DOE's position that the application of merit reviews must be flexible and tailored to the nature of the individual research and development programs, performers, missions, and objectives. However, he did not see the need for additional guidance for different levels of management or a centralized authority or office directing the merit review process, as suggested by the Board.

The Deputy Secretary said that, in accordance with these views, no additional periodic or random sampling of the use and effectiveness of merit review has been initiated since the Board issued its report. He would not rule out the possibility of such activities in the future. He said that the other proposals made by the Board were best considered and implemented at the program level, where differences in the nature of research and mission objectives best determine the specifics of merit review procedures.

Agency Comments

We provided a draft of this report to the Department of Energy for its review and comment. The Department concurred with our report, stating that it accurately describes the various types of peer reviews that the Department uses to manage its programs and provides a good description of the differences in peer review and merit review strategies that are used between the basic science and applied science programs. The full text of the Department's comments is in appendix II.

Scope and Methodology

Our work focused on the Office of Basic Energy Sciences within the Office of Science and the Office of Power Technologies within the Office of Energy Efficiency and Renewable Energy. We reviewed policies and files at the two offices' headquarters in Germantown, Maryland, and Washington, D.C.; the Golden Field Office in Golden, Colorado; the Oak Ridge Operations Office in Oak Ridge, Tennessee; the National Renewable Energy Laboratory in Golden; and the Oak Ridge National Laboratory in Oak Ridge. Our review focused on nondefense projects.

To determine what procedures DOE has established for performing merit reviews, we obtained information describing these procedures for the selected program offices, operations and field offices, and laboratories. We also interviewed DOE and laboratory officials, analyzed formal and

informal policies and procedures, and reviewed merit review documentation in program and project files.

To determine whether DOE has followed the merit review procedures it has established, we selected Office of Basic Energy Sciences and Office of Power Technologies program and project files at DOE headquarters, operations and field offices, and laboratories for detailed examination. Our examination efforts focused on those projects that had been funded in fiscal years 1998 and 1999. Because Office of Basic Energy Sciences files are maintained in Germantown, Maryland, we were able to randomly select 100 files for review from the 1,289 projects that were funded in fiscal year 1998. Our review of the Office of Basic Energy Sciences files consisted of examining them for documentation in accordance with established merit review criteria in the regulations and DOE procedures. The projects in our sample of 100 had the following characteristics:

- Seventy-five projects were financial assistance awards funded through grants, 24 were laboratory projects funded through field work proposals, and 1 was a laboratory project mandated by the Congress.
- Sixty-nine of the award recipients were institutions of higher education, 25 were DOE laboratories, 5 were other nonprofit organizations, and 1 was a small business.
- Ninety-seven of the projects were ongoing projects, while three were being funded for the first time.

Within the Office of Power Technologies, we could not make a random selection of project files because the files were not centrally located. However, during our visits to the one field office, one operations office, and two laboratories, we judgmentally selected and reviewed 52 Office of Power Technologies projects funded in fiscal year 1998. We also reviewed the most recent program reviews through fiscal year 1999 for various Office of Power Technologies programs. As with the Office of Basic Energy Sciences, our review of the Office of Power Technologies files consisted of examining them for documentation in accordance with established merit review criteria in the regulations and DOE procedures.

Overall, we focused our review efforts on whether documentation existed to demonstrate that DOE was following the merit review procedures it has established. We did not assess the quality or use of the merit reviews performed. Because our work was limited to project files from the Office of Basic Energy Sciences and the Office of Power Technologies, the results cannot be projected agencywide. The results from our review of 100 Office

of Basic Energy Sciences files can be generalized to all 1,289 of the office's projects funded in fiscal year 1998, however, as the projects selected were a random sample of the 1,289 projects in the universe. The maximum margin of error for estimated proportions is plus or minus 10 percent at the 95-percent confidence level.

We also obtained information on prior reviews of DOE's merit review process by internal DOE organizations, including the Office of the Inspector General, and the status of any recommendations made in such reviews.

We conducted our work from June 1999 through March 2000 in accordance with generally accepted government auditing standards.

