Intelligent Sustainment and Renewal of Department of Energy Facilities and Infrastructure

Committee on the Renewal of Department of Energy Infrastructure

Board on Infrastructure and the Constructed Environment

Division on Engineering and Physical Sciences

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Preface

With this report, the Committee on the Renewal of Department of Energy Infrastructure conveys its evaluation of the department's progress toward intelligent sustainment and renewal of Department of Energy (DOE) facilities and infrastructure (F&I). While it is clear that many challenges remain, the committee found many good people working with reasonable processes in DOE's F&I management system. However, significantly, the committee also became aware of a concept, prevalent throughout much of DOE, that spending resources on F&I activities is done at the expense of DOE's program missions. As a former industry executive, I view the lack of integration of F&I into overall DOE strategy as a major challenge for DOE senior managers. This zero-sum-game approach may have been relevant 50 years ago, but it has been discarded by most, if not all, successful organizations in government and industry. The intimate integration of missions and management processes applies not only to F&I but also to environmental performance, safety, health, community relations, and other supporting functions. Such elements are not competitors for program resources; rather, they are program enablers that make the program bigger and better than the sum of its parts.

The committee paid specific attention to this problem and offers recommendations in Chapter 2 for improvements to the DOE's strategic plan, organizational structure, and implementation of F&I policies, procedures, and guidelines. Chapters 3 and 4 identify challenges in infrastructure management and provide recommendations for improvement.

To naysayers who contend that a consistent holistic approach is not workable at DOE, I point with professional respect to the progress made within the National

Nuclear Security Administration (NNSA). While NNSA has not yet addressed every issue surrounding the integration of program and F&I needs, it has recognized F&I as an enabler. As a result, NNSA's execution of Real Property Asset Management (O 430.1B) (RPAM) is the most advanced in DOE. In the simplest of terms: NNSA "gets it." There is no reason that all DOE program offices cannot meet and exceed the progress made by NNSA. I believe it is a matter of leadership.

James M. Braus, *Chair*
Committee on the Renewal of Department
of Energy Infrastructure

Acknowledgment of Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its 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 review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Nancy Rutledge Connery, Consultant,
Lloyd A. Duscha, U.S. Army Corps of Engineers (retired),
G. Brian Estes, U.S. Navy (retired),
David Skiven, General Motors Corporation,
Richard Stegemeier, Unocal Corporation (retired),
Michael L. Telson, University of California Office of Federal Governmental Relations, and
James W. Wright, Naval Facilities Engineering Command.

Although the reviewers listed have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by John Ahearne. Appointed by the National Research

Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Contents

Acronyms and Abbreviations

ACI	asset condition index
APPA	Association of Higher Education Facility Officers
AUI	asset utilization index
BMAR	backlog of maintenance and repair
BSC	balanced scorecard
CAIS	Condition Assessment Information System
CAS	Condition Assessment Survey
CNI	Commander of Naval Installations Command
CRE	corporate real estate
CRV	current replacement value
CSO	cognizant secretarial office
DM	deferred maintenance
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE IG	U.S. Department of Energy Inspector General
DRIP	data rich and information poor
EM	Office of Environmental Management
F&I	facilities and infrastructure

FAR	Federal Acquisition Regulations
FCI	facility condition index
FDC	facility deterioration curve
FIMS	Facilities Information Management System
FIRP	Facilities and Infrastructure Recapitalization Program
FISC	Facilities and Infrastructure Executive Steering Committee
FMS	facilities management system
FRM	Facilities Recapitalization Metric
FRR	Facilities Revitalization Rate
FSM	Facilities Sustainment Model
GAO	U.S. Government Accountability Office (formerly U.S. General Accounting Office)
GPRA	Government Performance and Results Act
IRR	installation readiness report
LCAM	Life-Cycle Asset Management
LLNL	Lawrence Livermore National Laboratory
LPSO	lead program secretarial office
M&O	management and operation
MCI	mission condition index
MDI	mission dependency index
ME	mission effectiveness
NASA	National Aeronautics and Space Administration
NI	needs index
NNSA	National Nuclear Security Administration
NRC	National Research Council
OECM	Office of Engineering and Construction Management
OMBE	Office of Management, Budget, and Evaluation
PMCDP	Project Management Career Development Program
PSO	program secretarial office
RPAM	Real Property Asset Management
RPV	replacement plant value
S	alternative renewal strategies
SAM	Strategic Assessment Model
SC	Office of Science

SIM	shore installation management
S/RM	sustainment, restoration, and modernization
TYCSP	10-year comprehensive site plan
TYSP	10-year site plan

Executive Summary

Congress, the U.S. Government Accountability Office (GAO), and the U.S. Department of Energy (DOE) have long been aware of DOE's aging and deteriorating facilities and infrastructure, and of their threat to the department's ability to successfully complete its missions (DOE, 2003; GAO, 2003a, 2003b, 2003c, 2001; U.S. Congress, 2001). In 2001, the U.S. House of Representatives Committee on Appropriations directed DOE to contract with the National Research Council (NRC) to evaluate the steps the department is taking to improve its facilities and infrastructure (F&I) management. This report and the preceding preliminary assessment (NRC, 2004; included in this report as Appendix A) are the products of this evaluation.

The evaluation was conducted by the Committee on the Renewal of Department of Energy Infrastructure under the auspices of the NRC's Board on Infrastructure and the Constructed Environment. The committee has responded to its four-part statement of task through its observations, findings, and recommendations detailed in Chapters 2, 3, and 4 of this report. The overall findings relative to each component of the statement of task are summarized here.

Task 1. Assess DOE's facilities and infrastructure management practices and initiatives and provide recommendations for areas requiring additional focus.

The Department of Energy has developed and put in place a number of the policies, procedures, and day-to-day practices for facilities management that characterize high-performance organizations. However, the committee finds that

application of these policies and procedures is inconsistent across program offices and sites, hindering the implementation of a unified and effective corporate approach to facilities management. The committee has also identified challenges and opportunities for improving F&I planning and budgeting procedures to make the process more proactive and to improve oversight and quality control.

Task 2. To improve life-cycle performance and mission support, identify or develop "best-practice" tools and techniques for DOE real property asset management in such areas as site planning; maintenance and recapitalization planning; space and land utilization; disposal strategies; information technology applications; and financing, cost allocation, and cost recovery strategies.

Based on F&I management practices and techniques observed in federal government agencies, higher-education institutions, and industry, it is apparent to the committee that there is no single set of practices that can be readily adopted by DOE. Achieving success in facilities management requires an organization to identify the approaches that will work best for its unique circumstances and to apply them consistently throughout the organization. The committee believes that there are many paths to success and has identified examples of solutions to the types of problems and challenges faced by DOE.

Task 3. Develop guidelines for deciding when to repair, renovate, or replace DOE buildings and other facilities based on factors such as agency mission objectives and return on investment.

Determining when to repair, renovate, replace, or surplus a facility is a complex decision driven by mission requirements, facility condition, available funds, and the legal/regulatory framework, among other factors. The committee believes that a life-cycle systems model is appropriate for these decisions and has provided an example that could be tailored to the requirements of DOE.

Task 4. Define performance metrics that integrate budget with expected outcomes and ensure accountability.

Cost-effective facilities and infrastructure management requires reliable and robust performance measures consistently applied in an evaluation framework that reflects corporate goals and missions. The committee has proposed a facilities management system (FMS) composed of methods, procedures, data, software, policies, and decisions that link all facilities management activities. The system combines the asset condition index (ACI) defined by Real Property Asset Management (O 430.1B) (RPAM) with a proposed mission condition index (MCI)

and alternative strategies to identify the option that provides the optimal return on investment.

The consequences of years of failed F&I stewardship of the DOE complex cannot be quickly reversed. Dedicated leadership and committed federal managers and contractors at all levels, as well as the continuing support of Congress, will be required to effectively sustain and recapitalize the department's real property assets. Long-term improvement will require cultural and organizational changes, improved planning and budgeting procedures, and the development of improved performance measures. The process has begun with the promulgation of departmental policy RPAM, but much remains to be accomplished if DOE is to fully implement a corporate, holistic, performance-based approach to asset management and achieve the ultimate objective of effective and efficient facilities and infrastructure that support the department's missions.

The committee believes that for an appropriate F&I process to work successfully at DOE, the following issues need to be addressed by senior managers to ensure consistent implementation of the process throughout the department.

Improvement of F&I stewardship at DOE needs to begin with the explicit recognition of the importance of F&I in the department's strategic plan. The plan should include a definitive statement recognizing the critical role of facilities and infrastructure in mission accomplishment as well as prioritized goals with performance measures and targets, and a time frame and actions needed to accomplish these goals. The strategic importance of F&I should also be visible in the department's annual budget requests.

In order to create excellence in F&I stewardship throughout the department, the committee believes that DOE needs strong and involved senior leaders, beginning with the deputy secretary; well-defined authority, responsibility, and accountability at all levels of DOE and management and operations (M&O) contractors; and enhancement of a central F&I authority by strengthening the Facilities and Infrastructure Executive Steering Committee (FISC) and the Office of Engineering and Construction Management (OECM). FISC and OECM should be designated and fully authorized to lead the implementation of RPAM, transfer best practices across the department, ensure that DOE and contractor personnel are trained and qualified, and ensure the consistent, disciplined planning, budgeting, and implementation of life-cycle stewardship of F&I. Although the National Nuclear Security Administration (NNSA), the Office of Science (SC), the Office of Environmental Management (EM), and the other program secretarial offices (PSOs) with responsibility for real property assets have different mission requirements, there is a need for consistency in the way information is generated and decisions are made.

The committee has noted that DOE needs more robust, proactive planning and budgeting procedures to ensure an adequate program to sustain and recapitalize its facilities and infrastructure. The committee recognizes the improvements

accomplished by the Facilities and Infrastructure Recapitalization Program (FIRP) of the NNSA and recommends that similar programs be implemented for other program secretarial offices. The committee expects that the recent planning guidance issued by the deputy secretary—establishing a minimum target for spending on F&I sustainment—will help reverse the trend of ever-increasing deferred maintenance and that DOE, with the help of Congress, can establish a program of full sustainment and recapitalization to make DOE facilities effective and efficient now and in the future.

However, FIRP and RPAM rely on the 10-year site plans (TYSPs) to determine short- and long-term budgets for recapitalization without providing adequate guidance for performance measures or targets to support the roll-up of TYSPs into defensible budgets for the programs and the department. The committee suggests that the department consider adapting the facilities sustainment, restoration, and modernization (S/RM) construct developed by the Department of Defense for department-level planning and budgeting.

DOE facilities are government-owned, contractor-operated complexes. The department's role is thus that of a contract manager. DOE manages contractor performance through performance-based incentive fees. The committee suggests that all M&O contracts include significant incentive fees tied to the stewardship of facilities using metrics that assess performance based on a benchmark of 100 percent sustainment of F&I and on F&I capacity to provide complete support of the site's mission. DOE's goal should be for all contractors to earn their full incentive fee for facilities stewardship.

Because DOE's role is primarily one of oversight, there is a critical need for effective performance measures and quality control systems to ensure that the department's objectives are achieved. The performance measures currently used by DOE are consistent with industry practices, but the size and complexity of DOE's F&I require a more complete set of robust measures. The committee has noted examples of organizations that use a suite of measures to achieve this objective and suggest an approach that builds on the current metrics to create an integrated management system that will support F&I management decisions. DOE should also establish goals and performance measures to support a continuous improvement process for F&I management. Regardless of the specific group of measures, the process should include metrics that assess performance for the following aspects of F&I management:

- Costs and benefits of F&I sustainment and renewal
- Customers external to the F&I management organization
- People internal to the F&I management organization
- F&I management processes

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Introduction

> The society which scorns excellence in plumbing because plumbing is a humble activity, and tolerates shoddiness in philosophy because philosophy is an exalted activity, will have neither good plumbing nor good philosophy. Neither its pipes nor its theories will hold water.
>
> —John W. Gardner, *Saturday Evening Post,* December 1, 1962

BACKGROUND

The U.S. Congress (U.S. Congress, 2001), the U.S. Government Accountability Office (GAO, 2003), the DOE Inspector General (DOE IG, 2003), and DOE management (DOE, 2004) have recognized the importance of DOE's facilities stewardship to the department's ability to achieve its overarching mission of "protecting national, energy, and economic security with advanced science and technology and ensuring environmental cleanup" (DOE, 2003). They have also recognized that DOE has in the past exhibited severe management challenges in the development, sustainment, recapitalization, and demolition of real property assets. Given the criticality of DOE's mission and its extensive real property responsibilities—including 50 major facilities in 35 states with 243.57 million square feet of buildings and a replacement plant value of $73.1 billion (GAO, 2003)—DOE's ability to manage its real property assets is important to our nation's well-being.

