Assessing the Need for Independent Project Reviews in the Department of Energy

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ASSESSING THE NEED FOR INDEPENDENT PROJECT REVIEWS IN THE DEPARTMENT OF ENERGY

Lloyd A. Duscha, NAE, Principal Investigator
Board on Infrastructure and the Constructed Environment
Commission on Engineering and Technical Systems
National Research Council

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ASSESSING THE NEED FOR INDEPENDENT PROJECT REVIEWS IN THE DEPARTMENT OF ENERGY

Lloyd A. Duscha, Principal Investigator, Reston, Virginia
Richard G. Little, Study Director
Michael P. Greene, Senior Program Officer
John A. Walewski, Program Officer

Lloyd A. Duscha was elected to the National Academy of Engineering in 1987 for distinguished engineering and construction administration of water resources projects and military facilities. Mr. Duscha retired from the U.S. Army Corps of Engineers in 1990 as the highest ranking civilian after serving as deputy director, Engineering and Construction Directorate. He served in numerous progressive Army Corps of Engineer positions in various locations spanning five decades. Mr. Duscha is currently an engineering consultant to various national and foreign government agencies, the World Bank, and private sector clients. His numerous professional affiliations include Fellow of the American Society of Civil Engineers and the Society of American Military Engineers.

Mr. Duscha has served on numerous National Research Council committees, on the Board on Infrastructure and the Constructed Environment, and was vice chairman for the U.S. National Committee on Tunneling Technology. Other positions held include president, U.S. Committee on Large Dams and chair of the Committee on Dam Safety. He was a member of the International Commission on Large Dams; Executive Committee, Construction Industry Institute; and the Board of Directors, American Consulting Engineers Council Research and Management Foundation. He holds a bachelor of civil engineering degree from the University of Minnesota from which he was awarded the Board of Regents Outstanding Achievement Award. Mr. Duscha is the author of numerous publications covering topics such as dam safety, hydropower development, coastal engineering, and cold weather research.

BOARD ON INFRASTRUCTURE AND THE CONSTRUCTED ENVIRONMENT

Preface

THE STUDY PROCESS

Unlike most National Research Council (NRC) studies, which are undertaken by an appointed committee of experts, this project was conducted by a principal investigator (PI), Lloyd Duscha, a member of the National Academy of Engineering who was selected for his extensive engineering experience and expertise in cost estimation, contracting, project management, and federal government operations and budgetary practices. The findings presented in this report reflect his views, based on the information made available to him. The study was conducted under the aegis of the NRC Board on Infrastructure and the Constructed Environment.

The PI reviewed data and documents concerning DOE projects, including the decision-making criteria, assumptions, and methods used by various organizations within DOE that are associated with the acquisition of fixed assets, as well as justifications, scopes, budgets, and schedules for individual projects. Visits and meetings with DOE field personnel and contractors took place at the following sites: Hanford Reservation, Argonne National Laboratory, Sandia National Laboratory, Los Alamos National Laboratory, Albuquerque Operations Office, Savannah River Site, and the Oak Ridge Operations Office. Information-gathering sessions (see Appendix B) were held with staff members at DOE headquarters with expertise in management, policy, and technical issues.

Like all other NRC reports, this manuscript has been reviewed by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the authors and the NRC in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The content of the review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their participation in the review of this report:

Dr. Barry Bozeman, Georgia Institute of Technology
RAdm. (ret) Jack Buffington, NAE, University of Arkansas
Mr. Paul Gilbert, Parsons, NAE, Brinkerhoff, Quade, and Douglas
Mr. David Marshall, Fairfax County, Virginia
Mr. Charles McGinnis
Dr. Frank Parker, NAE, Vanderbilt University

Dr. Kenneth Reinschmidt, NAE
Mr. Theodore Stern, NAE

While the individuals listed above have provided many constructive comments and suggestions, responsibility for the final content of this report rests solely with the author and the NRC.

Bruce Alberts, Chairman
National Research Council

Contents

Executive Summary

The U.S. Department of Energy (DOE) manages some of the most sophisticated, complex, and technologically advanced energy and science related programs and facilities in the world. The various elements of DOE's diverse mission (i.e., energy systems, weapons stewardship, environmental restoration, and basic scientific and technological research) are supported by various major systems, projects, and programs. Included in this portfolio are defense laboratories and production facilities, energy research and development facilities and laboratories, and facilities and programs for the environmental cleanup of past agency activities. By their very nature, many of these projects are unique (or nearly so), complex, expensive, and reliant on technologies that are either still evolving or are unproven at field scale. Because of these complex and interrelated factors, some DOE projects have cost more than they might have in the private sector, some have encountered cost and schedule overruns, and some have ultimately been canceled after significant costs were incurred.

These recurrent problems with project management have raised questions on the part of the House and Senate Appropriations Committees about the credibility of the assumptions and processes DOE uses to develop conceptual designs and cost estimates and generally manage projects. The primary reason cited for this lack of confidence is that past performance by DOE on high technology projects (with regard to cost and schedules) has often been unsatisfactory, and the cost of civil infrastructure projects often seemed to be higher for DOE than for similar projects constructed for the private sector or other comparable government agencies. The current total costs for planned DOE projects is estimated at more than $125 billion. Therefore, these projects must meet critical standards for need and scope, budgeting, management, and execution.

In an effort to increase its confidence in DOE's budget, the Committee of Conference on Energy and Water Resources directed DOE to investigate establishing an independent project review process. DOE was directed to contract with an impartial, independent organization with expertise in evaluating government management and administrative functions to do a detailed analysis of the proposed independent assessments. To comply with this congressional directive, the DOE Office of the Associate Deputy Secretary for Field Management of the U.S. Department of Energy requested the assistance of the National Research Council (NRC) in preparing a report that:

- assesses the need for conducting independent reviews of DOE projects
- develops guidelines for the content of independent reviews
- assesses the capabilities of independent organizations (including, but not limited to, the U.S. Army Corps of Engineers) to conduct independent reviews

Although the language of the conference report may have suggested a project-by-project analysis, this NRC study was based on a systems, or project characteristic, approach, which could also be used as a continuing process. This report focuses on the development of criteria and guidelines for assessments that can be applied to projects in the FY98 budget request, as well as to future budget requests. Although specific projects are recommended for assessment, the short time frame for this study, as well as the cost of making individual assessments, favored this more generic approach. This report does not attempt to address the broader issues of systems acquisition and project delivery within DOE.

FINDINGS

DOE has constructed and managed large scale, often one-of-a-kind facilities to fulfill its mission and objectives. Given the many unknowns and complications inherent in DOE's mission, funding, management, and organizational structure, it should come as no surprise that the agency has encountered scoping problems, project delays, and cost overruns. Nevertheless, even though cost estimates and schedules naturally tend to drift under these conditions, radical deviations from approved baselines should not become the norm. Complexities and uncertainties should not be used as excuses for inadequate project planning, management, and oversight.

Although DOE has developed comprehensive practice guides for the design and construction phases of projects, the department has not developed comparable guidance for the early conceptual and preconceptual phases of projects when the potential is high for substantial savings in both cost and time. Independent reviews performed early in the process (i.e., at the conceptual stage) can be very helpful for identifying and evaluating alternative approaches so that the project scope, and hence the baseline, is well defined and less subject to change as the project matures. The potential benefits of the sound project guidance that has been developed by the department are diminished because use of the guides is not mandated by DOE Headquarters, and consequently, they are not always followed by the field offices.

The overall purpose of an independent assessment process should be to determine, by a nonproponent body or individual, whether the scope of projects, the underlying assumptions regarding technology and management, the cost and

schedule baselines, and contingency provisions are valid and credible within the budgetary and administrative constraints under which DOE must function.

RECOMMENDATIONS

Guidelines for Project Selection

To address the need for conducting independent project reviews, this report examined the history of DOE performance in energy, science, waste management, and environmental restoration programs. The report concludes that these reviews are warranted and would be beneficial. However, independent reviews are not justified for all projects, and all projects that are reviewed should not be subject to the same type and intensity of review. In practice, application of the proposed criteria will vary with the type and size of the specific project, and, ultimately, DOE must exercise judgment in selecting projects for review. The screening criteria are designed to provide guidance to DOE, not to prescribe a course of action. This report recommends a "graded approach." In other words, the resources expended to improve performance should be commensurate with the benefits obtained. The following criterion is recommended for initial screening of candidate projects for independent assessment:

- All projects with a total estimated cost (TEC) of more than $20 million should be considered for review.