As arranged with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies of the report to the appropriate House and Senate committees; interested Members of Congress; the Honorable Bill Richardson, the Secretary of Energy; the Honorable Jacob J. Lew, Director, Office of Management and Budget; and other interested parties. We will also make copies available to others on request. If you or your staff have any questions or need additional information, please call me at (202) 512-3841.

(Ms.) Gary L. Jones
Associate Director, Energy,
Resources, and Science Issues

Overview of Merit Review Practices in the Department of Energy

The information in this appendix was included in our March 1999 report, *Federal Research: Peer Review Practices at Federal Science Agencies Vary* (GAO/RCED-99-99). The term "peer review" is used throughout—even though DOE commonly uses the term "merit review" in referring to its own procedures—because the report from which the appendix was extracted was comparing peer review practices among 12 agencies.

Peer Review Practices at the Department of Energy

The following presents a description of the U.S. Department of Energy's (DOE) peer review and other quality assurance review practices.

Created in 1977, DOE's mission is to foster a secure and reliable energy system that is environmentally and economically sustainable, to be a responsible steward of the nation's nuclear weapons, to clean up its facilities, and to support continued U.S. leadership in science and technology. The agency conducts research and development on a variety of topics, including fossil, fusion, and nuclear energy production; energy conservation; renewable energy; biological and environmental research; materials science; engineering and geoscience; advanced computing; high-energy and nuclear physics; nuclear waste management; environmental remediation; radiation; nuclear stockpile management; nuclear nonproliferation; and the Human Genome Project.

DOE's research can affect a broad spectrum of federal policies and regulations. For example, DOE generates federal energy-efficiency rules for the manufacture, testing, and labeling of major home appliances and certain commercial products. The Environmental Protection Agency's Office of Radiation Protection and the Nuclear Regulatory Commission have used the results of DOE's research as part of the background used to set radiation standards. In addition, agency research was used to set standards for mobile pollution sources and fuel regulations under the Motor Vehicle Information and Cost Savings Act.

DOE's research and development budget for fiscal year 1999 is $7.8 billion. Approximately 80 percent of the budget will support research, research facilities, and related activities within the Department and its national laboratory system. The remaining 20 percent will support external research conducted by industry, universities, public and private research institutions, not-for-profit organizations, and research and development consortia through Department-awarded grants, cooperative agreements and contracts, and laboratory-awarded research subcontracts.

Because of its diversity, DOE's peer review practices are guided by a variety of laws and regulations. The Federal Acquisition Regulation, the DOE Acquisition Regulation, and the Competition in Contracting Act guide the agency's peer review practices for research and development contracts. Research grants and cooperative agreements, which are awarded through a merit-based selection process, follow the Department's Financial Assistance Rules, as promulgated in the Code of Federal Regulations (10 C.F.R. Part 600).

Peer Review Definition

DOE has no formal definition of peer review, but practices peer review as merit review with peer evaluation—a formal, competent, and objective evaluation process using specified criteria and the review and advice of qualified peers. Peers must be technically competent in the scientific or technical field under review and must be free from conflict of interest. Peers may come from any source, including industry, academia, private and nongovernmental institutions, government agencies, and their associated laboratories.

Peer Review Practices

DOE uses merit review with peer evaluation to guide research direction and to assess research progress. External research is peer-reviewed in conjunction with the preaward competitive selection process. This research is also reviewed as part of the award renewal process. Reviews of laboratory research occur at both the laboratory and departmental oversight levels. In addition, laboratories, user facilities, and major research divisions have committees of outside experts that provide periodic peer reviews of research relevance and quality. Research results are also extensively published in peer-reviewed journals. The methods for conducting reviews are tailored to each situation. The following provides examples of the different peer review practices among DOE's programs.

Reviews of Research Proposals

With few exceptions, merit review with peer evaluation guides DOE research, including that by its research laboratories. For example, regulations governing the Financial Assistance Program require peer review and competitive selection. The regulations specify that each grant proposal normally receive a minimum of three reviews per proposal by technically qualified experts in the proposed field, followed by a peer review panel. Proposals are peer-reviewed for scientific excellence. The Office of Science and Technology, in the Environmental Management Program, Project Selection Reviews, for new research and development activities, combine the judgments of technical peers and potential users of

the results. In addition, research subcontracted by DOE's national laboratories to outside researchers is governed by contract provisions, unless otherwise justified through formal documentation. These provisions require competitive selection processes, including merit review with peer evaluation.