In 2001, the U.S. House of Representatives Committee on Appropriations noted that:

> The Committee is aware of the continuing decline in the condition of the Department's facilities throughout the complex and of the Department's inability to properly evaluate and address the readiness and maintenance status of its facilities. Many of its aged, deteriorated facilities and infrastructure lack the functionality to provide adequate mission support. (U.S. Congress, 2001, p. 97)

In response to this observation, the appropriations committee started facilities recapitalization funding initiatives and directed DOE to contract with the National Research Council (NRC) to evaluate the steps the department is taking to improve its facilities and infrastructure management. This report and the preceding preliminary assessment (NRC, 2004) are the products of this evaluation. The preliminary assessment letter report is included in this report as Appendix A.

COMMITTEE COMPOSITION

The evaluation was conducted by the Committee on the Renewal of Department of Energy Infrastructure under the auspices of the NRC's Board on Infrastructure and the Constructed Environment. The committee's 13 members have expertise in a variety of disciplines, including construction and project management, corporate and strategic planning, capital programming and budgeting, land use and site planning, commercial real estate, and facility engineering and management. The group incorporates experience in large-scale strategic planning in the corporate environment, as well as facility planning and management in government, higher education, and other large institutions. See Appendix B for biographies of the committee members.

STATEMENT OF TASK

The committee was established to address the following statement of tasks:

1. Assess DOE's facilities and infrastructure management practices and initiatives and provide recommendations for areas requiring additional focus;
2. To improve life-cycle performance and mission support, identify or develop "best-practice" tools and techniques for DOE real property asset management in such areas as site planning; maintenance and recapitalization planning; space and land utilization; disposal strategies; information technology applications; and financing, cost allocation, and cost recovery strategies;
3. Develop guidelines for deciding when to repair, renovate, or replace DOE buildings and other facilities based on factors such as agency mission objectives and return on investment; and

4. Define performance metrics that integrate budget with expected outcomes and ensure accountability.

COMMITTEE EVALUATION PROCEDURES

The committee's evaluation is based on briefings by DOE headquarters staff in August and December 2003 and in March 2004. In October and November 2003, the committee also conducted site visits, which included briefings by DOE and contractor staff, at the Lawrence Berkeley, Lawrence Livermore, Oak Ridge, Sandia, and Los Alamos National Laboratories, as well as at the National Nuclear Security Administration Y-12 site and the Savannah River site. The committee reviewed DOE's departmental policies and procedures including Order O 430.1B (Real Property Asset Management), the Condition Assessment Survey, and the Facilities Information Management System database. The committee also reviewed guidance from the DOE program secretarial offices, including the National Nuclear Security Administration, the Office of Science, and the Office of Environmental Management, which are responsible for 95 percent of DOE's real property assets. Site-specific procedures for 10-year site plans and facility management tools were also reviewed. A list of briefings to the committee is provided as Appendix C.

In addition to drawing on its broad experience, the committee investigated the policies and procedures used by other federal agencies and private industry through briefings, interviews, and document reviews. These organizations included the Department of Veterans Affairs, the National Aeronautics and Space Administration, the Office of the Deputy Under Secretary of Defense for Installations and Environment, the Naval Facilities Engineering Command, the Navy Shore Installations Command, the Coast Guard, and E.I. du Pont de Nemours and Company.

The committee appreciates the cooperation and support of the Office of Engineering and Construction Management and of the DOE program offices, site offices, and site contractors as well as the support of all organizations referred to above in providing background information and facilitating the site visits. The committee recognizes that these facilities management professionals contributed significant time, effort, and enthusiastic support, thus enabling the committee to address its assigned tasks.

ORGANIZATION OF THIS REPORT

The committee's preliminary assessment (NRC, 2004) noted that "DOE has issued policies that if adequately and consistently supported by meaningful practices and procedures will improve the quality of facility management and will lead to better allocation of resources for the effective support of DOE's missions." The committee also noted that its final report would address opportunities

and methods to facilitate implementation of improved DOE policies and procedures consistently across DOE programs and sites.

The committee has addressed its assigned tasks in three chapters. Chapter 2, "Infrastructure Management Practices and Organization," discusses the opportunities for creating a DOE culture that fosters life-cycle facilities stewardship, including issues of leadership and delegation of authority. The role of the department's strategic plan is emphasized and an example is provided of effective life-cycle stewardship in industry. Options for increasing the opportunities for process improvement through organizational change and through investment in human capital and knowledge management are also discussed.

Chapter 3, "Infrastructure Management Challenges and Opportunities," discusses the actions needed to achieve the objectives of DOE's Real Property Asset Management order. The committee endorses the order but notes that additional detailed guidance is needed for its implementation and for the effective application of DOE's Condition Assessment Survey, Facilities Information Management System, and 10-year site plans. Opportunities to improve DOE's facilities and infrastructure planning and budgeting process are presented using Dupont and the new Department of Defense procedures as examples to be considered. Because DOE facilities are government owned but contractor operated, the committee emphasizes the federal oversight role and the need for clear accountability, consistent oversight and quality control, and appropriate performance incentives.

Chapter 4, "Infrastructure Management Performance Measures," discusses the importance of performance measures for management planning and budgeting as well as for process improvement. The committee identifies the qualities of effective metrics and describes the sets of metrics used by successful organizations in industry, education, and government. A construct for an integrated facilities management system based on metrics used by DOE and additional metrics developed by the committee is also described.

Chapter 5, "Conclusion," reviews and updates the assessment in the committee's February 2004 letter report and further defines actions that DOE should take to improve its F&I stewardship.

The appendixes include the full text of the February 2004 letter report, biographies of the committee members, and a list of the briefings to the committee.

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2

Infrastructure Management Practices and Organization

> Management means, in the last analysis, the substitution of thought for brawn and muscle, of knowledge for folkways and superstition, and of cooperation for force. It means the substitution of responsibility for obedience to rank, and of authority of performance for the authority of rank.
>
> —Peter F. Drucker, *People and Performance*

INTRODUCTION

The U.S. Department of Energy (DOE) has more than 50 major facilities in 35 states with a replacement plant value of more than $70 billion. These facilities are owned by the federal government but managed, operated, and maintained by contractors. Thus DOE has evolved into an organization with decentralized authority and responsibility, relying on contractors to achieve its facilities stewardship objectives. Oversight of the department's facilities and infrastructure (F&I) has been delegated to seven program offices.

The U.S. Government Accountability Office (GAO) notes that:

> Many of these [DOE] facilities are in poor condition, and others are reaching the end of their design life. For example, DOE's national laboratories were built during World War II and the early Cold War. Over 60 percent of the laboratory space is more than 30 years old, and 35 percent is more than 40 years old. DOE has begun to receive funding from the Congress to improve its infrastructure, and its offices are developing plans for improvements. The cost of upgrading DOE's infrastructure will exceed several billion dollars. DOE's challenge will

> be to spend this money effectively and efficiently, in a way that is consistent with its most important missions. (GAO, 2003, p. 25)

DOE has begun to address these issues by issuing new policies and procedures but, as noted in the committee's preliminary report (NRC, 2004), implementation is inconsistent across the department and additional changes are needed at all levels to create and maintain a culture of effective and efficient facilities stewardship at DOE.

This chapter discusses both the cultural issues that shape DOE's response to F&I management challenges and organizational issues that influence management decisions. Basic approaches to improving management processes and procedures are also discussed.

STEWARDSHIP CULTURE

Organizations that effectively manage F&I are characterized by a cultural understanding and communication of the strategic role that facilities and infrastructure play in achieving site missions and program objectives (NRC, 2004). The critical importance of DOE's missions for the nation's defense and well-being and for the advancement of science to benefit humanity make the stewardship of the real property assets that support these missions equally important. But the committee has observed a culture based on the premise that spending resources on F&I stewardship is done at the expense of program missions. On the contrary, the integration of mission at all levels and in all processes applies not only to F&I but also to environmental safety and health and community relations. Such functions are not competitors of program resources but rather enablers that make the program bigger and better than the sum of its parts. Proper integration of all support elements can only ensure program success. The department's level of dedication to the establishment of a robust F&I stewardship culture for its real property assets will determine whether it has the capability to fulfill its missions now and far into the future.

Leadership

Strong leadership will be required to consistently embrace strategies of thoughtful planning and a long-term perspective for stewardship of DOE's research laboratories and nuclear facilities. As stated in the 1998 NRC report *Stewardship of Federal Facilities*:

> The ownership of real property entails an investment in the present and a commitment to the future. Ownership of facilities by the federal government, or any other entity, represents an obligation that requires not only money to carry out that ownership responsibility, but also vision, resolve, experience, and expertise to ensure that the resources are allocated effectively to sustain that

> investment. Recognition of these obligations is the essence of stewardship. (NRC, 1998, p. v)
>
> The four most important elements in creating a climate that encourages effective stewardship of facilities in federal agencies are:
>
> - Leadership by agency senior managers;
> - The establishment and implementation of a stewardship ethic by facilities program managers and staff as their basic business strategy;
> - Senior managers and program managers who create or seek incentives for successful innovative facility management programs; and
> - Agency strategic plans that give suitable weight to effective facilities management. (NRC, 1998, p. 63)

These statements stress the importance of a DOE culture that recognizes the strategic role of facilities and infrastructure in program success and that therefore takes full responsibility and accountability at all levels of the organization for the life-cycle management of F&I.

Because DOE is coming from a past of failed stewardship, the implication is that many behaviors and practices need to change in order to create a new culture that embraces its life-cycle responsibility for F&I (GAO, 2003). Not only do new directives and policies, such as RPAM (DOE, 2003a), need to be issued, but a new culture needs to be created and reinforced at all levels of the department.

Strategic Plan

The committee believes that the DOE 2003 strategic plan (DOE, 2003c) does not provide sufficiently clear focus to the role of F&I in achieving the department's missions and that this lack of strategic focus may impede implementation of RPAM. The September 2003 strategic plan states that it establishes long-term goals, lays out strategies to achieve them, identifies key intermediate objectives along the way, and provides the basis for evaluating the department's performance. However, these goals and objectives have not been applied to F&I. Because of the absence of a clear, consistent link between strategic goals and facilities stewardship, the performance of the department's real property asset management is likely to receive less attention from senior managers and, consequently, managers at all levels.

The strategy for DOE's nuclear weapons stewardship mission is an exception, in that the plan lists a key intermediate objective to develop and maintain the facilities and infrastructure necessary to ensure the safety, security, and reliability of the stockpile. However, the strategy for world-class scientific research states only that DOE will provide world-class research facilities, without recognizing the need to sustain and recapitalize those facilities. The plans for DOE's other strategic goals include no recognition of the effort required to provide and maintain the facilities needed to achieve the goals. These observations are consistent

with the committee's preliminary assessment (NRC, 2004), which noted the relatively strong F&I program of NNSA as compared to the other program secretarial offices (NRC, 2004). Although NNSA has not addressed every issue of integrating program and F&I management, it has taken steps to recognize F&I as a strategic enabler of its program. NNSA top management has initiated actions to improve the quality and consistency of F&I planning, budgeting, performance measurement, and auditing processes as a central resource to assist site operations in achieving excellence.