The following criteria apply to projects whose TECs are less than $20 million but more than $5 million:

- projects that propose delivery methods with which DOE has little or no experience (e.g., privatization of waste management)
- projects for which new technology is proposed or the technology requires significant research and development to increase confidence that it will be workable at field scale
- projects that are not obviously or strongly supported by the mission objectives in DOE's Strategic Plan
- projects that have had significant cost or schedule overruns or that have a high potential for such overruns
- projects managed by an area operations office that has a history of project overruns, failures, or terminations

Content of Project Reviews

At a minimum, an independent review of a project should consider the technical scope, proposed technologies, cost estimates, schedules, underlying assumptions and supporting data, and the management and contracting strategy for delivering the project. The independent review should consider all life cycle costs (i.e., deactivation, decontamination, and decommissioning) as described in DOE Order 430.1, Life Cycle Asset Management (DOE, 1995). The assessment should be sufficiently detailed and rigorous to permit an objective, independent reviewer to reach a supportable conclusion about the project's justification in light of the current mission of the DOE program sponsor and about whether the project represents a technically valid, cost effective, realistic means of accomplishing its stated objectives. These criteria are also intended to identify projects that have a long history but which have been overtaken by world events or changes in administration policy and, therefore, are no longer supportable by DOE's mission. This includes ongoing projects that may be performing well but are no longer needed. Reviews of these projects might show that they should be rescoped or even terminated.

Each review should be augmented by two specific actions. First, assessments should contain a finding of whether, in the judgment of the reviewer, the project can be delivered within the cost, scope, and schedule baselines established by DOE or whether alternative solutions may be preferable. Second, in the event that this finding is negative or there are other significant differences between the results of the independent review process and the original project documentation, DOE must make a timely disposition of the findings.

Capabilities of the Independent Reviewer

The group or individual performing the independent review should have, or have available, the requisite capabilities to address the technical disciplines involved (e.g., civil, environmental, and nuclear engineering; high energy physics and energy research), as well as experience with systems and performance analysis, project management, and cost estimates. The appropriate mix and depth of expertise will depend on the nature of the project under review and anticipated problems. Experience suggests that, as long as the reviewing body is truly independent, whoever is chosen to conduct the review may be less critical than the protocols under which the review is conducted. The key capabilities of the reviewer appear to be technical capability, objective detachment from the project under review, and the absence of other conflicts of interest or agenda.

The value of these reviews will only be realized by an organization committed to continuous improvement and with a management structure that can act on the results. It is not important whether the review is conducted by a

specially constituted peer review group or a private contractor; whether it is managed by an outside entity, such as the Corps of Engineers, another federal agency, or the NRC; or whether it is performed by a DOE organizational element outside the proponent chain, such as the Office of Field Management. Regardless of who actually conducts and manages the assessment, procedures must be put in place at the highest levels of DOE to incorporate the results into the decision-making process to foster continuous quality improvement and accountability.

Although the project manager has both line management accountability and the resources and knowledge to advance specific recommendations, a culture supporting truly independent review (and the benefits to be derived therefrom) may not exist at the project level. Therefore, in implementing the independent reviews recommended in this report, the efficacy of the review, the type and scope of the review, and the body that conducts the review should be determined by a designated nonproponent element within DOE in consultation with the project manager. The establishment and tasks of the review body, as well as the disposition of review recommendations, should flow through higher levels of DOE and should not be under the sole direction of the project manager.

In the longer term, DOE should formalize a process for conducting independent reviews (and applying the results) to all programs within the organization. Ultimately, however, DOE must be responsible and accountable for the successful management of its programs. Success is affected more by culture, attitude, and organizational commitment to quality and service than by procedures. Therefore, adjustments by the upper management of DOE to the recommendations made in this report can, and should, be expected.

1

Introduction

BACKGROUND

The diverse elements of the mission of the U.S. Department of Energy (DOE) (i.e., energy systems, weapons stewardship, environmental restoration, and basic scientific and technological research) are supported by various major systems, projects, and programs. They range from environmental restoration at the individual sites of the weapons complex to the National Ignition Facility and the National Spallation Neutron Source. By their very nature, many of these projects are unique (or nearly so), complex, expensive, and reliant on technologies that are either still evolving or are unproved at field scale. Because of these complex and interrelated factors, some DOE projects have cost more than they might have in the private sector, some have encountered cost and schedule overruns, and some have ultimately been canceled after significant costs were incurred. Although these experiences are not unique to DOE (they are also experienced in the private sector), DOE's recurrent problems in this area have raised questions on the part of the House and Senate Appropriations Committees about the credibility of the assumptions and processes DOE uses to develop conceptual designs and cost estimates, and generally manage projects.

PURPOSE

DOE's budget is approved upon the recommendation of the subcommittees on Energy and Water Resources in both houses of Congress. In an effort to ensure that the projects submitted for the fiscal year 1998 (FY98) budget were based on demonstrated need and sound principles of cost estimating and project management, the Committee of Conference Report on Energy and Water Resources (House Report 105-271, excerpts in Appendix A) provided funds for external reviews of DOE's construction and privatization projects (U.S. Congress, 1997).

Prior to obligating these funds, however, DOE was directed to contract with an impartial, independent organization with expertise in the evaluation of government management and administrative functions for a detailed analysis of the proposed independent assessments. To comply with this congressional directive, the DOE Office of the Associate Deputy Secretary for Field Management requested the assistance of the National Research Council.

Statement of Task

As approved by the Governing Board Executive Committee of the National Research Council, this study will:

- develop a decision framework for determining the need to conduct independent reviews of DOE's proposed and ongoing fixed-asset projects
- propose guidelines for the content of these reviews
- assess the capabilities of various organizations to conduct such reviews

Projects to be considered for independent evaluation include: construction projects initiated in FY98, construction projects in the conceptual design phase, ongoing projects, and proposed privatization projects.[1]

SCOPE

Discussions were held with the staff of the Energy and Water Subcommittee of the House Appropriations Committee in an effort to define more fully the task directed by the Conference Report. These discussions revealed that the members of the subcommittee and the staff did not have much confidence in DOE's cost estimates and schedules, or even in the technical scope of construction projects submitted in the budget process. Several reasons were cited for this lack of confidence, but the most common were: (1) that past performance by DOE on high technology projects had often been unsatisfactory in terms of cost and schedule; and (2) the cost of civil infrastructure projects often seemed to be higher when constructed for DOE than for the private sector or other comparable government agencies.

Although the language of the Conference Report could be interpreted to suggest that this report should focus on a project-by-project analysis of the FY98 budget request, a systems or project characteristic approach was used instead in hopes that the criteria and guidelines for assessment could be applied to both current and future projects. The short time frame available for this study and the cost of individual assessments both favored the more generic approach. The criteria developed in this study are used to recommend specific projects from the FY98 budget request for assessment.

Privatization is defined as the DOE contracting strategy that awards a competitive, fixed-price performance contract. For example, DOE may purchase waste cleanup services from a private contractor but retain ownership of the facility and be held accountable to the regulating bodies and law. See the DOE report, Harnessing the Market: The Opportunities and Challenges of Privatization, for further discussion (DOE, 1997).

In addition to mandating this study, the Conference Report requests that DOE's "overall management structure and process for identifying, managing, designing and constructing facilities also be reviewed by an impartial independent organization with expertise in the evaluation of government management and administrative functions." That review will be a follow-up to the present study and will focus on DOE's management structure and processes for identifying, managing, designing, and constructing facilities. However, because management and procedures are critical to assessing the need for independent reviews of DOE projects, these topics are introduced and discussed in this report, as necessary.

To avoid any confusion over this issue, the purpose of this report is limited to the initial charge in the language of the Conference Report, namely, an immediate assessment of the need for independent review of certain DOE projects that are either included in the FY98 budget request or are likely to be initiated in the FY99 request. The Conference Report also directs that a study be done of the procedures DOE uses to identify, plan, and manage major projects. However, because of the limited time available, no attempt has been made in this report to address the broader issues of systems acquisition and project delivery within DOE, even though this is where many of the root causes of the problems that occasioned this study probably lie. For example, during the several field visits undertaken in support of this study, an almost universal comment by field personnel was that baseline commitments too early in the design process, overly long project time frames (particularly in comparison with the private sector), and dependence on variable annual appropriations are among the prime causes of cost overruns and schedule slippage. Although these issues are not addressed in this report, they suggest that a single round of independent reviews or even a series of independent reviews may not improve the overall process. Despite a very real need to examine DOE's underlying acquisition strategy, policy and procedures, and philosophy of project management, this report, by necessity, only presents a framework for selecting projects from the FY98 budget request for independent review, outlines the content of the independent reviews, and identifies the necessary capabilities of reviewers. The broader issues of DOE project management will be the subject of a subsequent study by an organization yet to be determined.

ORGANIZATION OF THE REPORT

The remainder of this report is organized into three chapters and two appendices. Chapter 2 describes the characteristics of the projects under review and DOE project delivery systems. Chapter 3 presents background information on independent reviews as performed by DOE and other organizations. Chapter 4 presents the findings and recommendations of this study and identifies candidate projects for independent review. Appendix A contains an excerpt from H.R. 105-271, which mandates the study. Appendix B is a listing of individual site visits, meetings, and interviews held to gather information during the course of this study.

2

DOE's Construction Program and Procedures

BACKGROUND

Funding for large scale, complex construction projects has historically been a major element of DOE's budget. In 1942, President Roosevelt authorized an initial expenditure of $500 million for the construction of plants to produce the materials necessary to manufacture an atomic bomb. By the end of World War II, the U.S. Army Corps of Engineers Manhattan District had spent approximately $2.2 billion on facilities associated with the development of the bomb. The enormous buildup of facilities involved with the research, development, and deployment of nuclear weapons continued throughout the Cold War. In response to urgent needs that could only be met by unproven technology, projects were approved with little regard for scope or expense.