Peer review is applied to the selection and approval of most laboratory field work proposals. Field work proposals are the means by which the laboratories formally propose future work and seek authorization for expending research and development funds. In the Office of Science, all field work proposals are required to be peer-reviewed for quality by external, independent experts. Each laboratory research program is reviewed annually. For example, the Technology Development Program of the Office of Environmental Management uses teams of subject matter specialists from technical, regulatory, business, and stakeholder perspectives. In addition, peer review is used to allocate available time and to select the experiments conducted at specialized research facilities located at DOE's laboratories. Such facilities include accelerators for the study of high-energy physics and the world's most powerful computers and lasers.

At the laboratories, each director's discretionary research and development program and the laboratory field work proposals are reviewed. The Laboratory Directed Research and Development Program provides certain laboratory directors discretionary funds (up to 6 percent of their laboratory's budget) to develop new scientific ideas and opportunities and to initiate new directions. The laboratories rely on individual scientific investigators and the scientific leadership of the laboratory to identify opportunities that will contribute to scientific and institutional goals.

Reviews of In-Progress Research

Peer review is also used in conjunction with the evaluation of ongoing research. While the substance of the reviews is similar, such as considering the quality and relevance of the research and the investigator's or research group's record of accomplishment, the nature of the reviews can differ. For example, the Office of International Health Programs uses independent, external review panels to conduct in-progress reviews. The Office of Science and Technology within the Environmental Management Program conducts technical reviews of continuing projects in their third year of support or when reaching engineering demonstration, or when considered a new start, through a formal process externally managed by the American Society of Mechanical Engineers. The Society selects reviewers who assess technical excellence, relevance, progress, and productivity. In addition, for

new environmental-management technologies, mid-year progress reviews are held annually for each program element, with potential users assessing the applicability and performance requirements.

Reviews of Publication

Publication in open literature constitutes another form of peer review. Publication of original work is considered essential at DOE, and the scientists it supports (both external and internal) are continually evaluated by the quality of their original research, as indicated, in part, by publications in archival, peer-reviewed journals.

Other Peer Reviews

Retrospectively, scientists who are independent of the laboratory conduct reviews of laboratory research in conjunction with program reviews and advisory committee oversight. These reviews provide advice on the quality, relevance, and productivity of laboratory-conducted research. The following are three examples of such reviews.

- The Office of Science regularly conducts retrospective peer reviews of research and development programs throughout the Department, which include an evaluation of a sampling of research projects. Individual programs also conduct reviews.
- The Office of Defense Programs uses an Inertial Confinement Fusion Advisory Committee, constituted under the Federal Advisory Committee Act, which reports directly to the Assistant Secretary for Defense Programs, to assess program results. For highly classified research, the Department interacts with the Department of Defense for customer feedback on program performance.
- The Office of Civilian Radioactive Waste Management uses peer review to help assess the quality and validity of completed technical work and to ensure the quality of data for use in adjudicatory hearings. Because of the U.S. Nuclear Regulatory Commission's role under the Nuclear Waste Policy Act, the Commission has provided guidance on the conduct of peer review. A primary selection criterion for peer reviewers is independence. When there is a potential or an apparent conflict of interest that may bring the independence of a participant into question, a documented rationale is included in the peer review report.

Other Agency Quality Assurance Reviews

Many of DOE's energy technology development and related research and development programs are deliberately designed to accommodate industrial partners. In various ways, these industrial partners provide opportunities for external merit review by engaging themselves as full participants in planning, executing, and commercializing the research and

development. Such reviews extend beyond the peer review procedures that characterize science programs. For most major technological development programs, the formulation and enforcement of a comprehensive Quality Assurance Program is required. For the Energy Efficiency Program, quality control involves three stages: peer review for basic research, merit review for applied research, and market review for judging commercial application.