The 2003 DOE strategic plan includes commentary on achieving its stated goals, noting that: "In order to meet the Nation's needs for cutting-edge science, the Department must periodically replace or make major upgrades to aging or outdated major experimental facilities. These requirements will be weighed against the benefits from cost-effective modifications to existing facilities to ensure that the maximum national benefits are derived from existing infrastructure" (DOE, 2003c, p. 39). However, this statement represents only part of what the committee believes is needed in the department's strategic plan to ensure consistent life-cycle stewardship of its facilities. Facilities management and infrastructure renewal need to be recognized as critical to DOE's achieving its goals and included as a key performance metric for the department. Consideration should therefore be given to adding a specific F&I strategic goal to the department's four basic mission goals.[1] This strategic goal should call for facilities and infrastructure to be planned, constructed, sustained, and recapitalized to support all departmental missions and for facilities and infrastructure that no longer support departmental missions to be disposed of safely, efficiently, and in a timely manner. The strategy should be further defined by establishing criteria for setting priorities, defining performance measures (discussed in Chapter 4), and setting performance targets. The strategic importance of F&I should also be visible in the department's annual budget requests.

Delegation of Authority and Responsibility

In a December 15, 2003 memorandum from DOE Deputy Secretary Kyle McSlarrow (DOE, 2003b) to Robert Card, Under Secretary for Energy, Science, and Environment, and Linton Brooks, Under Secretary for Nuclear Security, the

[1]DOE has four strategic goals that support its mission: "(1) Defense Strategic Goal: To protect our national security by applying advanced science and nuclear technology to the Nation's defense; (2) Energy Strategic Goal: To protect our national and economic security by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy. (3) Science Strategic Goal: To protect our national and economic security by providing world-class scientific research capacity and advancing scientific knowledge. (4) Environment Strategic Goal: To protect the environment by providing a responsible resolution to the environmental legacy of the Cold War and by providing for the permanent disposal of the Nation's high-level radioactive waste" (DOE, 2003c, p. 3).

deputy secretary delegated responsibility for implementing RPAM to the program secretarial offices (PSOs). The deputy secretary also stated that:

> I am committed to improving the management of our real property assets. Successful implementation of the Order [RPAM] will enable the Department to better carry out its stewardship responsibilities, and will ensure that its facilities and infrastructure are properly sized and in a condition to meet our mission requirements today and in the future. I expect your leadership in implementation of RPAM within your organizations. (DOE, 2003b, p. 1)

Although RPAM contains reporting and oversight requirements, the delegation of authority from the deputy secretary to the under secretaries, assistant secretaries, program managers, site managers, and federal facility managers raises issues that concern the committee. (See Figure 2-1 for a chart of RPAM F&I authority and responsibility.) The committee believes that even though authority is delegated, senior executives retain the ultimate responsibility for the effective implementation of RPAM through both reporting and ongoing evaluation of subordinates' performance in achieving the desired goals. Effective evaluation will require the identification and implementation of effective metrics and their consistent application throughout the department. It should be abundantly clear that executives at the highest levels are ensuring life-cycle stewardship of DOE F&I.

Responsibility was described by Admiral H.G. Rickover as a unique concept that can reside in only a single individual. He noted that one may share it with others, but one's responsibility is not diminished. It may be delegated, but it remains with the delegater; it may be disclaimed, but it cannot be divested. Once responsibility is rightfully assigned, no evasion, or ignorance, or passing of blame can shift the burden to someone else. Unless a senior manager can point a finger at the man or woman who is responsible when something goes wrong, then responsibility has never been assigned.

The committee believes that even with the delegation of authority, it is the responsibility of DOE leaders to ensure the department's life-cycle stewardship of F&I. Issues such as the sufficiency, utilization, condition, and disposition of facilities need to be addressed at all levels of the department, beginning at the top. DOE reliance on contractor execution creates a situation where operational liabilities are shared among site contractors and federal employees. However, overall responsibility and accountability for the condition of F&I and for the general health, safety, and welfare of employees and the public will always fall back to DOE.

The committee observed that, in some cases, DOE site office employees have diminished authority and limited resources to direct the actions of contractors, resulting in a loss of continuity of authority in executing corporate directives. For example, at one of the sites visited by the committee, members learned that the DOE site staff had been told to discontinue directing the actions of the site contractors in an effort to avoid change order requests from the contractors. While this practice may have reduced short-term cost increases, the

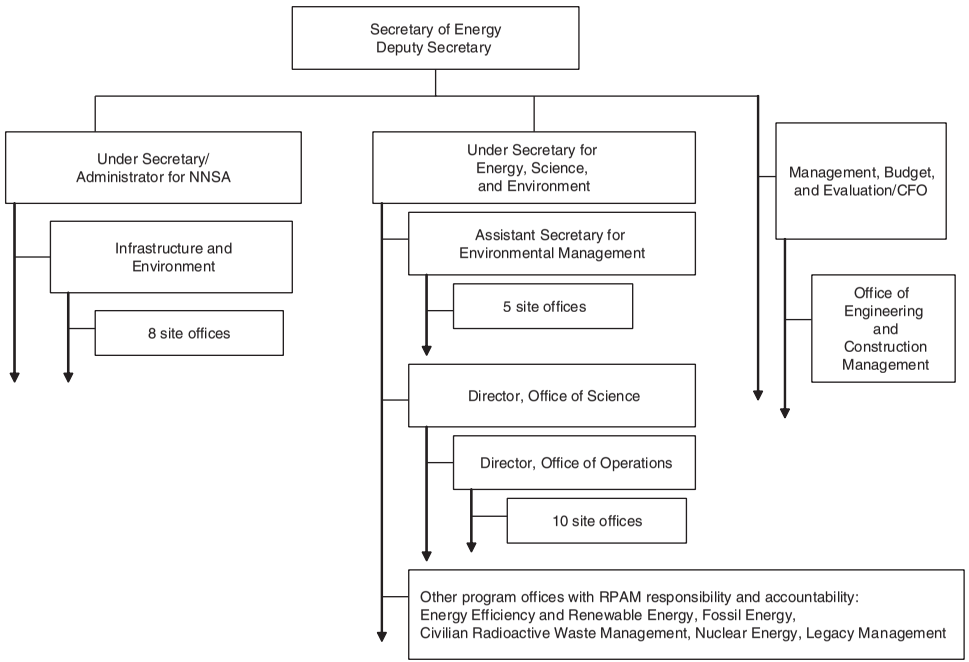

FIGURE 2-1 Organization chart for U.S. Department of Energy Real Property Asset Management (O 430.1B) accountability.

long-term effect was to diminish the role and responsibility of DOE staff and to prevent the necessary control and influence traditionally embodied by DOE staff.

Consistent Implementation of Policies

As noted above, implementation of RPAM was delegated by the deputy secretary through his memorandum of December 15, 2003 (DOE, 2003b). The committee's review of subsequent actions through March 2004 shows inconsistent implementation processes employed by NNSA, the Office of Science (SC), and the Office of Environmental Management (EM). While progress has been made by all programs, the inconsistencies reduce the overall rate of improvements that could have been achieved in the department's management of real property assets. The committee is concerned that DOE's plans for implementing RPAM lack complete guidelines, common metrics, and evaluation processes, and that training for federal facility managers is only in the pilot stage of development. The committee believes that a facilities management manual, detailing how to implement RPAM and the best process to achieve implementation success, could increase the rate of improvement of DOE facilities management. In the absence of an F&I management manual, a clear statement of the characteristics of excellence of performance should be made by senior DOE management.

Life-Cycle Stewardship

DOE's current approach to life-cycle F&I stewardship is fragmented. The department assigns primary responsibility for facilities planning, development, and operations to site managers and contractors. Headquarters controls critical decisions for line item projects (greater than $5 million), but smaller projects and ongoing operations are delegated to site offices. Disposition of excess facilities is overseen by the site office, but a third party, EM (or the proposed Office of Future Liabilities), is responsible for the disposition of contaminated facilities.

This practice of multiple handoffs in F&I management contributes to a situation in which no one party is responsible and accountable for the overall success of the life-cycle stewardship of F&I. Indeed, the committee observed instances where the involvement of multiple PSOs, acting as the lead PSO or tenant, resulted in the failure of stewardship responsibilities. For example, at the NNSA Y-12 site, there is a contaminated excess laboratory that had been an SC facility but there are no plans for SC, EM, or NNSA to undertake the necessary disposition of the facility; and at the Savannah River Site, the lead PSO (EM) had no plans for the long-term needs of the NNSA facilities that have an ongoing mission on the site. (EM has only recently recognized its responsibilities as the site lead PSO to maintain the facilities' mission readiness for tenants that will use the site after EM's mission is completed.)

The committee has observed that successful corporations in industry, such as

DuPont, have a more integrated view of managing the facility life cycle. DuPont's definition of responsibility for facilities, from inception through demolition, recognizes the detailed management attention needed during the entire life cycle and that decisions made at any one point in the facility's life cycle will affect future actions (DuPont, 1996). DuPont's approach also ensures that existing assets are properly maintained, renewed, and utilized, and that construction of additional assets is approved only after existing facilities are evaluated and there is a clear business case for the new assets. An annual review ensures that all facilities add value, or that they are prioritized for revitalization or elimination. See Figure 2-2, Asset Life Cycle, for an illustration of DuPont's approach to facilities life-cycle management.

The 1998 NRC report *Stewardship of Federal Facilities* noted that:

> An owner is responsible for funding not only planning, design, and construction, but also maintenance, repair, replacement, alterations, and normal operations, such as heating, cooling, and lighting, and finally, demolition. Failure to recognize these costs and provide adequate maintenance and repair results in a shorter service life, more rapid deterioration, and higher operating costs over the life cycle of a building. . . .
>
> The full life cycle costs of new facilities are considered in the current federal

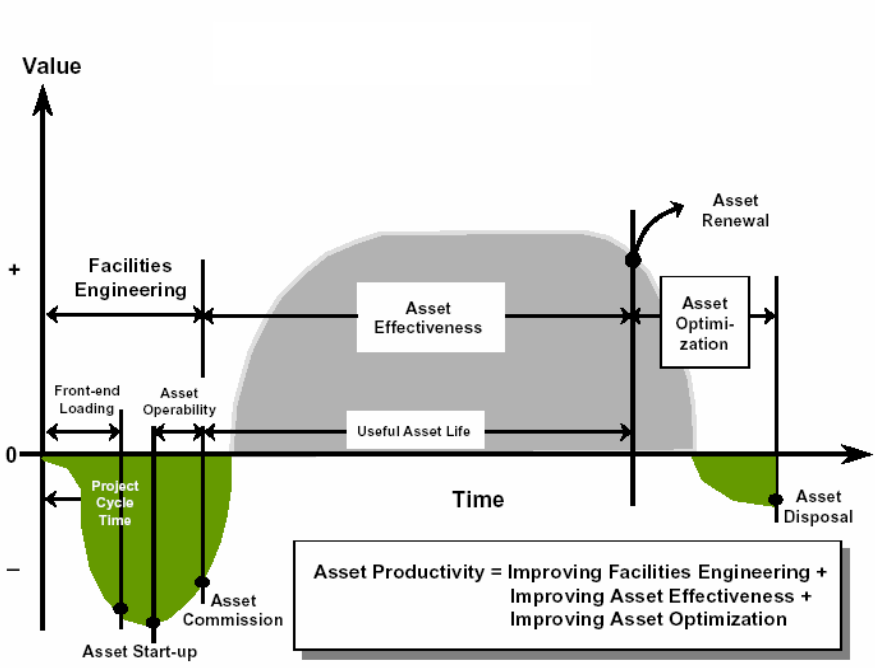

FIGURE 2-2 Asset life cycle. SOURCE: E.I. du Pont de Nemours and Company. Copyright © 2004, reprinted with permission of E.I. du Pont de Nemours and Company.

> budget process. . . . The costs of designing and constructing a new facility, then, may receive considerable scrutiny during budget hearings, but the budget process is so structured that 60 to 85 percent of the total costs, the cost of operating and maintaining the facility, do not receive the same scrutiny. Thus, the federal budget process is not structured to consider the total costs of facilities ownership. (NRC, 1998, pp. 13-14)

DOE, like other federal agencies, is faced with developing its own policies and procedures to address its life-cycle F&I stewardship responsibilities.