DOE, which was established in 1977, fostered scientific discovery and required extensive facilities to fulfill the various objectives of its mission. With its core mission of developing and producing nuclear weapons, supplemented by objectives of research and development in energy-related science, the agency received overwhelming support for its programs and for the construction of associated facilities. The agency's mission has continued to expand into technically complex areas, such as the civilian and military uses of nuclear energy and the environmental remediation of the weapons complex.

NATIONAL LABORATORIES

A cornerstone of DOE's research and development programs has been the national laboratory system. The laboratories originally focused exclusively on the development of nuclear weapons, but as the need for these complex weapon systems has waned, they have increasingly branched out to other activities related to environmental remediation, commercial energy, and other research. The national laboratories, with varying management organizations and cultures, have traditionally operated in an independent and decentralized manner. This is largely due to security concerns and the demands placed upon them to deliver extremely complex systems for highly specific functions within definitive time frames. Cost was seldom a major constraint for their projects; and this philosophy has endured despite significant changes in the world.

The laboratories, through DOE, continue to design and construct facilities that are world class and essentially one-of-a-kind. DOE science programs in high energy physics, for example, require specialized facilities that carry with them a considerable amount of risk that the facility may not actually function as intended and designed. Projects such as the Continuous Electron Beam Accelerator Facility (at a cost of more than $500 million) and the Advanced Photon Source Project (at a cost of more than $800 million) are typical research facilities that appear as line items in the DOE budget. The overall complexity of these facilities makes them difficult to plan, design, and construct.

CONTRACTING PRACTICES

Because of DOE's heavy reliance on management and operating (M&O) contractors to operate government facilities, DOE manages its capital acquisition and operational program somewhat differently from other federal agencies. The precedent of using M&O contractors was established by the Manhattan Project during World War II and continued by the Atomic Energy Commission, and the practice continues today. Even the national laboratories are operated under the M&O concept although a university, as opposed to a private firm, may be the prime contractor. Until recently, these contracts were largely cost reimbursable, and the same contractor was often used for an extended period of time. Although this system may have provided advantages for producing weapons in wartime, it may not be the most cost effective method for the delivery of constructed facilities today.

In many cases, the responsibilities of DOE personnel and the M&O contractor have become intertwined and blurred over time. This problem has been compounded by the relatively small number of DOE personnel available to manage large contractor operations. Although the DOE/contractor relationship and the propriety of its organization are not within the scope of this study, M&O contractors (and their subcontractors) have largely been responsible for developing the budgetary data for DOE construction. DOE personnel serve mainly in an oversight capacity. This raises a serious question about whether the present acquisition system provides DOE managers with sufficient management and review capability and accountability to ensure that budget requests are realistic in terms of scope, costs, and schedules.

PROJECT ACQUISITION

For the purposes of this discussion, DOE projects were divided into four categories: strategic systems; major systems; general plant projects; and other

projects. *Strategic systems* are acquisitions for which the total project cost (TPC)[2] exceeds $400 million. *Major systems* are acquisitions for which TPCs range from $100 million to $400 million. *General plant projects* (GPPs) have TPCs of less than $5 million. *Other projects* include all other line item projects for which TPCs are between $2 million and $100 million.

The process that has been established for planning and constructing major fixed-asset projects has four phases: preconceptual; conceptual; execution; and close out. The *preconceptual* phase includes activities that take place prior to the formal definition of a project. Preconceptual activities include the identification of an idea and a preliminary evaluation of its feasibility and document the need for the project. Costs in the preconceptual phase do not accrue to the TPC. The *conceptual* phase defines the technical criteria and project configuration and identifies the specific resources necessary to accomplish the objectives of the project. In this phase of the project, a conceptual design report and project execution plan are prepared. These documents are the foundation for the scope, cost, and schedule baselines. Costs for the conceptual phase of the project are included in the TPC. The *execution* phase includes design and construction of the facility and the transition to operations (start-up and acceptance). A *close out* decision may be made at any time during the life of the project and may entail the termination of an incomplete project, the retirement of a facility at the end of its useful life, or, usually, after the project is completed and has been turned over for operations. These phases and their related decision sequence are shown in Figure 2-1.

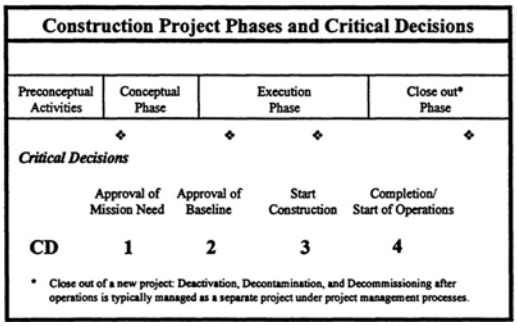

Figure 2-1. Construction project phases and critical decisions

[2]*Total project cost* (TPC) includes all costs specific to a project incurred prior to the start-up of operations, including research and development, operating, plant, and capital equipment costs. The TPC includes the total estimated cost. *Total estimated cost* (TEC) is an estimate of the total cost of a task, demonstration, or program. The TEC differs from a planning estimate in that it is based on definitive information regarding technical scope, contracting methods, schedule, and resource requirements. It is closely related to actual construction cost.

Activities related to the project management of environmental restoration are organized into three phases: the assessment/remedial investigation/feasibility study (RIFS); remediation/cleanup; and close out. Environmental restoration projects are subject to regulatory or other legally binding requirements and decision-making processes. Critical decisions for environmental restoration projects are appropriately integrated with legally binding requirements.

PRIVATIZATION

A subset of projects in the environmental management category is classified as *privatization* projects. In the FY98 budget request, there are 12 privatization projects, the largest of which is the Hanford Tank Waste Treatment project, a mammoth and challenging undertaking. The term privatization in the case of DOE projects is not consistent with the traditional use of the term because the government retains ownership of the facility and is still accountable to regulating bodies and laws. Nevertheless, the privatization concept is very different from the cost-reimbursement contracts that have traditionally been used for environmental restoration and waste management projects.

The privatization concept involves competitively bid fixed-price contracts, performance specifications, and delayed reimbursements based on the satisfactory cleanup of unit quantities. The disadvantage of the traditional cost-reimbursement contracts for environmental restoration is that they provide little incentive, if any, for controlling costs or introducing competing technologies (although DOE is experimenting with alternative contract forms that do not require DOE, as the owner, to assume the full risk and do not require the contractor to include the full risk in a fixed price). The more recent M&O contracts awarded by DOE contain incentive and penalty features that are designed to share the risks and rewards between DOE and its contractors. The advantage of cost-reimbursement contracts is that risk costs are not introduced into the bid price. The success of a fixed-price contract is largely dependent on a project having a precise scope and definitive specifications. If the specifications are imprecise or incomplete, the fixed price is subject to renegotiation. Performance specifications may be used, and may even be preferable to definitive specifications, if the goal is a condition that is reasonably attainable by the current state-of-the-art technology. Performance specifications may even push the state of the art somewhat.

Privatization is being proposed at several DOE sites. A perceived benefit of the privatization approach is that it could encourage the development of competing technologies for solving environmental problems. At first glance, this competition should produce cost savings. If it is properly conceived and administered, and the risks are understood, it could become a meaningful

contracting approach. It remains to be seen, however, if the savings will be realized because competitors will include the cost of added risk and the opportunity cost of money in their unit prices. Estimated cost savings from privatization contracts are still mostly conjectural. Even under the best of circumstances, environmental restoration projects involve some uncertainties and unsuccessful approaches and cost overruns can easily occur.

Privatization projects warrant sizable up-front investments in project and contract definitions. An independent review of privatization projects could ensure that the acquisition and funding strategies are appropriate, that the Requests for Proposals (RFPs) and subsequent contract documents are properly constituted, that the risks are fairly distributed for the technology involved, that contractors proposals are responsive to the RFP, that the DOE management team is properly configured and staffed, and that proposed solutions are viable. Independent reviews could also assess whether potential contingencies have been recognized and whether a system for promptly resolving disputes is in place. From the standpoint of quality assurance, independent reviews of the RFP, the contractor's proposal, and periodic oversight of the work plan would be in order.

3

The Independent Review Process

Construction projects have traditionally been subject to various kinds of independent review. The specific type of review depends on interrelated factors, such as the culture of the institution, the structure of the organization and its supporting components, the competence of the staff, the technical complexity and public and political sensitivity of the project, and the level of risk and amount of investment. Many engineers seek independent opinions of their projects, particularly if public safety or health is involved. Many organizations, including DOE, perform reviews routinely as part of their quality management programs.

Independent reviews can take various forms. Private sector architect-engineer firms review their projects internally, both by individuals other than the designer and as part of general overviews by higher echelon individuals. In most cases, the client (owner) also conducts a review of the product, the detail of which depends on the talent in the client organization and the complexity or sensitivity of the project. Also, it is not uncommon for a client to hire another architect-engineer firm to perform a peer review of work by another firm.