Under reforms begun in 1994, all of the Department's new contracts for the management and operation of its national laboratories require regular, performance-based merit reviews of the contractor's performance. Colleagues, laboratory superiors, and administrators at DOE headquarters evaluate the research and development projects. The nine multiprogram national laboratories also have various industrial advisory panels to review research. In addition, all research subcontracted by the laboratories to outside researchers is governed by contract provisions that generally require periodic evaluations of the subcontractor's performance.

Panels constituted under the Federal Advisory Committee Act frequently advise DOE program administrators on program content, quality, future directions, and priorities. For example, the Office of Science uses advisory committees for recommendations on the Office of Basic Energy Sciences, biological and environmental research, high-energy physics, nuclear sciences, and fusion energy. Similarly, the Office of Civilian Radioactive Waste Management has standing advisory committees and just completed a 2-year participatory peer review.

For classified nuclear weapons design-related research, where no broad industrial, university, or other independent source of expertise exists, a process of merit review exists within DOE's Defense Programs laboratories. For example, every 5 years, with annual updates, the three Defense Programs laboratories review the nuclear weapons in the active stockpile through a formal internal peer review Weapons Appraisal Process. The University of California, the contractor that operates the Lawrence Livermore and Los Alamos laboratories, also uses a President's Council Panel on National Security to assess the nuclear weapons program. Each of the laboratories' directors also appoints review committees for each of the laboratories' divisions, with members coming almost exclusively from industry and academia but sometimes from DOE and its contractors. The committees report to the laboratory directors with an assessment of the division's technical and scientific quality. The directors, in turn, file a self-assessment with a review council convened by the

president of the University of California. From this process, the president reports to DOE on the laboratories' technical and scientific quality. Finally, additional reviewing bodies such as JASON (a civilian science advisory group), the National Academy of Sciences, the Nuclear Weapons Council, and other senior advisory groups review DOE's Defense Programs' research and development program.

Research Not Subject to Review

According to DOE officials, most congressional mandates and earmarks, which designate projects and the institutions to conduct them, are not subject to the peer review process in deference to the congressional directives. However, once a grant is funded, it is likely to receive merit review before being competitively renewed, unless waived with a written determination by the project administrator. When merit review is not conducted before an award's renewal, the award must be considered to be noncompetitive and must meet different selection requirements.[1] Whenever the merit review system is not used for applications and proposals, the Director of Grants and Contracts must obtain written prior approval for a different review procedure. Very rarely are contracts peer-reviewed when sole-source selection is used, but the administrator making this decision must justify this process. In addition, nonreviewed grants cannot be extended for more than 6 years; periodic reviews of the research results are another check.

[1] 10 C.F.R. 600.6 (c).

Comments From the Department of Energy

Department of Energy
Washington, DC 20585

APR 17 2000

Ms. Gary Jones
Associate Director, Energy
Resources, and Science Issues
United States General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Ms. Jones:

We appreciate the opportunity to comment on the draft report, "Federal Research: DOE Is Providing Independent Review of the Scientific Merit of Its Research" (GAO/RCED-00-109). We commend your staff for their balanced and informative report. We concur with your assessment of the use of merit review with peer evaluation by the programs in the Office of Basic Energy Sciences in the Office of Science (SC) and the Office of Power Technologies in the Office of Energy Efficiency and Renewable Energy (EE). The report accurately describes the various types of peer reviews that we use to effectively plan and manage our programs. It also provides a good description of the differences in peer review and merit review strategies that are used between basic science programs and applied science programs.

The Department firmly believes that merit review with peer evaluation is a powerful and effective tool for ensuring the quality and productivity of its research and development programs. For basic research programs managed by SC, peer review stimulates competition, establishes high standards for quality, rewards productivity and, on balance, fosters creativity and promotes fairness of opportunity. For applied research programs managed by EE, continued emphasis has been placed on effective merit reviews, which use subject matter experts and tailored evaluation criteria that focus on achieving intended outcomes and results. Through management emphasis on competition and effective peer reviews and merit reviews, we are providing best value to the taxpayer for Federal investments in our important research and development programs.

Sincerely,

James F. Decker
Acting Director
Office of Science

Dan W. Reicher
Assistant Secretary
Energy Efficiency and Renewable Energy

Key Contacts and Staff Acknowledgments

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