The objective of the previous DOE asset management policy, Order 430.1A, Life-Cycle Asset Management (LCAM) (DOE, 1998), which was replaced by RPAM, was that the management of physical assets from acquisition through operations and disposition be an integrated and seamless process linking the various life-cycle phases. Although DOE failed to fully achieve the LCAM objective the committee believes the objective is still valid. RPAM focuses on management procedures and performance measures but it also needs to consider the desired outcome—that is, effective life-cycle F&I stewardship.

ORGANIZATIONAL STRUCTURE

At DOE, the functions of facilities and infrastructure management are currently dispersed throughout the organization, with responsibilities distributed among the National Nuclear Security Administration (NNSA), the Office of Science (SC), and the Office of Environmental Management (EM), which each have responsibility for multiple sites and have been the focus of this assessment. Other programs that have direct F&I responsibilities defined in RPAM include the Office of Fossil Energy, the Office of Civilian Waste Management, the Office of Energy Efficiency and Renewable Energy, the Office of Nuclear Energy, Science, and Technology, and the Office of Legacy Management. The Office of Management, Budget, and Evaluation (OMBE) and the Office of Engineering and Construction Management (OECM) have no direct F&I management responsibility but provide departmental policy and staff support functions. The committee believes that DOE's asset management is adversely influenced by the diverse approaches to F&I inherent in this broad decentralized organization.

The central organization in DOE for F&I issues is OECM. OECM developed the RPAM and is currently responsible for the following functions:

- maintaining the Condition Assessment Survey (CAS), Condition Assessment Information System (CAIS), and Facilities Information Management System (FIMS),
- developing training materials,
- observing and reviewing PSO activities, and
- developing reports for senior managers based on FIMS data.

However, critical F&I functions such as the implementation of RPAM, the identification and deployment of best practices, development of performance measures and targets, determination of budget targets and allocation of resources, and quality control and oversight have been delegated to the PSOs and to their respective site offices. The result is that DOE F&I management activities are fragmented and implemented with varying degrees of effectiveness.

Centralized facilities management allows a decision maker to set priorities across all sites in order to maximize performance of the entire complex, whereas decentralization of facilities management often results in independent decisions based on factors unrelated to mission-based facilities needs. In industry, a facility's funding could be based on the leadership's influence in the organization or on the current success of a product in the marketplace. Neither of these factors has anything to do with the condition of the facility or life-cycle stewardship. In DOE similar decision making may occur based on the prominence of a project. A centralized approach to decision making places the strategic direction for the facilities at a single point. The M&O contractors can deal with the tactical and operational decisions; however, DOE should not delegate the strategic, mission-critical decisions that depend on centralized facilities management.

Comparison of Organizational Models

A recent study by the Corporate Executive Board's Real Estate Executive Board, entitled *Aligning the Real Estate Organization: Enabling Fast Response to Business Needs* (CEB, 2004), concluded that the design of the corporate real estate (CRE) organization is a key factor in meeting a number of current challenges facing the CRE executive, including alignment with business needs, cost reduction, and efficiency enhancement. All of these items are also critical to the success of DOE programs. In choosing the optimal organizational design, the CRE executive needs to decide on the appropriate level of centralization and strike a balance between functional and regional alignment. The governance spectrum runs from fully centralized to fully decentralized, with a hybrid model in the middle. The study found that 64 percent of companies are primarily centralized in their CRE organizations, with 22 percent hybrid and only 14 percent decentralized. Furthermore, the vision for the future estimates those numbers at 77 percent, 14 percent, and 8 percent, respectively.

The trend of the corporate approach to F&I management is clearly toward the centralized and functional CRE model, which allows companies to:

- easily map decisions to corporate needs and strategies (i.e., overall DOE strategies and objectives),
- leverage economies of scale,
- enforce consistent decision-making procedures,

- provide global perspective and develop best practices across business units and geographies,
- develop core competencies, and
- assist regional or local operations with centralized resources.

The U.S. Navy's Commander of Naval Installations Command (CNI) is an example of a government organization that has reaped the benefits of stronger central F&I authority. The Navy recently undertook initiatives that resulted in unifying the installations and service providers under a single installation management organization that is responsible for shore installation support to the fleet. The mission of CNI is "to provide consistent, effective and efficient shore installation services and support to sustain and improve current and future fleet readiness and mission execution" (Navy, 2003). This centralized responsibility has reduced redundancies and established clear operational control of resources by creating a single responsible office that is an advocate and point of contact for naval shore installations, and by integrating management of the 16 naval regions, including 98 naval activities around the world, into one central structure for resource policy and business guidance. DOE could also look to DuPont, which supports a mature facilities and infrastructure organization that focuses on achieving desired results in DuPont's financial performance by clearly aligning F&I performance with the corporate mission.

Successful private corporations, such as DuPont, place the authority and responsibility for F&I at the level of senior vice president. At DOE, the deputy secretary is the departmental chief operating officer and is therefore the senior responsible authority for institutional accountability for addressing management issues and leading transformational change (GAO, 2004). For DOE's F&I issues, the deputy secretary's responsibilities should include: strategic planning; oversight of compliance with key directives and orders; tracking and documentation of management performance for all DOE facilities; definition of key operating metrics and benchmarks; training of an adequate, qualified F&I management staff; and assistance to the secretary in the evaluation of the competency and performance of key DOE personnel and contractors. The deputy secretary has delegated most of the day-to-day responsibilities for the policy and oversight activities to OECM while the PSOs have been delegated the direct responsibility for implementing F&I stewardship. Thus, in order to elevate the strategic importance of F&I in DOE and improve the level and consistency of F&I performance, the committee believes that OECM should be strengthened (i.e., given additional responsibility, authority, and resources) to encompass including the following:

- Analysis and review of data used in FIMS and CAIS;
- Review and interpretation of CAS data;
- Planning and implementation of F&I projects as a unified effort across all

PSOs to support funding and performance of DOE's entire facilities complex;
- Establishment of specific metrics to be used in evaluating the performance of all PSOs using consistent criteria;
- Preparation of specific guidelines relating to consistent implementation of RPAM;
- Promotion of significant and meaningful sharing of best F&I management practices across all PSOs;
- Periodic audits relating to essential performance measures reported by the site management teams;
- Development and/or refining of policies and procedures for the purpose of creating durable and long-lasting directions and implementation of F&I management; and
- Oversight to ensure that existing and new facilities support DOE's missions, are fully justified, and are developed efficiently by employing rigorous life-cycle and project management methods.

These functions should be undertaken by qualified personnel with multidisciplinary experience and expertise in facilities management, environmental management, energy and utility services, and capital acquisition projects. OECM's authority in ensuring consistent application of best practices should be unequivocal.

Facilities and Infrastructure Executive Steering Committee

The DOE Facilities and Infrastructure Executive Steering Committee (FISC) was established to guide the overall direction of real property asset management in the department and promote the resolution of cross-program issues. FISC is composed of senior-level representatives of the DOE program offices that have responsibilities for real property assets. It is sponsored and coordinated by OECM by virtue of a departmental charter that expires in 2004.

The committee reviewed the FISC charter and it is the committee's opinion that FISC should continue to serve as an executive-level action arm to assist with implementation and ongoing support for RPAM. The steering committee could also be the primary vehicle for implementing the actions discussed in this report. FISC should continue to be led by OECM in a strengthened and fortified position with senior representatives from all PSOs, and should continue to employ ad hoc working groups. The committee also believes that FISC needs to be chartered as a standing committee with performance measures to assess its success. Best practices, once identified, reviewed, and accepted by FISC (probably through an appropriate working group), should become DOE standard practice and not subject to further debate by program offices, sites, and contractors.

PROCESS IMPROVEMENT

In reviewing the management history of DOE, the committee found that many excellent management concepts related to facilities and infrastructure stewardship were developed and issued in the form of orders to field offices, but that they did not result in any significant change in F&I performance (DOE, 2000). The process of issuing policies is limited as an effective communication tool and change agent. For DOE to succeed in addressing its facilities and infrastructure challenges, it needs to articulate the problems, identify possible solutions, develop partnerships and create opportunities for collaboration among managers at all levels, develop training and provide tools, monitor progress, and provide incentives for participation and consequences for nonparticipation. RPAM provides a structure but meaningful change will require action.

Human Capital and Knowledge Management

RPAM specifies that "a qualified DOE Federal facilities management staff must be assigned at cognizant headquarters offices and field elements to provide for implementation of this Order and to ensure accountability" (DOE, 2003a, p.16). However, the order does not identify the qualification requirements and therefore each office will determine its own version of what is required. OECM is responsible for managing the certification program for DOE project managers and real estate specialists and has prepared a draft RPAM certification course. It appears logical that OECM should also be responsible for establishing department-wide qualification requirements for facilities management at all levels.

For ongoing support of practices to improve real property asset management, the committee believes it is important that the organizations and individuals charged with the implementation of RPAM also be charged with developing a qualified DOE federal facilities management staff and that they have the support of DOE senior management for this effort. The committee also believes the OECM is well positioned to take the responsibility to lead this effort. Three initiatives should be implemented to foster this support.

- A facilities management forum for facilities managers and program officials to reach consensus on issues such as performance measures;
- A process to identify and promulgate best practices to be mandated for use across DOE; and
- A facilities management training and career development program.

Facilities Management Forum

The committee believes that a critical part of creating a successful facilities management community is a vibrant facilities management forum for the discus-

sion of new facilities management ideas as well as a mechanism to promote the health and growth of the community. A facilities management forum is a platform for facilities managers and program officials to reach consensus on issues such as the skills needed by DOE employees and contractors. It is also an excellent mechanism for individuals to seek assistance for tackling difficult issues. As mentioned previously, the committee believes that OECM should be the organization to host such a forum and that FISC should be involved in its development.

Best Practices

The committee believes that OECM should develop processes and procedures to identify best facilities management practices and promulgate them across DOE. Without these processes and a facilities management forum, the transfer of successful practices is unlikely to occur, thus reducing significantly the effectiveness of efforts to improve F&I management at DOE. The need for such an effort is justified by the significant variation in the maturity and competence of facilities management capabilities among the DOE sites visited by the committee. Continued implementation of RPAM could be enhanced with minimal effort if the effective practices and processes established at some of the labs were implemented throughout the department. For example, Lawrence Livermore National Laboratory (LLNL) was one of the labs selected as a pilot site for a cost-effective maintenance management program in response to a congressional mandate to provide models for improving facilities management in the DOE. In August 2003, LLNL issued its Pilot Program Report (LLNL, 2003), which identified the practices and processes used along with management accomplishments. The most promising practices identified by LLNL are listed below:

- A single system for counting and categorizing real property inventory;
- A single valid engineering-based system for assessing facility conditions with adequately trained personnel and multiple levels of review;
- Prioritized budget allocations based on physical conditions, mission relevance, life-cycle costs, and budgets;
- Charges to users of an annual maintenance fee based on the number of square feet used;
- A real property maintenance budget controlled by a central office with power to shift resources to facilities in the greatest need;
- A maintenance system for correcting low-value deficiencies and conducting preventive maintenance;
- Training and certification of facility and project managers; and
- Training for leadership development.

The committee was impressed with the management initiatives undertaken at LLNL toward establishing effective processes and practices, and with the progress

made in their implementation. While much has yet to be accomplished to overcome past problems, the effects and accomplishments to date have improved the situation significantly. The committee believes that the early implementation of RPAM throughout DOE would be enhanced if all department sites used LLNL practices and processes as models. Although some specific LLNL activities, processes, and tools may not be directly applicable to all DOE sites, the committee believes they should be considered for adoption and adapted as necessary. If the LLNL program activities are to be considered for DOE-wide use there will need to be more documentation and training for new users.

As mentioned previously, the committee believes that OECM is well positioned to coordinate the development of mechanisms to effectively identify best practices and rapidly communicate them to those charged with facilities stewardship at DOE. The committee also urges that the use of clearly established "best practices" be mandated. A best practice is one that has been reviewed, vetted, and accepted by FISC for use throughout DOE. Thus its use throughout the department should not be subject to frther program review and debate.