Federal organizations that have construction missions strive to have independent reviews of their own projects, as well as of the projects of private sector architect-engineers. Usually, a contract with a private sector firm requires that a quality management plan be submitted. In some cases, federal organizations have hired private firms to review the output of another architect-engineer, as well as experts to review specific features of a project.

Even though some of the reviews described above are internal, their value should not be peremptorily dismissed. If an organization has the proper internal culture and commitment to quality management, internal reviews can be as valuable as external reviews. The International Organization for Standardization (ISO) has introduced a rigorous methodology (ISO9000) for assessing the quality of professional services that can improve the quality of internal review procedures. However, external reviews are considered desirable to promote competition and advance the state of the art.

INDEPENDENT REVIEW PROCESSES OF OTHER AGENCIES AND ORGANIZATIONS

During the course of this study, several independent review processes, both inside and outside of government, were examined. Review processes are routinely used by the U.S. Department of Defense (DoD), the National Aeronautics and Space Administration (NASA), the World Bank, and by DOE. Although these processes have been adapted to meet the specific needs of the agencies that use them, they are all based on independent assessments of major projects and programs. The need for independent reviews is based on the supposition that those who use or benefit from a project may not be the most objective reviewers of that project. Independent reviewers are more likely to present all of the attributes of a project, both positive and negative. Brief descriptions of some review practices are presented below, but the degree to which the review practices are implemented in agencies other than DOE is not discussed.

U.S. Department of Defense

DoD has stated its rationale for using independent reviews (DoD, 1996):

> Assessments, independent of the developer and the user, are extremely important to ensure an impartial evaluation of program status. Consistent with statutory requirements and good management practice, DoD shall use independent assessments of program status. Senior acquisition officials shall consider these assessments when making decisions. Staff offices that provide independent assessments shall support the orderly progression of programs through the acquisition process.

DoD has established a Cost Analysis Improvement Group (CAIG) to serve as the independent advisory body to the principal decision authority for major systems acquisitions. CAIG is charged with reviewing programs, estimating assumptions, and evaluating their validity (DoD, 1992):

> In preparing its estimate, the CAIG shall employ the best current professional practice for that task. The CAIG may incorporate in its estimate, with or without adjustment, specific portions of the program office cost estimate…if it has independently established that the portions included are valid.

The CAIG is chaired by the Deputy Assistant Secretary of Defense (Resource Analysis) in the Office of the Assistant Secretary of Defense (Program Analysis and Evaluation) and is comprised of members appointed by each permanent member of the Defense Acquisition Board, one member appointed by the Assistant Secretary of Defense (Force Management and Personnel), and ad hoc representatives appointed by the CAIG chair for special purposes. Although CAIG is primarily a program management or systems acquisition tool, the

principles of the underlying graded approach can be readily applied to reviews of individual projects.

National Aeronautics and Space Administration

NASA uses a series of independent reviews in the management of its programs and projects. These include non-advocate reviews (NARs), independent annual reviews (IARs), and independent assessments (IAs) (NASA, 1997). NARs provide independent verification of candidate programs or project plans, life-cycle cost status, and readiness to proceed to the next phase. These reviews provide NASA management with independent assessments of the adequacy of the program or project's formulation effort. IARs are yearly reviews of the status of the performance, cost, and schedule commitments in the performance agreement between the NASA administrator and the cognizant associate administrator. IARs are designed to measure performance against the program or project baseline and established thresholds. IAs are a more traditional peer reviews for validating advanced systems or scientific concepts. All three kinds of reviews are conducted by teams of highly knowledgeable management, technical, and budget specialists from organizations outside the advocacy chain of the program and the project being reviewed; members of the reviewing team do not participate in the implementation of the proposed program or project under review.

The World Bank

The World Bank has launched a program to assess the quality of supervision of its extensive portfolio of international infrastructure investments. The reviews are intended to complement other programs designed by the Quality Assurance Group to improve operations, notably the quality of projects at initiation and the performance of the investment portfolio. Although the World Bank reviews focus on a specific aspect of project management, namely oversight by the bank staff, the review process is instructive because it recognizes the need for ongoing assessment as part of a comprehensive program of quality assurance and continuous improvement. The assessments are performed by independent panels of senior professionals with recognized knowledge of, and experience in, the geographic region and the type of project. The reviewers have had no previous contact with the project under review. The results of the assessments are used to promote systemic improvements in the efficiency and effectiveness of bank supervision (The World Bank, 1997).

U.S. Department of Energy

In the last few years, DOE upper management has emphasized the need for more and better project reviews and has increased its commitment to quality improvement. Although most of DOE's reviews cannot be classified as totally independent or non-advocacy reviews, their value should not be discounted. For example, an independent cost estimate (ICE) for the Tritium Extraction Facility at the Savannah River site was performed by a private contractor at the behest of DOE's independent oversight organization. The ICE team estimate was $140 million less than the estimate prepared by the Savannah River site M&O contractor. A thorough reevaluation of the technical approach by the site project team identified additional cost reductions, and the project cost estimate was ultimately reduced by $257 million.

DOE has developed an extensive body of documentation on its program and project management. The primary requirements document for project planning and management is DOE Order 430.1, Life Cycle Asset Management (LCAM) (DOE, 1995a). To facilitate implementation of the LCAM Order, DOE has developed "Good Practice Guides" for many areas of project and fixed asset management, including descriptions of key processes, performance measures, best-in-class examples, and lessons learned.

Good Practice Guide, GPG-FM-015, *Project Reviews* (DOE, 1996b), for example, describes the purpose, scope, and circumstances of different types of reviews that can be performed at various stages of a project for effective project management. The potential benefits of this sound project guidance are diminished, however, because use of the guides is not mandated by DOE Headquarters, and consequently, the field offices do not always follow them. Regarding the independence of review bodies, the guide states:

> The project manager should also consider using external, unemotionally attached resources for performance of reviews, because project control systems often affect most project participants and can provoke bias in internal project review personnel.

In DOE's Office of Energy Research, a practice of using independent reviews has been in place for more than 15 years. Because a significant constituency outside of government is interested in energy research (e.g., high energy and plasma physics, applied genetics, and advanced materials), DOE has traditionally engaged the scientific community in evaluating its projects. First a group of knowledgeable individuals familiar with the subject is assembled. The members of the group (peers) are drawn from DOE program elements not involved in the proposed project and the national laboratories, augmented by relevant representatives of industry and academia. Reviews are carried out at the proposal stage for projects that exceed approximately $20 million prior to

submittal to Congress. The reviews focus on the baseline (technical scope, costs, and schedules) but do not generally address higher level issues, such as the relationship to mission objectives, i.e., whether the facility is needed or not. Once a project has been approved and funded, the peer review team makes semiannual reviews during the execution phase.

In the area of environmental management, where poor cost and schedule performance are acknowledged by both the Subcommittee on Energy and Water and DOE, no formal system of external or independent reviews has been established. However, the Office of Environmental Management did commission two major external studies, which produced substantive findings and recommendations for improving the process and for achieving cost savings in the preconceptual and conceptual phases of a project. Environmental management projects involve either site restoration or waste management and processing, both of which require highly complex technical solutions with inherently high degrees of uncertainty. The NRC (National Research Council) has also undertaken a series of reviews and assessments of the science and technology base of the environmental management program (NRC, 1996, 1997a, 1997b).

For civil infrastructure projects, the LCAM Order largely governs the review process. Many of these projects are comparable to conventional construction projects in that they are less complex and uncertain than environmental management projects, and historical experience can be used to develop cost estimates and schedules. However, the high cost of construction on secure DOE facilities, or, construction "inside the fence," is also an issue. These higher costs are attributable to the operating cost of the DOE staff and management and operating contractors, stringent security requirements, investigative and preparatory costs, complicated and sometimes duplicative regulations, and the inherent costs of operating in a somewhat noncompetitive environment. These factors are discussed in reports prepared for DOE by Independent Project Analysis, Inc. (IPA, 1993, 1996).

In addition to the reviews encouraged by the LCAM Order, field offices and prime site contractors engage other governmental organizations or private contractors/individuals to perform independent reviews for selected projects. DOE Headquarters, through the Office of Field Management, also has a quarterly review process to track project performance and address current and anticipated problems.

EXTERNAL REVIEWS OF U.S. DEPARTMENT OF ENERGY PROGRAMS AND PROJECTS

In the past few years, three external reviews (with varying levels of detail) have been conducted of DOE programs and projects. The General Accounting

Office (GAO), Independent Project Analysis, Inc. (IPA), and the U.S. Army Corps of Engineers (USACE) undertook these reviews.

General Accounting Office

The GAO study assessed DOE's ability to complete its largest and most significant projects and addressed three specific topics: DOE's performance in completing its major system acquisitions; key factors that hinder timely, cost-effective completion of the acquisitions; and measures taken by DOE to improve performance (GAO, 1996). The GAO report found that, from 1980 to 1996, 31 of 80 major systems acquisitions were terminated prior to completion for a number of reasons. In some cases, conditions had changed and projects were no longer needed. In other cases, cancellation could be traced to changes in administration policy. In still other cases, however, management problems or ineffective oversight by DOE had led to cost overruns and schedule slippages that caused the projects to be terminated.

GAO identified four key factors that had hindered the successful completion of major systems acquisitions:

- a continuously changing mission for DOE, which often makes it difficult to maintain departmental and congressional support for long-term high cost projects
- incremental funding of projects from year to year, which often causes delays or even terminations
- a flawed system of incentives that does not always reward organizations for doing the right thing or punish them for poor contract performance;
- difficulty in hiring, training, and retaining people with requisite skills to provide effective oversight

The GAO report came to the following conclusions (GAO, 1996):

> DOE's management initiatives [contract reform, strategic systems and life-cycle asset management, strategic planning, information resources management, and financial planning] offer the opportunity for the agency to begin addressing some of the key factors affecting the Department's management of its major system acquisitions.

Independent Project Analysis, Inc.

In 1993, the Office of Environmental Management commissioned IPA to assess the progress of its environmental restoration program. IPA is a private firm that specializes in measuring project performance according to key parameters

developed (in a proprietary database) from assessments of many similar projects both in the private sector and by other government agencies. Even though IPA analyzed individual environmental restoration and waste management projects, the study is a macro-level review that measures trends and highlights problem areas (IPA, 1993). A follow-up study completed in April 1996 compares the progress of the Office of Environmental Management against the benchmarks established in the earlier study.

The follow-up study found that performance had improved since 1993 and that better project definition at the front-end of the process is the single most important step for further improving project performance. Project definition requires integrating financial resources, facilities, personnel, and organizations in a manner that exploits technical opportunities or satisfies regulatory requirements. The primary objective of project definition is to minimize changes and define what will be done, who will do it, when it will be done, and what resources will be required. In other words, the project baseline depends directly on project definition. Earlier and better project definition should lead to fewer design changes and shorten schedules. The construction industry has already recognized that most of the benefits of management attention and independent review occur in the early stages of a project and can favorably affect investments.

The IPA study also suggested that the turnover of project personnel (government and contractor) should be kept to a minimum, that DOE should be more actively involved in project management, and that contingencies comparable to industry norms should be included in DOE project estimates. IPA concluded that DOE generally lags behind the private sector in project definition, even though private contractors largely define the projects for DOE. The report recognizes that not all DOE projects suffer from a lack of definition and that many have been successful. The IPA follow-up study was directed primarily toward assessing the effects of project management on the TEC portion of the budget estimate (IPA, 1996).

U.S. Army Corps of Engineers

In late 1996, USACE was commissioned to provide an independent program assessment of DOE's Ten Year Plan for integrating environmental remediation projects (USACE, 1997). USACE reviewed the scope of the projects, cost estimates, and schedules in the program baseline and recommended ways to improve the baseline components.

Phase 1, which was completed in February 1996, was a reconnaissance-level assessment of 13 sites. This assessment disclosed that more than 40 percent of cost estimates had been developed using an assumed level-of-effort rather than activity-based cost elements. USACE acknowledged that a lack of relevant cost

data for environmental restoration projects favored the level-of-effort approach, but activity-based costing results in a more detailed representation of labor, equipment, and materials. The study also found that the scope, costs, and schedules of about three-quarters of the projects evaluated had not been reviewed independently to ensure that the necessary measures for fulfilling a given mission were being performed and that they were being performed as cost effectively as possible. Another finding was that only about one-third of the schedules evaluated were in a form that could be integrated into the program baseline. These findings reinforced the findings of the IPA study that project definition at the front-end must be improved.

USACE's Phase 1 study identified 58 targets, with a potential cost savings of $4 to $5 billion, for further investigation in a Phase 2 study. Unfortunately, the Phase 1 study included only a few FY98 projects. The Phase 2 study is under way and will include a more detailed analysis of each project using activity-based cost estimates, critical analyses of scope, costs and schedules, and suggestions for re-engineering and improved integration. The estimates being developed in the USACE study are fairly detailed and reflect the TPC.

SUMMARY

All of the studies cited are considered to be of high caliber and should help DOE improve its budgetary data from the perspective of higher-level program management (GAO), better project management procedures (IPA), and better recognition of the mechanics and elements involved in producing good cost estimates (USACE). All three also point out the wisdom of having good project definition and good estimates before moving into the budgetary phase of a project.

DOE environmental remediation has long been regarded by the people involved as a program-level rather than project-level activity. Programs continue at a level of effort until completed, while projects are discrete operations with defined objectives and specific costs and schedules. Therefore, one of the significant issues for DOE is to integrate program-based attitudes with project-based thinking, in other words, to convert waste management programs into definable projects. Providing specific project definitions in the early stages of environmental restoration projects (as well as some waste management projects) may prove to be very difficult, however, because of the overwhelming scope and complexity of the problems. Establishing baselines for projects that must meet massive demands, for which defining the extent and characteristics of the problem is a major undertaking, and for which technological solutions are still being explored during the preconceptual and conceptual phases, poses major challenges. In fact, adjusting or fine tuning the baseline periodically and carefully documenting the changes, might be a preferable approach (each successive reanalysis should refine the scope, schedules, and cost estimates).

The technical scope, cost estimates, and schedules presented in future budgetary data should improve as DOE and its contractors gain experience and because of DOE management's commitment to continuous quality improvement. After examining the history of DOE's performance in energy, science, waste management, and environmental restoration programs, this study concludes that independent reviews are generally warranted and would be beneficial. Subsequent reviews should complement the existing ones as much as possible. However, independent reviews are not justified for all projects, and all projects that are reviewed should not be subject to the same type and intensity of review. In practice, application of the proposed criteria will vary with the type and size of the specific project, and, ultimately, DOE must exercise judgment in selecting projects for review. Recommendations for independent reviews of specific projects appear in Chapter 4.

4

Findings and Recommendations

This study was begun with no preconceived opinions regarding the technical, economic, or budgetary validity of any of the DOE projects that are potential candidates for independent review. The purpose of the study is to identify construction and large operating projects that should be considered for independent review and to specify the scope of those reviews. However, in order to understand how independent project reviews might satisfy the needs of Congress, it is necessary to take into account the diversity of DOE's projects.

DOE construction projects can be divided into four general categories: basic energy and science research (including weapons); environmental restoration (of sites and buildings); waste management and processing; and site infrastructure. With the general exception of site infrastructure, all of these projects entail some measure of uncertainty (in some cases very high levels of uncertainty) regarding the availability and/or workability of the necessary technologies at full operational scale. Nevertheless, even though cost estimates and schedules would naturally tend to drift under these conditions, radical deviations from approved baselines should not become the norm.

The overall purpose of an independent assessment process should be to determine, by a nonproponent body or individual, whether the scope of projects, the underlying assumptions regarding technology and management, the cost and schedule baselines, and contingency provisions are valid and credible within the budgetary and administrative constraints under which DOE must function. Throughout this report, the key factors that have contributed to poor performance by DOE have been noted. The overall findings of this study are summarized below.

FINDINGS

Finding 1. Evidence is well documented that DOE projects have experienced cost growth and schedule slippages in the past and that some projects continue to experience difficulties in maintaining approved baselines.

DOE has constructed and managed large scale, often one-of-a-kind facilities to fulfill its mission and objectives. Given the many unknowns and complications related to DOE's mission, funding, management, and organizational structure, difficulties with defining the scope of projects, delays, and cost overruns should come as no surprise. However, complexities and

uncertainties should not be used as excuses for inadequate project planning, management, and oversight. Although DOE has developed sound project guidance, the potential benefits of this guidance have not been fully realized because much of it is not mandated by DOE Headquarters, and, consequently, the guidance is not always used by the field offices.

Finding 2. The problems at DOE are more institutional than technical. Although independent and external reviews are warranted in certain cases, they will not automatically solve the problems. A single round of independent reviews or even a series of them is not the sole answer to achieving comprehensive process improvement. The system should be amended to foster continuous and permanent improvement.

DOE upper management recognizes the lack of credibility in its budget estimates and appears to be committed to solving the problem. By virtue of placing greater emphasis on program/project management, developing procedural direction and a clear approach to the proper use of contingencies in project budgets, and formalizing the review process, the credibility of project baselines (measured against project performance) should improve. Field units also expressed a commitment to improving the process and stressed that notable improvements have been made in the recent past. Interviews with field personnel and the material reviewed for this report substantiated that opinion, although there is room for further improvement. Considering the size of the organization and the large contractor population, changes will not occur overnight. But improvements have been made and will probably continue to be made, provided that the leadership remains committed to that goal.

Finding 3. Many projects, especially in the area of environmental management, are initiated too long before a credible baseline has been developed.