Facilities Management Career Path

A formalized training program that meets the technical and management needs of the positions involved and a designated career path that defines the training and experience needed for advancement are essential to the long-term implementation of RPAM. The committee is encouraged by the progress made by OECM in establishing the draft RPAM Course (PMCE 07), which will assist in providing consistent and repeatable RPAM implementation throughout DOE. The committee believes that this training effort should be expanded to establish a core facilities management curriculum and a facilities manager career path similar to the Project Management Career Development Program (PMCDP).[2] Such a curriculum could be used to train personnel for the various levels of facilities management assignments at headquarters and in the field. More importantly, this effort could provide DOE with the required cadre of facilities management professionals, knowledgeable in DOE processes and procedures, to move among the various government positions.

In providing the oversight required of facilities stewardship, the committee believes that professional licensing is an important mechanism that could be used by DOE to raise the credentials, stature, and credibility of facilities engineering staff. Just as the PMCDP defines the qualifications for various levels of project

[2]DOE Acquisition Career Development Program (Order O 361.1A) states that "The PMCDP establishes a well-defined career path that includes certification, minimum training and continuing education (CE) requirements, and project responsibilities that are commensurate with qualifications" (DOE, 2004, Chapter IV, Appendix A, p. A1).

management responsibilities, DOE should define the qualifications for planning, evaluating, and managing F&I and ensure that federal and contractor personnel are qualified to undertake their assigned tasks.

FINDINGS AND RECOMMENDATIONS

Finding 2a. DOE is coming from a past of failed stewardship of its facilities and infrastructure and has begun to address this challenge through new policies and procedures, but implementation is inconsistent across the department. Strong leadership will be needed to overcome the impediments caused by decentralized and dispersed responsibility and by reliance on contractors to achieve the department's facilities stewardship objectives. A successful F&I stewardship culture needs management at all levels to take ownership and responsibility for addressing the life-cycle requirements for F&I. DOE leaders need to ensure that the department's missions are supported by its facilities and infrastructure.
Recommendation 2a. DOE needs to inculcate a facilities stewardship culture that embraces a central management approach to ensure that:

- There is a clear understanding and acceptance of the strategic role of F&I in program mission performance and success;
- There are well-defined performance measures for facilities management that are tied to the achievement of strategic goals;
- Sufficient guidance is provided for efficient and effective implementation of policies and procedures;
- DOE and its contractors take ownership and responsibility for addressing the life-cycle requirements for F&I;
- The best practices and principles are adopted and applied at all levels of DOE and are integrated into departmental policy and procedures;
- The allocation of roles and responsibilities between DOE and its contractors is clearly defined, and managers at all levels are held accountable; and
- DOE employees and contractors are trained to meet or exceed their performance requirements.

Finding 2b. The DOE 2003 strategic plan does not provide sufficiently clear focus to the role of F&I in achieving the department's missions and this lack of strategic focus may impede the effective implementation of RPAM. There is an absence of a clear, consistent link between strategic goals and facilities stewardship.
Recommendation 2b. DOE's strategic plan should include a facilities and infrastructure goal that is applicable to all missions. The plan should include a vision that encompasses the goal of quality performance as well as supporting activities, including both project and F&I management. The goal should also include performance targets.

Finding 2c. The trend of the private corporate approach to F&I management is toward centralized and function-defined organizations. Following the current trends in corporate asset management, the roles of DOE central staff organizations need to be strengthened.
Recommendation 2c. In order to increase central control and elevate the strategic importance of F&I, OECM's responsibilities, authority, and resources should be strengthened.

Finding 2d. The Facilities and Infrastructure Executive Steering Committee (FISC) was established in early 2002. This committee could serve as a valuable executive-level action arm to assist with implementation and support for RPAM.
Recommendation 2d. FISC should be reestablished as a standing committee and led by OECM. The consensus nature of the existing charter should be modified so that once best practices are identified, reviewed, and accepted by FISC they become standard practices throughout the department.

Finding 2e. In the recent past DOE has issued orders setting forth many excellent management concepts related to F&I stewardship. But these orders have not resulted in any significant change in F&I performance. It is important that those charged with the development of processes and procedures have the support of DOE senior management and the resources to initiate change. In order to manage change, DOE needs to identify performance measures and performance targets to define success, address a wide spectrum of parameters that are relevant to all stakeholders, and provide the means for programs to succeed.
Recommendation 2e. The committee recommends three initiatives to support F&I process improvement. OECM should identify appropriate process metrics (as discussed in Chapter 4) and managers at all levels should be held accountable for performance.

- A facilities management forum for facilities managers and program officials to reach consensus on issues such as performance measures;
- A process to identify and promulgate best practices (such as those documented in the LLNL pilot program) to be mandated for use across DOE; and
- A facilities management training and career development program.

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3

Infrastructure Management Challenges and Opportunities

> It is the capacity for maintenance which is the best test for the vigor and stamina of a society. Any society can be galvanized for awhile to building something, but the will and the skill to keep things in good repair day-in and day-out are fairly rare.
>
> —Eric Hoffer, *Working and Thinking on the Waterfront*

INTRODUCTION

Successful facilities and infrastructure (F&I) management programs have a balanced blend of resources composed of funding components for maintenance, recapitalization, and demolition. While it is essential that the level of funding be fair and equitable, even an underfunded F&I program can show substantial success when it has a balanced portfolio that integrates all appropriate components. Successful programs are based on recognition of F&I's contribution to operational program success. In the competition for funds among operational programs and F&I, funding priorities cannot concentrate on program funding to the detriment or exclusion of F&I. When all's said and done, successful F&I management requires a systematic approach that is consistent over time and place for assessing F&I needs and establishing priorities.

This chapter discusses the management challenges that DOE faces as it tries to achieve the objectives of Real Property Asset Management (Order O 430.1B) (RPAM), and describes examples of how these challenges have been met in other government organizations and industry. The specific challenges of oversight and quality control faced by DOE managers are also discussed.

MANAGEMENT CHALLENGES

A number of recent reviews by the U.S. Government Accountability Office (GAO) and DOE have identified DOE facilities and infrastructure management challenges (DOE, 2003a; GAO, 2003a, 2003b, 2003c, 2001), and DOE has responded to these critiques by developing improved policies and procedures. A GAO report acknowledged the improvement initiatives, but concluded that the implementation of the initiatives remains a management challenge (GAO, 2003a). Although some progress has been made in DOE program offices and sites, the improved practices and procedures have not been fully adopted for implementation throughout the department. The committee noted this inconsistency in its preliminary report (NRC, 2004a) and continues to observe an inconsistent response to DOE Order O 430.1B, Real Property Asset Management (RPAM).

The objective of RPAM is to

> establish a corporate, holistic, and performance-based approach to real property life-cycle asset management that links real property asset planning, programming, budgeting, and evaluation to program mission projections and performance outcomes. To accomplish the objective, this Order identifies requirements and establishes reporting mechanisms and responsibilities for real property asset management. (DOE, 2003b, p. 1)

The committee enthusiastically endorses this objective and believes that the policies in RPAM are encouraging, as they demonstrate that DOE is beginning to focus on effective management of real property. RPAM is a commendable first step that identifies expectations of DOE site managers and contractors for F&I management, and DOE should continue on the course set by RPAM. However, the committee believes that improvements and additional actions are needed to enhance RPAM's effective implementation and ultimate success in achieving its objectives.

The committee believes that RPAM needs the following to improve facilities management and infrastructure renewal at DOE:

1. A clear statement of motivation that ties objectives to a corporate, holistic, and performance-based approach to achieving DOE's missions;
2. A clear quantitative statement of organizational F&I objectives tied to incentives for compliance and consequences for noncompliance;
3. Metrics that quantify condition assessment and connect facilities condition to mission, goals, and objectives in order to justify budget decisions;
4. A single software database tool to track the condition of facilities as well as the costs of repair and replacement; and
5. A rigorous quality assurance program customized for F&I.

A clear quantitative statement of DOE's organizational F&I objectives, with incentives for compliance and consequences for noncompliance, is absent from

RPAM and from the department's strategic and long- and short-term plans. DOE has stated that it desires a real property asset inventory that is properly sized and in a condition to effectively support its mission. Yet to accomplish this goal, RPAM and related planning documents need to provide a quantitative statement of overall size and condition objectives for DOE F&I. The associated metrics in RPAM—the asset utilization index (AUI) and the asset condition index (ACI)—have little meaning unless and until specific goals are established and taken to heart by the department. Statements such as "The program will attain an AUI of 0.90 by 2005" or "Budget execution will be focused to attain an ACI of 0.95 by 2006" are examples of the specific goals needed to clarify DOE objectives. (Note that the quantities in this example are illustrative only; actual values need to be determined by DOE to reflect the program's and the department's goals. Care must be taken to set metrics that will result in the outcomes desired by the department. See Chapter 4 for a discussion of the impact of performance measures on management decisions.) The deputy secretary's directive that programs budget at least 2 percent of the replacement plant value (RPV) for maintenance is a step forward; however, as discussed later, a more robust measure for determining maintenance budgets is needed. Establishing clear objectives leads to the development of an action plan or at the minimum a milestone chart of progress, which then supports a factual review of progress and correction of process along the way.

DOE will not attain its facilities goals through a business-as-usual approach. If meaningful facilities management improvement is to occur, changed business practices need to be adopted throughout the department, tracked as progress is made, and corrected where necessary.

The metrics currently defined by RPAM quantify condition assessment but do not connect facilities condition to DOE mission, goals, and objectives. RPAM appropriately requires the definition of performance goals and measures for F&I, and ostensibly requires that these goals and measures be consistent with programmatic outcomes. The committee believes that a clear connection between programmatic objectives and performance measures is key to long-term improvement of facilities management. Tying facilities management to programmatic needs is necessary in order to foster the organizational determination to manage facilities properly. Furthermore, while RPAM identifies what it considers good performance, it does not specify when or how it intends to achieve this level of performance, nor does it explain why a specific level of performance is important in relation to programmatic needs.

The shortcomings of the budget and planning process established by RPAM are illustrated by comparison with the Department of Defense (DoD) program for facilities sustainment, restoration, and modernization. This program establishes department-wide sustainment budget targets based on the real property inventory and recapitalization budget targets based on a recapitalization rate (in years). As such. this model is significantly more proactive than the budget tools used by DOE—for example, deferred maintenance as a percent of RPV, which is retroac-

tive. The committee notes that the National Aeronautics and Space Administration has adopted a program with metrics similar to those of DoD and suggests that DOE evaluate the DoD facilities sustainment model for adaptability to its needs. The DoD facilities sustainment and recapitalization construct are discussed in more detail below.

Overall, the committee believes that RPAM is a sound policy document. The management challenges discussed above involve the detailed guidance and direction needed for effective implementation of the policy. The committee recommends that these issues be addressed through a manual that clearly defines implementation procedures and sets performance targets.

Facilities Information Management System

RPAM does not prescribe the use of a single software database tool to track both the condition of facilities and the costs of replacement and repair. However, RPAM Attachment 5 appropriately identifies two major components of an effective facilities management strategy:

- A detailed, centrally controlled, computerized database of facilities inventory information, and
- Accurate knowledge of the condition of facilities and of the costs to replace and repair facilities systems and components.

The Facilities Information Management System (FIMS) is DOE's facilities inventory database (DOE, 2003c). FIMS is managed and maintained through broad user involvement in the Facilities Data Development Committee and is further supported by a FIMS Advisory Committee and FIMS Technical Monitors. The committee is impressed by the consistent, robust, and thorough process validation and feedback loops provided in FIMS to ensure an up-to-date and complete facilities inventory. The committee wholly supports the provision that requires all DOE sites to input data. This is a system that has consistency, apparent reliability, and thus credibility both inside and outside DOE.

Condition Assessment System

The committee could not find the same measure of effectiveness regarding a standard condition assessment survey (CAS) (DOE, 2003d). Despite identifying such a system as the second element of an effective facilities strategy, the department, through RPAM, has not established the same mandated compliance for this effort. Although OECM has developed a Condition Assessment Survey and Condition Assessment Information System (CAIS) that appear to fulfill departmental requirements, their use is not required. Rather than mandating consistent use and providing the associated support staff (as is done with FIMS), the department has

allowed sites to use CAS/CAIS "or equal." It is difficult to understand why use of this second essential input to a facilities strategy was left arbitrary, while the use of FIMS was mandated. As stated in RPAM, "real property data elements in . . . the CAIS . . . must be consistent with the corresponding FIMS real property data elements." A standardized and mandated CAS/CAIS would assist in ensuring such consistency.