A study by IPA found that a lack of good project definition at the front-end has had a major adverse effect on cost and schedule performance. This finding confirmed the findings in other studies. The proper application of contingencies in the cost estimate could help to mitigate some of the risk involved in developing baselines for environmental management projects, especially when the proposed technology is still evolving. Independent reviews performed early in the process (i.e., at the conceptual stage) can be very helpful for identifying and evaluating alternative approaches so that the project scope, and hence the baseline, is well defined and less subject to change as the project matures.

Finding 4. There are definite benefits to be had from subjecting all projects to some form of assessment by someone other than the project proponent. However, not all projects require an independent, external review.

DOE subjects its projects to various types and degrees of reviews by a variety of DOE personnel from horizontal and vertical echelons, management and operating/integrating contractors, independent contractors and experts, and other governmental organizations. As projects approach the budgetary stage, the reviews becomes more rigorous. Although DOE has developed comprehensive practice guides for the design and construction phases of a project, the department has not developed comparable guidance for the early conceptual and preconceptual phases of projects when there is a high potential for substantial savings in both cost and time.

Although all projects should be subject to some form and intensity of nonproponent review, not all projects should be subject to an independent external review. Some small projects and projects that are comparable in complexity to projects in the civil construction industry would not gain much from in-depth reviews. In these cases, a standard value engineering review would probably be sufficient. Independent cost estimates can account for any biases in an internal estimate and are likely to be more accurate than the internal cost estimate. However, within a range of accuracy, any two estimators can be expected to come to different estimated values for the same work. The validity of cost estimates can best be determined by competitive market forces.

Finding 5. The independent assessment by the U.S. Army Corps of Engineers of DOE's environmental restoration projects during 1996–1997 proved to be very beneficial for refining the baselines and cost estimates.

The USACE assessment did not reveal significant savings in direct construction costs but did find discrepancies in the items that were added to the TEC to make up the TPC. These items include overhead, plant equipment, research and development, and operating costs.

Finding 6. DOE has distinct program areas, each of which may warrant a different approach to project management, baseline development, and independent review. Assigning all reviews to a singular external institution may not be the most effective course of action.

Based on its experience with environmental restoration and waste management projects for DOE and the Department of the Army, USACE has established a unique body of knowledge that can be beneficial to DOE. The Naval Facilities Engineering Command and the Air Force Center for Environmental Excellence also have capabilities in related areas.

Finding 7. Costs for DOE construction “inside the fence” will probably be higher than costs for similar work done on the outside in the private sector.

At DOE sites and laboratories, the operating cost of the DOE staff and management and operating contractors, stringent security requirements, investigative and preparatory costs, complicated and sometimes duplicative regulations, and the inherent deficiencies of operating in a somewhat noncompetitive environment all contribute to the higher costs of "inside the fence" construction.

RECOMMENDATIONS

Recommendation 1. DOE should use screening criteria to identify projects that should be subject to independent review.

The first step in the approved Statement of Task for this report is to develop a decision framework for determining the need for independent reviews of DOE projects. This charge has been addressed by identifying criteria that could be used by DOE to screen projects or groups of projects for independent review. In practice, application of the proposed criteria will vary with the type and size of the specific project, and, ultimately, DOE must exercise judgment in selecting projects for review. The screening criteria are designed to provide guidance to DOE, not to prescribe a course of action. This report recommends a "graded approach." In other words, the resources expended to improve performance should be commensurate with the benefits obtained.

The previous discussion of the factors underlying the concerns expressed in the Conference Report and the nature of the DOE project mix suggest what the screening criteria should be, i.e., project characteristics that suggest that either their credibility or performance (or both) could be enhanced through review by a nonproponent body. For example, DOE has traditionally experienced difficulty maintaining cost and schedule baselines with certain types of projects (e.g., the restoration of sites of the nuclear weapons complex) and has little or no history with others (e.g., privatization). In addition, some projects are so large in scope, cost, or complexity (e.g., the National Ignition Facility) that simple prudence dictates that a full, rigorous review be done before significant funds are committed and that reviews be done periodically during the execution phase of the project. By the same reasoning, there would seem to be little benefit to subjecting all projects to an independent review regardless of their magnitude and complexity, previous history, or stage of development. Therefore, for the initial screening of all projects that have not had an independent review, the following criterion should be used:

- All projects with a total estimated cost (TEC) of more than $20 million should be considered for review.

For projects whose TEC is less than $20 million but more than $5 million, the following criteria should apply:

- projects that propose delivery methods with which DOE has little or no experience (e.g., privatization of waste management)
- projects for which new technology is proposed or the technology requires significant research and development to increase confidence that it will be workable at field scale
- projects that are not obviously or strongly supported by the mission objectives in DOE's Strategic Plan
- projects that have had significant cost or schedule overruns or that have a high potential for such overruns
- projects managed by an area operations office that has a history of project overruns, failures, or terminations

The $20 million threshold was selected for two reasons. First, it is the value currently applied by the Office of Energy Research to identify projects for scientific peer review. Second, DOE Good Practice Guide 10, *Project Execution and Engineering Management Planning,* (DOE, 1996a) suggests $10 million as a threshold value to distinguish between high intensity and low intensity reviews. In the absence of compelling logic that suggests a different amount, the recommended threshold of $20 million appears to be a reasonable basis for initiating an independent review process that will not overload the system with reviews and possibly cause delays to necessary projects. Once this initial round of independent project reviews is completed, the number to be undertaken in future years may decrease as DOE gains experience with the process and applies the lessons learned in the preconceptual and conceptual phases of newly emerging projects. The five secondary criteria are proposed to capture projects with TECs below $20 million with characteristics that present the highest risk to maintaining cost and schedule baselines. General plant projects (with TECs of less than $5 million) should not generally be reviewed unless the scope of the project indicates a high level of uncertainty regarding cost or schedule.

Recommendation 2. Independent reviews of DOE projects should evaluate all relevant technical, economic, and management factors used to justify the project and develop its scope.

The Conference Report specifies the appropriate contents of an independent project review, i.e., technical scope, cost estimates, schedules, and supporting data. Little can be added to this list beyond a caveat that assessments should not be reduced to checklists. Although the level of detail and the amount of

effort invested in a review of a small utility or administrative building should not be comparable to the detail and effort of a review of a multibillion dollar research facility, the assessment process should be sufficiently detailed and rigorous to permit an objective, nonadvocate of the project to reach a supportable conclusion regarding (1) its relationship to the mission of the sponsoring DOE program element, and (2) whether the proposed project (and its acquisition strategy) represents a technically valid, cost-effective, realistic means of accomplishing its stated objectives.

In order for the review process to be useful for both quality assurance and as a decision-making tool, reviews should be augmented in two ways. First, assessments should contain a finding of whether, in the judgment of the reviewer(s), the project can be delivered within the cost and schedule baselines established by DOE or whether alternative solutions may be preferable. Second, in the event that this finding is negative or if there are other significant differences between the results of the independent review and the original project documentation, DOE must make a timely disposition of the findings. Disposition of the findings of the independent review is essential to improve the quality of DOE's baselines and increase confidence in the projects themselves.

Recommendation 3. DOE should chose as independent reviewers organizations or individuals that have the appropriate technical capability, are objective and detached from the project under review, and do not have other conflicts of interest or agenda.

The organization or individual performing the independent review should have, or have available, the requisite capabilities to address the technical disciplines involved (e.g., civil, environmental, and nuclear engineering; high energy physics, and energy research), as well as systems and performance analysis, project management, and cost estimating. Selection of the appropriate mix and depth of expertise will depend on the nature of the project and the particular problems anticipated. The subcommittee originally intended that USACE conduct all reviews of DOE construction and operationally-funded projects. With its long experience with construction and contracting, USACE could be a reasonable choice. However, the broad range of skills described above are not all organic to USACE. Although there are some similarities between the review of a major research facility and the review of a site-based infrastructure renewal program, there are many more differences, and a single organization, public or private, is not likely to have all of the skills necessary to review both types of projects. The approach used by other organizations that routinely conduct independent assessments may be useful to DOE in resolving this dilemma.

Earlier in this report, the experiences of four organizations (DoD, NASA, The World Bank, and DOE) with independent project assessments were briefly described. Although the independent review processes of all four organizations

are essentially private, in-house matters, they all recognize that specialized technical expertise that is not resident within the organization is often required. NASA and The World Bank review teams are comprised of nonproponent members of the organization and outside technical consultants, as required. DoD's CAIG reviews make use of ad hoc members specially appointed by the CAIG chair. DOE's peer review process for evaluating proposed research facilities makes extensive use of volunteers from throughout DOE, the national laboratories, and the broader scientific community. Numerous other examples can be cited, including “Tiger Team” reviews of specific issues addressed by DOE and other agencies and panels and committees appointed by the NRC and other independent bodies at the request of a government agency or by direction of Congress.

Underlying all of these reviews and supporting their credibility is the combination of the technical competence of the reviewers and their independence from the proponent chain of the subject project or program. NASA's reviews are done by ad hoc teams managed by the Langley Research Center under the direction of the NASA chief engineer. The World Bank has a Quality Assurance Group to conduct reviews. Both organizations require that members of a review team not be associated with the project under review; at the same time they take great pains to ensure that reviewers have first-rate technical capabilities. The reviews undertaken by USACE at the request of the DOE Assistant Secretary for Environmental Management to assess the site baselines (costs, scope, and schedules) of remediation and waste management projects were described earlier. USACE used a combination of internal, DOE, and contract personnel under the direction of a USACE project manager to conduct reviews of individual projects.