The committee also notes that an auditing mechanism is needed for CAS/CAIS.[1] Sites are required to have a quality assurance plan for their FIMS data, but no such requirement exists for CAS/CAIS. In response to the committee's inquiry, the Office of Science (SC) stated that, "since most of the SC sites rely on nationally recognized CAS/CAIS contractors to perform the surveys, it has been assumed that a quality product is being delivered." The committee considers the level of effort for quality assurance of condition assessments to be insufficient. The success of the DoD program is in large part due to the consistent department-wide use of the DoD sustainment model. The committee recommends that CAS/CAIS use be required throughout DOE.

In addition, the committee believes that DOE's condition assessment procedures should focus on facilities that are critical to the agency's mission; on life, health, and safety issues; and on systems that are critical to a facility's performance. These procedures should optimize available resources, provide timely and accurate data for formulating maintenance and repair budgets, and provide critical information for the ongoing management of facilities.

Ten-Year Site Plans

The committee supports the RPAM requirement that sites develop and revise annually a ten-year site plan (TYSP). The committee believes that such a practice is critical for all DOE sites and that steps should be taken to ensure their quality and consistent development throughout the department. The use of TYSPs is an excellent mechanism to enforce the discipline of carefully considering the condition of current physical assets, their support of the site's mission, and the budgetary requirements for F&I to meet the planned mission objectives. The committee believes it is important that the TYSP document the planning process and contain supporting evidence of the basis on which F&I decisions have been made. The TYSP should clearly discuss the plan's impacts on F&I performance metrics as well as on the site's mission performance.

The committee also notes the title confusion between the NNSA ten-year comprehensive site plans and the RPAM ten-year site plans. The committee suggests that a single title be adopted for site planning documents of all PSOs.

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[1]The committee notes that in July 2004 NNSA contracted for parametric estimates to verify deferred maintenance data in CAIS.

SUSTAINMENT AND RECAPITALIZATION BUDGET CONTROLS

The committee reviewed several F&I planning and budget processes and identified those of Dupont and the Department of Defense (DoD) as examples of best practices. The Dupont facilities engineering process begins with the determination of customer needs and requirements, then maps the needs into a business plan, which is then interpreted and developed into a facilities plan (Dupont, 1996). The facilities plan incorporates elements of asset effectiveness, facilities engineering, and asset optimization to develop a joint business and facilities plan. The needs and requirements, business plan, and facilities plan are coupled together to analyze asset productivity and to support planning decisions.

The asset optimization process at Dupont is designed to be embedded in core business processes versus a stand-alone operation. The key thrust of the optimization process is directed toward businesses operating with a minimum net asset strategy that incorporates a "decapitalization" goal. The process recognizes the need to link the achievement of the organization's vision through its business plan to the facilities required to implement the plan. There are obvious differences between a business plan for private industry facilities, which are driven by financial return on investments, and a plan for DOE facilities, which are mission driven; however, as indicated in the NRC publication *Investments in Federal Facilities: Asset Management Strategies for the 21st Century,* the frameworks for making effective decisions are similar and include the following:

- Common terminology,
- A basis of shared information,
- Decision processes that are clearly defined and incorporate multiple decision points,
- Performance measures,
- Feedback process,
- Methods for establishing accountability, and
- Incentives for groups and individuals.

> Together these components support decision making related to facilities requirements and investments, create an effective decision-making environment, and provide the basis for measuring and improving facilities investment outcomes. (NRC, 2004b, p. 45)

The committee applauds the direction provided by the department's *FY2006–FY2010 Planning Guidance* (DOE, 2004a) that maintenance expenditures should be a minimum of 2 percent of RPV annually. However, the committee is concerned that this target, although based on NRC recommendations that maintenance expenditures should be 2 to 4 percent of RPV (NRC, 1990), is not sufficient for the long-term management of DOE assets. When applied to DOE assets, this judgment-based rule of thumb results in a range of about $1.5 billion between the 2 percent and 4 percent targets. The committee believes that DOE needs to develop historical data to refine the planning target for its facilities. It is critical

that DOE also develop useful metrics to assess what it needs to spend on an ongoing basis at each site and track its progress against those metrics. The committee believes that the current target is a productive first step, but encourages DOE to look beyond a simple rule of thumb to ensure that maintenance budgets for its facilities are adequate to meet current and future challenges.

Recapitalization Management

An assessment of four approaches to managing capital reinvestment was developed by the Pacific Partners Consulting Group (PPCG) (Beidenweg et al., 1998). The review assessed the cost, accuracy, impact on policy, and several other less critical factors affecting the robustness of four approaches for planning and budgeting for facilities capital reinvestment that included (1) physical plant audits, (2) plant depreciation, (3) fixed percentage of current replacement value, and (4) predictive maintenance based on facility subsystems.

PPCG did not identify a clearly best method, but rather focused on the strengths and weaknesses of each alternative. The analysis showed the benefits of the predictive maintenance model, which either achieved the best score or tied for the best score in 10 of the 15 subelements of the four criteria. This model does not depend on a physical audit of condition, but rather compares the inventory to industry standards for replacement costs and life-cycle predictions. The predictive maintenance model achieved the best score for impact on policy, accuracy, and robustness. The predominant weakness of the model results from its dependency on facilities inventory and the associated subsystem inventory in those facilities.

PPCG concluded that

> a combination of approaches may be the most effective strategy to meet an institution's specific needs. Including facility depreciation in the annual financial report has the advantage of highlighting to policy makers and governing bodies the fact that institutions use up physical assets. Seeking agreement to fund a facilities reserve or provide an annual operating budget based upon either calculated depreciation or a fixed percentage of RPV may be a successful approach to generate an annual stream of revenue. A predictive sub-system model could be used, inexpensively, to provide estimates of actual facility renewal and deferred maintenance needs. The predictive sub-system model can also be used to identify facilities and sub-systems that need further focused facility audits. (Beidenweg et al., 1998)

DoD Facilities Sustainment, Restoration, and Modernization Construct

In an attempt to further validate the perceived advantages of the predictive subsystem model, the committee examined the DoD Facilities Sustainment, Restoration, and Modernization (S/RM) construct (DoD, 2002).

The S/RM construct is an outgrowth of several years of DoD research into best practices outside DoD. Much of this research has been summarized by the National Research Council in *Stewardship of Federal Facilities: A Proactive Strategy for Managing the Nation's Public Assets* (NRC, 1998). Also, the S/RM construct represents, in part, DoD's response to problems identified in a 1999 GAO report on real property management practices in DoD (GAO, 1999). Finally, the S/RM construct has been designed to support and strengthen DoD's compliance with the Government Performance and Results Act and the Chief Financial Officers Act.

The challenges that DoD faced before applying the S/RM process appear analogous to those faced by DOE:

- Prior to S/RM, no single tool was employed throughout the agency to calculate facilities recapitalization rates and associated program funding levels. Each DoD component was using its own metrics and accounting. This appears similar to the inconsistencies presented by DOE's programs.
- There were difficulties in identifying what portion of various funding sources was being devoted to recapitalization. Similar inconsistencies and difficulties through some program budgets have led DOE to establish the cross-cut budget in an attempt to collect, identify, and understand expenditures.
- There was confusion among DoD branches regarding site recapitalization responsibilities vis-à-vis specific budgets. Again this mirrors the DOE's difficulties of site landlord responsibilities conflicting with other site program responsibilities.

The S/RM construct is based on the general assumption that facilities performance degrades as facilities age. Thus, S/RM posits "that full sustainment is the most cost-effective approach to managing facilities because it gains the most performance over the longest time for the least investment." However, S/RM acknowledges that "even with full sustainment, facilities eventually either physically wear out or become obsolete. Once facilities reach the end of their expected service lives, they must be replaced or extensively renovated or modernized (i.e., they must be recapitalized) if they are to continue providing adequate performance."

DoD established a Facilities Sustainment Model (FSM) in order to determine its sustainment requirements. Based on actual field inventories, FSM assesses sustainment requirements for a facility from its associated components or subsystems. The costs to sustain these components are calculated based on their respective quantities, unit costs to maintain, area cost factors, and inflation. By using this component approach, similar to the subsystem approach described above, even complex and unique facilities can often be referenced to standard sources, thus providing validity to the resulting summary sustainment requirements. For example, the Navy indicated that 93 percent of its current sustainment

costs have been estimated using standard, off-the-shelf commercially published resources. The resulting summary sustainment value provides management with the budget amount necessary to sustain the existing inventory. To the extent that changes in the inventory can be predicted, the sustainment model can be applied against the modified inventory and timeline (adjusted for inflation) to predict the required sustainment dollars needed for the future inventory.

The committee's discussions with DoD indicated that while 100 percent sustainment was still not attained in existing budgets, the information from the model gives decision makers the tools to determine the minimum acceptable sustainment level to be programmed (currently set at 95 percent of requirement) as well as to identify at what point in the out-years the 100 percent sustainment goal will be achieved.

Similarly, DoD developed the Facilities Recapitalization Metric (FRM). As with the sustainment model, DoD used its substantial inventory of commercial sources to establish a goal for an acceptable recapitalization rate of the DoD inventory, as an average of the wide variety of component elements. Thus the current DoD-accepted recapitalization rate goal of 67 years is a composite made up of 100-year rates for airfield aprons, ground drainage systems, electrical distribution systems, etc., averaged with 50-year rates for roads, railroad tracks, and heat distribution systems, with 25-year rates for pipelines and refrigeration plants, and with recapitalization rates for other F&I with shorter useful life expectancies. It is important to point out that the resulting recapitalization rate is designed as a macrolevel tool for corporate-level physical plant analysis. The rate to be applied to a smaller set of facilities or to even a single facility must be recalculated to the specific details of that facility.

With the service-life benchmark established as indicated above, DoD is then able to determine the budget program recapitalization rate by dividing the total value of assets (plant replacement value) by the investment amounts budgeted for facilities recapitalization. To the extent that recapitalization rates meet the goal, the budget is in balance with facilities requirements. Adjustments to the goal can then be assessed against appropriate sustainment impacts.

The committee believes that the DoD example illustrates eight important considerations for sustainment and recapitalization budget controls:

1. Both sustainment and recapitalization funding are needed to adequately support facilities and infrastructure. The basic commercial standards demonstrate the essential aspects of adequately funding both sustainment and recapitalization accounts. If one is underfunded there will be impacts in the other account.
2. An accurate facilities inventory is extraordinarily important to the operation of these models. Since DoD relies on the models to establish departmental programming values, there is an incentive to maintain accurate inventories throughout the system.

3. The FSM and FRM values are clear, consistent guidelines that can be shared from the most senior leader down to the most junior operator. They are understandable metrics that concisely capture an abundance of facilities processes. DoD representatives indicated to the committee that the secretary of defense had personally adjusted a service-level budget when he discovered that the service was underfunding its sustainment requirements. The committee believes that the secretary of energy should be able to apply similar attention and controls to DOE programs.
4. Since the DoD metrics are sensitive to inventory, there is an internal mechanism encouraging the components to reduce inventory. A larger inventory results in both higher sustainment values and higher recapitalization rates. Efficient budgeting strives to decrease these overhead values, thus providing the most efficient inventory.
5. The S/RM construct provides visibility and accountability of actions and the resulting budgets to all parties in F&I activities. Too often program managers are allowed to understate their program requirements by ignoring issues that are too complex to evaluate. Providing proper levels of facilities support is a function that frequently falls into this category.
6. The FRM encourages a life-cycle thought process in facilities management. The calculation to establish the FRM service-life benchmark requires an analysis of the components of the associated facilities along with their time-phased funding requirements.
7. The DoD process identifies the budget required to operate the facilities inventory accepted by the agency. By all measures this may seem obvious, but the S/RM construct can be a real eye-opener to those who never realized the actual costs required to adequately run the facilities needed to support the program and thus the full costs of the programs.
8. The DoD process also demonstrates a substantial reliance on established commercial standards. Thus the resulting products generally have been found to be more acceptable and reliable than products based solely on internally produced analyses.