Experience suggests that, as long as the reviewing body is truly independent, whoever is chosen to conduct the review may be less critical than the protocols under which the review is conducted. The key capabilities of the reviewer appear to be technical capability, objective detachment from the project under review, and the absence of other conflicts of interest or agenda. The value of these reviews will only be realized by an organization committed to continuous improvement and with a management structure that can act on the results. It is not important whether the review is conducted by a specially constituted peer review group or a private contractor; whether it is managed by an outside entity, such as the Corps of Engineers, another federal agency, or the NRC; or whether it is performed by a DOE organizational element outside the proponent chain, such as the Office of Field Management. Regardless of who actually conducts and manages the assessment, procedures must be put in place at the highest levels of DOE to incorporate the results into the decision-making process to foster continuous quality improvement and accountability.

Recommendation 4. DOE should conduct independent external reviews of a number of projects included in the FY98 budget request.

The line item construction projects in the FY98 DOE budget request were analyzed In accordance with the criteria specified in Recommendation 1 and a judgment made to identify which ones warrant further independent external review. A few projects that were identified as line items in the budget but were funded from operational programs were also reviewed. Although there are a great many line item projects, only those with the greatest potential to realize the cost savings that would warrant the time and money required for a review are recommended for a review. Projects that did not warrant an independent review because they were relatively small, or were at a stage in the cycle when changes could not be implemented efficiently, were excluded.

In the environmental restoration category, which is a large part of DOE's budget, only a few projects are construction-funded, capital assets. The others are operations-funded programs, which do not identify discrete projects and the associated costs. It was not possible to analyze environmental restoration projects the way construction-funded projects were analyzed because the environmental restoration process does not fit well under the definition of a capital asset. In these cases, the greatest benefits of external review would be gained from reviewing the system solution proposed for an entire site. It may be judicious for DOE to continue its agreement with USACE for reviewing environmental management projects and to use the Phase 2 study approach for reviewing environmental projects that are still in the conceptual phase.

Environmental restoration at a particular site or group of sites requires integrating numerous distinct activities, which must necessarily remain somewhat fluid to adjust to changes in the situation as they are revealed. To retain some control and to document progress, DOE may want to divide a environmental restoration program into distinguishable units or categories that can be monitored more easily.

Candidate Projects Recommended for Independent Review

The recommended screening criteria were applied to 118 ongoing and proposed projects identified in the FY98 appropriation request. Of the 118 projects, 32 are recommended for independent assessment based on complexity, scope, cost, or status. Following this listing, recommendations are made regarding the type of review and appropriate reviewers are presented.

98-D-125 Tritium Extractor Facility, SRS

Design and demonstrate the feasibility of extracting and purifying tritium from irradiated rods in a commercial light-water reactor.

98-D-126 Accelerator Production of Tritium, Various Locations

Design and demonstrate the feasibility of producing tritium using an operational accelerator plant.

98-D-453 Plutonium Stabilization and Handling Facility for the Plutonium Finishing Plant, RL

Design and construct the facilities at the Plutonium Finishing Plant to meet plutonium storage standards using a standardized package.

97-D-102 Dual Axis Radiographic Hydrodynamic Facility, LANL

Design and construct a 38,200 square foot laboratory facility housing sophisticated x-ray, electronic, and optical machinery.

97-D-122 Nuclear Materials Storage Facility Renovation, LANL

Renovate a 30,400 square foot building completed in 1987 that did not meet standards, including standards for safety and security.

97-D-402 Tank Farm Restoration and Safe Operation, RL

Restore to acceptable design basis the tank farm instrumentation, ventilation, transfer mechanisms, and electrical systems that would support waste disposal privatization.

97-D-470 Environmental Monitoring Laboratory, SRS

Design and construct a 54,000 square foot facility that meets current environmental, health, and safety standards replacing existing 40+ year old facilities.

96-D-103 Atlas, LANL

Design and construct a facility for enhanced pulsed power experimental capability to support stockpile stewardship.

96-D-104 Processing and Environmental Technology Laboratory, SNL

Construct a new building to accommodate various laboratory functions to meet the latest environmental, safety and health requirements.

96-D-111 National Ignition Facility, LNL[1]

Design and demonstrate experimental inertial confinement fusion to achieve controlled thermonuclear fusion in the laboratory.

[1]The scientific and technical basis for the National Ignition Facility have been reviewed by the National Research Council (NRC, 1997c). The proposed independent assessment would focus on the assumptions underlying the cost and schedule baselines.

95-D-102 Chemical and Metallurgy Research Upgrades Project, LANL

Replace 40+ year old electrical and mechanical equipment in a 550,000 square foot building.

93-D-187 High-Level Waste Removal from Filled Waste Tanks, SRS

Design and construct the facilities needed for the removal of waste from tanks.

98-G-304 Neutrinos at the Main Injector, Fermi Lab

Design and construct a new experimental facility to study the properties of neutrons using a high flux beam housed in a tunnel.

96-G-300 Combustion Research Facility, SNL

Add approximately 32,300 square feet to an existing facility to provide more laboratory space and two facility laser laboratories.

CDR[2]Stockpile Management Restructuring Initiative, KCP

Alter and reduce the infrastructure of the existing plant, and change the operational approach.

CDR Capability Maintenance and Improvements Project, LANL

Improve and maintain the infrastructure for processing, manufacturing, and waste management associated with the production of plutonium pits.

CDR Nuclear Material Safeguards and Security Upgrades, LANL

Provide additional safeguards and improve existing security systems associated with the production of plutonium pits.

CDR Tank Farm Support Services, F & H Areas, SRS

Replace deteriorated existing direct-buried service piping of various utility services with new below grade trench pipelines or above ground piping systems.

CDR National Spallation Neutron Source, ORNL

Provide an accelerator six times more powerful than the ones currently available worldwide to expand research capability in several sciences.

CDR Pit Disassembly and Conversion Facility, Various Locations

Provide a facility to disassemble surplus plutonium pits and convert the plutonium to an oxide suitable for (1) disposition by immobilization or (2) fabrication into fuel for burning in reactors.

[2]Projects noted as CDR are in the conceptual design stage and are included per direction in the Conference Report.

Privatization of Defense Environmental Management Projects

The following environmental remediation projects are slated to be competitively bid as either fixed price contracts or unit price contracts with payment to be made to the contractor on successful completion:

- Hanford Tank Waste Treatment, RL
- Contact Handled Transuranic Waste Transportation, Carlsbad, New Mexico
- Low Activity Waste Treatment Project, INEL
- Power Burst Facilities Deactivation, INEL
- Spent Nuclear Fuel Dry Storage, INEL
- Environmental Management/Waste Management Disposal, ORNL
- Transuranic Solid Waste Treatment, ORNL
- Waste Pits Remedial Action, FEMP
- Silo 3 Residue Waste Treatment, FEMP
- Decommission Building 886, Rocky Flats, Colorado
- Decommission Building 779, Rocky Flats, Colorado
- Spent Nuclear Transfer and Storage, SRS

Recommendations for Specific Projects

Of the preceding projects, peer review teams would be most appropriate for 98-D-125, 98-D-126, 97-D-102, , 96-D-103, 96-D-111, 98-G-304, and the National Spallation Neutron Source project. These projects, which have research or materials production missions, should be reviewed by peer groups specifically constituted to address the scientific assumptions underlying their design, construction, and operation. This process would be similar to the peer review process currently used by DOE in the energy and science areas but should be augmented to incorporate more nonproponent parties. The reviews should pay special attention to technical scope, alternatives, costs, and schedules.

The other projects identified as CDR projects, which are primarily for waste management and weapons fabrication, and projects included in the privatization of defense environmental management should be subjected to peer review by specifically constituted external teams with expertise in these technical areas. Projects 98-D-453, 97-D-122, 97-D-470, 96-D-104, 95-D-102, 93-D-187 and 96-G-300, which are buildings and facilities, could be reviewed by organizations experienced in the design and construction of similar facilities, such as USACE, the Naval Facilities Engineering Command, or private contractors.

Although the project manager has both line management accountability and the resources and knowledge to advance specific recommendations, a culture

supporting truly independent review (and the benefits to be derived therefrom) may not exist at the project level. Therefore, in implementing the independent reviews recommended in this report, the efficacy of the review, the type and scope of the review, and the body to conduct the review should be determined by a designated nonproponent element within DOE in consultation with the project manager. The establishment and tasks of the review body, as well as the disposition of review recommendations, should flow through higher levels of DOE and should not be under the sole direction of the project manager.

In the longer term, DOE should formalize a process for conducting independent reviews (and applying the results) to all programs within the organization. Ultimately, however, DOE must be responsible and accountable for the successful management of its programs. Success is affected more by culture, attitude, and organizational commitment to quality and service than by procedures. Therefore, adjustments by the upper management of DOE to the recommendations made in this report can, and should, be expected.