The DoD transition to the S/RM construct is relatively recent with between one and two years' worth of effort expended in execution (and several additional years in review and implementation). Yet the committee is impressed by the advantages already achieved in this process. At a minimum, once fully implemented (i.e., once the underlying standards have been established and applied against an acceptable inventory), the S/RM construct exposes the cost of ownership for the associated facilities. Understanding the cost of ownership is a big step in ultimately identifying discrepancies and providing adequate F&I resources.

The committee believes that DOE should review the DoD S/RM construct and implement it to the extent deemed appropriate. The committee also recommends that DOE establish a corporate sustainment standard to be applied across

all programs and a DOE recapitalization rate for the overall plant. Budget formulation by programs should then be required to at least meet the required metrics.

CONSISTENT IMPLEMENTATION

RPAM requires the preparation of ten-year site plans (TYSPs) that are to be based on the condition of facilities, their relationships to mission needs, what needs to be done to support the mission on a priority basis, and the related estimates of costs and schedules. But RPAM does not address the federal facilities manager's oversight for the TYSP or for the implementation of an approved plan. RPAM defines some performance metrics but does not define a measure to fully assess implementation of the TYSP. At most sites the M&O contractor prepares the plan in accordance with DOE direction. The committee believes, however, that that there may be too much overall authority delegated to the M&O site manager and too few specific responsibilities assigned to the DOE site manager. As a result of these factors, the consistent implementation of RPAM may be compromised.

Review and Oversight

Additional definition of the expectations of DOE site managers and their responsibilities for oversight of contractor compliance and accountability is needed. This definition may not be appropriate for inclusion in RPAM, but nevertheless senior management needs to clarify its expectations. RPAM implements a 2002 management policy (P 580.1) with a principal goal of ensuring proper stewardship of real property assets (DOE, 2002). As the first level of oversight, the DOE site manager is responsible for oversight of contractor compliance and accountability. Policy P 580.1 requires that federal managers be responsible for F&I stewardship through proper planning, programming, budgeting, operation, maintenance, and disposal practices. Furthermore, DOE federal managers are responsible for ensuring that real property assets under their purview are managed with integrity and in compliance with applicable laws.

RPAM also provides for the review and approval of the TYSP by LPSOs and CSOs/PSOs. However, there is no provision, direction, or guidance provided for a consistent review and approval process. Good management practices should include a documented basis for the oversight process. A formal process should be developed and required for the review and approval of TYSPs, including definitions of the findings to be made and the timing of submittals. There also needs to be a process that includes requirements for all PSOs and DOE site managers to keep OECM informed of changes in program missions, budgets, and schedules as well as problems encountered in implementing the requirements in the order. NNSA has learned from implementing TYCSPs (or TYSPs) and addressing problems with process and quality control (described below) to create a guide for

developing ten-year site plans that has also been adopted by EM. The NNSA guide could be the basis for a consistent departmental process for TYSPs (DOE, 2004b).

Quality Control

A review of the DOE inspector general's audit report *Planning for National Nuclear Security Administration Infrastructure* (DOE, 2003f) on the reliability of TYCSPs for three NNSA sites has led the committee to confirm its prior conclusion that there is an urgent need for improvement in oversight, establishment of a quality assurance/quality control program, and development of more detailed direction for RPAM implementation. The IG's report found that the plans

- did not provide accurate assessments,
- did not identify and prioritize mission-critical facilities,
- used out-of-date information,
- did not have a standardized methodology for assigning the level of mission criticality, and
- did not include any guidance to help sites prioritize maintenance and repair needs.

The report recommended that NNSA develop and implement guidance establishing standard criteria for identifying mission-critical facilities and define the types of facilities to be included. Although based on a brief review, the committee believes that the IG's recommendations should apply throughout the department. The committee also notes that although there is room for improvement, the NNSA F&I planning and management procedures are more mature than those of other DOE PSOs.

The IG auditors assessed the significant internal controls and performance measures established under the Government Performance and Results Act of 1993 (GPRA) and concluded that the act did not address the need for complete and accurate site plans. However, GPRA does specify that annual performance plans should establish performance goals expressed in measurable forms and performance indicators to assess relevant outputs, and that they should provide a basis for comparing results with goals. This further illustrates the need for DOE to build on previously established objectives and requirements, and to establish more department-wide procedures, methods, and tools.

F&I Management Standards

The primary objective of the 1994 DOE *Criteria for the Department's Standards Program* (DOE, 1994) was stated thus: "Work is planned, performed and appropriately documented as meeting standards for protecting the environment

and the safety and health of the public and workers." It was added that achieving the objective would also:

- Allow for good judgment in planning work and allocating resources,
- Create consistency and stability in expectations and accountability,
- Maintain protection, while establishing a balance between cost and benefit,
- Permit judgment to be exercised at the appropriate decision level, and
- Increase effectiveness of work.

Establishing a standards program in support of facilities and infrastructure would provide similar benefits if the implementation of such a program were taken seriously and enforced by management at all levels.

The Work Smart Standards effort undertaken at LLNL is an example of what is involved when a program is taken seriously. This effort was considered to be a key component of DOE's Integrated Safety Management System (LLNL, 1998). Similarly, an F&I standards program could be the key to achieving the objectives of RPAM. The necessary coupling of F&I with program missions could well be called the integrated F&I management system. The committee believes that, whatever the name, the key to meeting the RPAM objective is the development and use of department-wide standards.

Contract Management Options

For the most part, DOE facilities and infrastructure are government owned and contractor operated. F&I stewardship responsibilities are part of the M&O contract for each site. DOE has structured its M&O contracts to be performance-based, cost-plus-award-fee contracts. The Federal Acquisition Regulations (FAR) state:

> (a) *Description.* A cost-plus-award-fee contract is a cost reimbursement contract that provides for a fee consisting of (1) a base amount fixed at inception of the contract and (2) an award amount that the contractor may earn in whole or in part during performance and that is sufficient to provide motivation for excellence in such areas as quality, timeliness, technical ingenuity, and cost-effective management. The amount of the award fee to be paid is determined by the Government's judgmental evaluation of the contractor's performance in terms of the criteria stated in the contract. This determination and the methodology for determining the award fee are unilateral decisions made solely at the discretion of the Government.
>
> (b) *Application.*
>
> (1) The cost-plus-award-fee contract is suitable for use when—
> (i) The work to be performed is such that it is neither feasible nor effective to devise predetermined objective incentive targets applicable to cost, technical performance, or schedule;

(ii) The likelihood of meeting acquisition objectives will be enhanced by using a contract that effectively motivates the contractor toward exceptional performance and provides the Government with the flexibility to evaluate both actual performance and the conditions under which it was achieved; and
(iii) Any additional administrative effort and cost required to monitor and evaluate performance are justified by the expected benefits.

(2) The number of evaluation criteria and the requirements they represent will differ widely among contracts. The criteria and rating plan should motivate the contractor to improve performance in the areas rated, but not at the expense of at least minimum acceptable performance in all other areas.

(3) Cost-plus-award-fee contracts shall provide for evaluation at stated intervals during performance, so that the contractor will periodically be informed of the quality of its performance and the areas in which improvement is expected. Partial payment of fee shall generally correspond to the evaluation periods. This makes effective the incentive which the award fee can create by inducing the contractor to improve poor performance or to continue good performance. (GSA, DoD, and NASA, 2001, 16.405-2)

As previously discussed, a robust facilities and infrastructure program, properly planned and executed with adequate funding, is an enabler for program objectives. Because DOE has delegated its facilities management authority to the site M&O contractors, it is important that the site contractors share DOE's vision and embrace the overall F&I policies and procedures. Because M&O contracts are performance based, F&I contract incentives need to be clearly identified to ensure effective F&I stewardship.

The committee asked OECM, NNSA, SC, and EM to provide a compilation of the performance-based contract metrics used at each site and the percentage of the total performance score that is determined by F&I stewardship performance. OECM deferred to the PSOs and the responses varied widely among PSOs and sites.

- NNSA indicated that the performance data are part of the annual performance evaluation plan developed by the DOE site office with input from headquarters. The data are collected, compiled, and retained at the DOE site offices, and become the basis for the federal appraisal of each contractor's F&I management performance.
- SC provided a comprehensive listing of the contractor performance measures for all labs and noted: "Percent of total award fee rating associated with infrastructure performance varies from lab to lab as shown." The percentage of incentive fee for F&I performance ranged from zero at Ames National Laboratory to a maximum of 11 percent at Oak Ridge National Laboratory.

- EM noted that "Facilities and Infrastructure Management performance is generally not identified as a specific fee-bearing activity in EM contracts. EM maintains the philosophy that infrastructure is a necessary part of performing EM's scope of work but is not a performance metric or fee item by itself."

As with so many other issues discussed in both this report and the preliminary assessment, the disparity and lack of consistency among PSOs and sites hinders department-level review of F&I status and improvement efforts. The committee believes that the long-term success of DOE's F&I stewardship depends on M&O contractors' consistent attention to their F&I responsibilities. This does not preclude DOE's responsibility to establish performance requirements and to evaluate processes and outcomes. Without appropriate attention, fractured and diffuse execution is inevitable. Incentive payments as established by the award-fee determinations are powerful tools for focusing contractors on what DOE considers important. The amount of emphasis on and consistency in F&I-dependent incentives will determine expectations among the contractors.

During its brief site visits, the committee observed an apparent, and not surprising, correlation between the level of importance placed on F&I by senior M&O contractor management and the quality of F&I stewardship. The committee notes that the award fee is not the only reason M&O senior managers are involved in F&I issues but it is a major factor.

The committee believes that OECM should take the lead in documenting the performance measures and award fees utilized throughout DOE M&O contracts and use this information to validate a set of best practices that should be considered for department-wide implementation.

The committee was asked to consider the possible benefits or problems that might occur if DOE F&I were managed under a separate contract from the site M&O contract. The committee believes that F&I management contracts should not be separate from program management contracts. It has been increasingly evident that F&I management and existing problems should not be considered independently of the implementation of program missions. Particularly for M&O contracts, mission activities can be affected adversely in many ways by independent F&I management activities. For example, the lack of clear, centralized management in a laboratory or complex would require the involvement of DOE to resolve frequent interface considerations and issues between the mission and facilities activities. Planning and implementation of both activities should be continuous and interrelated. Lack of a clear management authority could also result in duplication of effort in assessing interface impacts and would dilute the overall responsibility to DOE that presently exists in a single M&O contractor. The shutdown or timing of facilities for routine and special maintenance is likely to have an impact on the timing and ability to conduct mission activities. Unavailable or reduced infrastructure services could also affect the conduct of mission activities.

FINDINGS AND RECOMMENDATIONS

Finding 3a. A clear quantitative statement of the organizational F&I objectives, and the specification of incentives for compliance and consequences for noncompliance, are absent from DOE action plans. If meaningful facilities management improvement is to occur, improved business practices need to be adopted throughout the department, tracked as progress is made, and corrected where necessary.

The DOE plan needs to provide a clear, quantitative statement of overall F&I objectives and these objectives should be further detailed in departmental polices, orders, and implementation guidance. Without quantitative F&I objectives, the metrics required by RPAM—the asset utilization index (AUI) and the asset condition index (ACI)—have little meaning.

Recommendation 3a. DOE F&I performance plans should include quantitative objectives, such as "programs will attain an AUI value by a target date," or "Budget execution will be focused to attain an ACI value by a target date," which are needed to clarify DOE objectives. The F&I objectives should lead to the development of action plans and progress charts to support the factual review of progress and correction of process along the way.

Finding 3b. The DoD facilities sustainment, restoration, and modernization (S/RM) construct establishes sustainment budget targets based on the real property inventory and recapitalization budget targets based on a target recapitalization rate (in years). This process is significantly more proactive and robust than the budget tools used by DOE—for example, deferred maintenance as a percent of replacement plant value (RPV).