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Appendixes

Appendix A

EXCERPT FROM HOUSE REPORT 105-271

Independent Assessment of DOE Projects

The conference agreement provides $35,000,000 as proposed by the House to provide for external reviews of the Department's individual construction and privatization projects, and an external review of the Department's facility acquisition management process. The immediate concern of the conferees is a review of all Department of Energy construction projects initiated in fiscal year 1998, construction projects currently in the conceptual design phase, ongoing projects if recommended by the initial assessment required below, and projects proposed by the Department for privatization. These evaluations should include a review and assessment of the quality of the technical scopes, cost estimates, schedules, and supporting data regarding these construction projects, and should make recommendations on the validity of the proposed costs, scopes, and schedules.

While the House bill directed that these reviews be conducted by the Corps of Engineers, the conferees acknowledge that there may be other qualified, unbiased external organizations that could conduct this type of assessment. Therefore, prior to obligating any funds provided for review of these construction and privatization projects, the conferees expect the Department to contract with an impartial independent organization with expertise in the evaluation of government management and administrative functions, for a detailed analysis of the proposed independent assessment of construction projects. This contract should produce a report to be submitted to the House and Senate Committees on Appropriations not later than December 31, 1997. The report should address the need for conducting independent assessments of the Department's proposed and ongoing construction projects and projects proposed for privatization, assess the proposed content of these reviews as outlined above, as well as recommend the appropriate entity(ies) (including, but not limited to, the Corps of Engineers) to conduct these reviews. The conferees expect this contract to be entered into as soon as possible, and expect the Department to consult with the Appropriations Committees regarding the selection of an independent organization to produce this report. In addition to the report on the need for an independent assessment of the Department's construction projects, the conferees direct that the Department's overall management structure and process for identifying, managing, designing and constructing facilities also be reviewed by an impartial independent organization with expertise in the evaluation of government management and administrative

functions. The report should be provided to the Committees on Appropriations by June 30, 1998. The process used by the Department and its contractors to identify project requirements, develop scopes of work, execute and manage design, prepare cost estimates, select contract types, and execute and manage construction must be examined. The review should assess the level of oversight and experience of field and headquarters Federal personnel involved in this process. The recommendations of the report should include an analysis of the effectiveness of this process, advantages, disadvantages, and recommended improvements with the ultimate goal of establishing an overall departmental process that has more control of the projects and reduces project cost growth and schedule slippages. This study should also include a review of large operating projects such as environmental projects which may or may not involve much construction, but should clearly be managed with the same principles and guidelines.

Appendix B

SITE VISITS, MEETINGS, AND INTERVIEWS

In the development of this report, various presentations were made to the Principal Investigator and National Research Council staff on DOE policy and practices related to the acquisition of fixed assets and environmental restoration. Telephone and personal interviews were also conducted with personnel at field offices, DOE Headquarters, and other organizations to gather information relevant to the study.

November 4, 1997
Discussions with HQ DOE staff
Richard Little, National Research Council
Tony Tavares, Office of Project and Fixed Asset Management
Topic: Background and origin of study

November 7, 1997
Discussions with HQ DOE staff
Richard Little, National Research Council
Frank Peters, Associate Deputy Secretary for Field Management; Michael Telson, Chief Financial Officer
Topic: Commitment of DOE and the Office of Field Management to the study

November 13, 1997
Discussion with House Appropriations Committee for Water and Energy staff
Lloyd Duscha, Principal Investigator
Richard Little, National Research Council
Staff of the Energy and Water Subcommittee, House Appropriations Committee
Topic: Background and congressional intent of the language in H.R. 105-271

November 20, 1997
Telephone interview with Patricia Dehmer, Office of Basic Energy Sciences, DOE
Mike Greene, National Research Council
Topic: External reviews in energy research

November 20, 1997
Telephone interview with Jim Roberto, Oak Ridge National Laboratory
Mike Greene, National Research Council
Topic: External reviews in energy research
November 21, 1997
Telephone interview with Jack Rush, National Institute of Standards and Technology
Mike Greene, National Research Council
Topic: External reviews at DOE
November 21, 1997
Telephone interview with Tom Russell, University of Massachusetts
Mike Greene, National Research Council
Topic: External review of Spallation Neutron Source program
November 21, 1997
Discussion with HQ DOE staff
Lloyd Duscha, Principal Investigator
Michael Greene and John Walewski, National Research Council,
Tony Tavares, Office of Project and Fixed Asset Management, DOE
Don Smith, Office of the Chief Financial Officer, DOE
Topic: Role of the Office of Field Management in project development, review and management, independent assessment, budgetary involvement, and financial oversight
November 21, 1997
Phone interview with reference to DOE Energy Research program
Mike Greene, National Research Council
Don Lehman, Construction Management Department, DOE
Topic: Procedures for developing baselines, validating cost estimates, technical cost schedule, scheduling reviews and oversight of construction projects in the Energy Research area
November 24, 1997
Phone interview with DOE staff
Mike Greene, National Research Council
David Moncton, Head Advanced Photon Source, Argonne National Laboratory
Topic: Review process and procedures for a major system acquisition at Argonne
National Laboratory

November 25, 1997
Discussions with HQ DOE staff
Lloyd Duscha, Principal Investigator
Michael Greene, National Research Council
Richard Little, National Research Council
Mike Telson, Chief Financial Officer, Frank Peters, Associate Deputy Secretary for Field Management. Tony Tavares, Office of Project and Fixed Asset Management, DOE
Topic: Perception of causative factors for problems encountered, corrective procedures being implemented, operational philosophy, and the organizational culture
November 25, 1997
Discussion with General Accounting Office Staff
Lloyd Duscha, Principal Investigator
Michael Greene, Richard Little, National Research Council
Victor Rezendes, Farrell Fenzel, GAO
Topic: GAO audits of DOE, findings and perceived causes of the problems
December 3, 1997
Telephone interview with Roy Cutler, International Isotopes, Inc.
Mike Greene, National Research Council
Topic: His role in external review of National Spallation Neutron Source
December 15, 1997
Site visit and discussions at Hanford
Lloyd Duscha, Principal Investigator
Michael Greene, National Research Council
Topic: Field inspection of major environmental remediation and waste management programs and plans for future projects; briefings and discussions of the processes and reviews involved in establishing an integrated baseline and the need to adjust this baseline as experience and definition are gained in resolving complex problems
December 16, 1997
Site visit and discussions at Albuquerque Operations Office, DOE
Michael Greene, National Research Council
Bruce Elsner, DOE
Topic: Management of projects at Albuquerque; issues related to projects at Sandia and Los Alamos; relations between regional offices and headquarters; effective use of external review

December 17, 1997
Site visit and discussions at Chicago Operations Office, DOE
Lloyd Duscha, Principal Investigator
Bob Wunderlich, Frank Gorup, George Paliulionis, Drew Gabel, Chicago Operations Office, DOE
Topic: Argonne area office overall project management and assessment processes over a range of projects, with a focus on front-end project definition, conceptual design reviews, development of cost estimates, establishment of baselines, review procedures, and conformance with the Life Cycle Asset Management Order
December 17, 1997
Site visit and discussions with staff of Los Alamos National Laboratory
Michael Greene, National Research Council
Topic: project management, reviews, and approvals at Los Alamos; effective use of external review
December 17, 1997
Site visit and discussions with staff at Sandia National Laboratory
Michael Greene, National Research Council
Topic: project management, reviews, and approvals at Sandia; effective use of external review
December 17, 1997
Site visit and discussions at Savannah River Site
Richard Little, National Research Council
John Phillips, DOE; G.W. Stanley, A.C. Kelley, Bechtel Savannah River
Topic: Savannah River Project Management System Overview; overview of current and planned Savannah River Site projects; overview of Project Operations Office
December 18, 1997
Site visit and discussions at Oak Ridge Operation Office
Richard Little, National Research Council
Richard Anders, Dennis Boggs, Ron Ogelsby, DOE
Topic: Project management at Oak Ridge; Oak Ridge waste privatization projects; overall project mix
December 22, 1997
Discussion with Headquarters DOE staff
Lloyd Duscha, Principal Investigator
Richard Little, National Research Council
Topic: Impressions from site visits; clarification of procedural points with respect to budgets and the approval process

Acronyms

CAIG	Cost Analysis Improvement Group
CDR	conceptual development report
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
FY	fiscal year
GAO	Government Accounting Office
GPP	general plant project
IA	independent assessments
IAR	independent annual reviews
ICE	independent cost estimate
IOM	Institute of Medicine
IPA	Independent Project Analysis, Inc.
ISO	International Organization for Standardization
LCAM	life-cycle asset management
M&O	management and operating contractor
NAE	National Academy of Engineering
NAR	non-advocate reviews
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NRC	National Research Council
PI	principal investigator
RFP	request for proposal
RIFS	remedial investigation/feasibility study
TEC	total estimated cost
TPC	total project cost
USACE	U.S. Army Corps of Engineers