Recommendation 3b. DOE should evaluate the DoD facilities sustainment, restoration, and modernization (S/RM) construct for adaptability to its needs. The committee also recommends that DOE establish departmental sustainment targets and recapitalization rates for all programs. Program budgets should then be required to meet the required metrics.

Finding 3c-1. Although OECM has developed the Condition Assessment Survey (CAS) and Condition Assessment Information System (CAIS) that fulfill departmental needs, their use is not required. Other federal agencies, such as DoD and NASA, have demonstrated the benefits of a department-wide model for developing facilities sustainment budgets.

Finding 3c-2. The committee applauds the direction provided by the *FY2006–FY2010 Planning Guidance* (DOE, 2004a) that maintenance expenditures should be a minimum of 2 percent of RPV annually. However, the committee is concerned that this target, although based on NRC recommendations (NRC, 1990), is not sufficiently rigorous for the long-term management of DOE assets.

Recommendation 3c. DOE should continue to invest in improving CAS/CAIS and develop a schedule for requiring their use across the department. The committee believes that DOE needs to collect and analyze historical data to refine the

planning target for its facilities maintenance budget. It is critical that DOE also develop useful metrics to assess what it needs to spend on maintenance on an ongoing basis at each site and track its progress against those metrics.

Finding 3d. The RPAM implementation processes employed by NNSA, SC, and EM are inconsistent. While all programs have made progress, the inconsistent approaches reduce the overall rate of the improvements in management of real property assets and compromise the department's ability to achieve the objectives of RPAM.
Recommendation 3d. OECM should take the lead in establishing consistent implementation guidelines for RPAM. The development of an implementation guidance document, such as a manual, is needed to direct implementation of the order and clearly align authority and responsibility for facilities and infrastructure throughout the department. Additional definition of the expectations of DOE site managers and their responsibilities for oversight of contractor compliance and accountability is needed.

Finding 3e. RPAM defines some performance metrics but does not define a measure to fully assess implementation of the TYSP. RPAM provides for the review and approval of the TYSP by lead program secretarial offices (LPSOs) and cognizant secretarial offices (CSOs)/PSOs; however, there is no provision, direction, or guidance provided for the departmental review and approval process.
Recommendation 3e. A formal process should be developed and required for the review and approval of TYSPs, including definitions of the findings to be made and timing of submittals. The process should include requirements for LPSOs and DOE site managers to keep senior management informed of changes as well as problems encountered in implementing the requirements set forth in RPAM.

Finding 3f. The DOE inspector general's audit report *Planning for National Nuclear Security Administration Infrastructure* (DOE, 2003f), on the reliability of ten-year comprehensive site plans (TYCSPs) for three NNSA sites, has led the committee to confirm its observation that there is a need for improvement in oversight, establishment of a quality assurance/quality control program, and development of more detailed direction for RPAM implementation. The inspector general (DOE IG) recommended that NNSA develop and implement guidance establishing standard criteria for identifying mission-critical facilities and define the types of facilities to be included. The committee also notes that although there is room for improvement, the NNSA F&I planning and management procedures are more mature than those of other DOE PSOs and could form a basis for a department standard.
Recommendation 3f. The DOE IG's recommendations should be extended to apply to quality control of reported data and to the application of procedures used to measure and interpret those data throughout the department.

Finding 3g. The committee believes that the long-term success of DOE's F&I stewardship depends on M&O contractors' attention to their F&I responsibilities. And this in turn depends on DOE's leadership in requiring such attention from the M&O contractors. Incentive payments as established by the award-fee contracts and determinations are powerful tools for focusing contractors on what DOE considers important. The committee found disparity and lack of consistency in the use of incentive fees among PSOs and sites.

Recommendation 3g. OECM should take the lead in documenting the use of performance measures and award fees among DOE M&O contracts and use this information to define and validate a set of best practices that should be considered for department-wide implementation.

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4

Infrastructure Management Performance Measures

> If you can't measure it, you can't manage it.
>
> —Peter Drucker

> Everything that can be counted does not necessarily count; everything that counts cannot necessarily be counted.
>
> —Albert Einstein

INTRODUCTION

Industry and management gurus have long espoused the importance of performance measures to achieving management objectives. Like the instruments in an airplane cockpit, measures are needed for managers to know the effect of decisions on the direction and rate of change in performance. However, it is also important that the performance measures be based on criteria that correspond to the desired outcomes. In management, as in physical science, it is often difficult and not always possible to obtain objective measures of key outcomes.

Since enactment of the Government Performance and Results Act of 1993, performance measures have played an increasingly important role in the management of federal agencies. They are used by agencies and by the Office of Management and Budget to gauge the progress an agency is making in achieving its annual goals; however, they can also be used internally as a management tool to improve procedures and thus increase long-term performance.

This chapter is in four parts: (1) a discussion of performance measures and related models that have been employed by other organizations to assess their

facilities and infrastructure (F&I) performance and to guide efforts to improve management policies and procedures; (2) a critique of the metrics that DOE currently uses to manage its F&I; (3) a proposal for an integrated management approach for DOE with an illustration of how it might be applied; and (4) a brief discussion of a decision system to determine whether to sustain, recapitalize, or dispose of a facility.

BEST PRACTICES

The NRC report *Stewardship of Federal Facilities: A Proactive Strategy for Managing the Nation's Public Assets* (NRC, 1998) argues that there is a direct relationship between the condition of a facility and its ability to serve a mission or to continue to serve as the mission changes. The report noted that:

> Performance measures are critical elements of a comprehensive management system for facility maintenance and repair. Determining how well the maintenance function is being performed or how effectively maintenance funds are spent requires well-defined measures. Although it may appear that mission readiness and cost alone are insufficient to judge the performance of the maintenance and repair function, if the measures are broad enough, they will capture all relevant aspects of a facility's condition. (NRC, 1998, p. 71)

In the course of the current study, the committee reviewed several processes and performance assessment models from private and public organizations that were considered to be among the best practices for facilities and infrastructure management. Some of these models specifically address the performance of facilities, while others address broader facilities management issues and process improvement. Although no single entity presented a model that was completely applicable to DOE, components of these models appear appropriate for consideration in an integrated management approach for DOE.

Strategic Assessment Model

The Association of Higher Education Facilities Officers (APPA) developed and maintains an assessment model called the Strategic Assessment Model (SAM) (APPA, 2001). It is an evaluation and management tool that enables facilities professionals to track organizational performance along an array of key performance indicators or metrics. SAM was used for an APPA-sponsored survey that collected data from 165 educational institutions (including K-12, community colleges, and institutions of higher education) as a benchmark for comparing facilities management performance. It enables the facilities professional to assess an organization's performance, the effectiveness of its primary processes, the readiness of employees to embrace the challenges of the future, and the ability to

satisfy its clients. Facilities managers can utilize the model for self-improvement, benchmarking, and to support a program of continuous process improvement.

SAM is derived from two widely accepted systems for continuous process improvement: the Malcolm Baldrige National Quality Award and the "balanced scorecard" (BSC). It incorporates the best of both systems and provides a consistent vocabulary for continuous improvement of facilities management. As a process improvement tool, SAM addresses the following three basic questions: (1) Where have you been (*the past*)? (2) Where are you going (*the future*)? and (3) What do you need to get there (*the present*)?

The Malcolm Baldrige National Quality Program

The Malcolm Baldrige National Quality Program[1] is generally recognized as a premier continuous improvement program in the United States. It was established over a decade ago to stimulate businesses and industry to focus on quality and continuous improvement. Its primary objective is to improve enterprises to meet the demanding challenges of the ever-changing and competitive environment.

The Malcolm Baldrige Criteria for Performance Excellence are reviewed, updated, and refined annually to ensure that the program emphasizes the factors that will make the greatest difference in improving an organization and achieving performance excellence. The criteria (NIST, 2004) are the basis for organizational self-assessment, with the core values and concepts of the program embodied in 7 main categories and 19 subcategories. The seven main categories are:

- Leadership
- Strategic Planning
- Customer and Market
- Innovation and Analysis
- Human Resource Focus
- Process/Internal Management
- Business Results

The Balanced Scorecard

The second paradigm for improvement is the "balanced scorecard" (BSC). BSC is a concept developed by Robert S. Kaplan, professor at the Harvard Business School, and David P. Norton, president of Renaissance Solutions, Inc.

[1]The U.S. Department of Commerce is responsible for the Malcolm Baldrige National Quality Program and annual award. The National Institute of Standards and Technology (NIST) manages the program. Additional information regarding the program can be obtained online at http://www.nist.gov.

(Kaplan and Norton, 1996). Developed as a tool for organizational leaders to mobilize their staff for achieving organizational goals effectively, BSC addresses performance metrics from four perspectives: (1) financial, (2) the organization's internal processes, (3) innovation and learning, and (4) customer service. The BSC approach provides a holistic view of current operating performance, as well as the drivers for future performance. While the concept primarily addresses the needs of business and industry, its success and acceptance have also been growing rapidly in the public sector.

The Strategic Assessment Model uses elements of the balanced scorecard approach to integrate both financial and nonfinancial measures both to show a clear linkage between facilities and organizational goals and strategies, and to assess successful facilities management across organizations. Under this concept, goals become the road map to the desired outcomes. BSC can be used as a management tool for communicating goals and strategies throughout an organization, as well as for communicating the progress and status of the strategies for accomplishing the goals.

SAM combines quantitative performance indicators with the qualitative criteria for determining the levels of performance of an organization in each of the BSC perspectives. Key performance indicators have been defined for each of the four BSC perspectives listed below:

1. **The financial perspective** reflects the organization's stewardship responsibility for capital and financial resources associated with the operation and preservation of physical assets. Financial performance indicators are tracked to ensure that services are delivered in an efficient, cost-effective manner. The financial perspective is linked to the other perspectives through the relationships between costs and results in achieving the other scorecard objectives. The primary facilities management competencies include:
   - operations and maintenance,
   - energy and utilities,
   - planning, design, and construction, and
   - administrative and support functions.
2. **The internal process perspective** addresses the key aspects of the organization's processes for the delivery of internal services. These processes may include handling of work orders, procurement, billing, and relationships with suppliers. Measures should indicate that the processes for services are efficient, systematic, and focused on customer needs. There is an emphasis on identifying internal opportunities for improvements and measuring results.
3. **The innovation and learning perspective** addresses key practices directed to creating a high-performance workplace and a learning organization. In a learning organization, people at all levels, individually and

collectively, are continually increasing their knowledge and capacity to produce the best practices and best possible result. This perspective considers how the organization's culture, work environment, employee support climate, and systems enable and encourage employees to contribute effectively. There is an emphasis on measuring results relating to employee well-being, satisfaction, development, motivation, work systems performance, and effectiveness.

4. **The customer service perspective** addresses how the organization determines the requirements, expectations, and preferences of customers to ensure the relevance of its services and to develop new services.

An objective of RPAM is to increase accountability and improvements in facilities management. In pursuit of this objective DOE needs to be aware of the varied interests of its stakeholders and satisfy their unique requirements. Taxpayers are interested in ensuring that health, safety, and national security are protected and that resources are efficiently and effectively utilized. Facility users want cost-effective services that are of high quality and sufficient to meet their own mission requirements. Employees have certain expectations of their supervisors and have personal needs in the workplace environment. A scorecard approach could help DOE managers balance these interests.

Navy Shore Installation Management Balanced Scorecard

The Navy has developed a system for shore installation management (SIM) based on a balanced scorecard approach. The Navy's SIM FY2003 *Stockholders Report* (Navy, 2003) notes that:

> The balanced scorecard is particularly applicable for SIM because it is a management system (not only a measurement system) that enables organizations to clarify their vision and strategy and translate them into action by viewing the organization from four perspectives, developing metrics, collecting data, and analyzing the results relative to each of these perspectives. Simplified, and as agreed by the Navy's SIM Shore Installation Planning Board (SIPB), it provides an improved methodology to gauge overall performance. (Navy, 2003, p. 10-1)

Although not yet fully populated, the SIM scorecard includes seven metrics to manage the Navy's shore facilities and infrastructure to provide the greatest long-term benefit to the fleet. Following the balanced scorecard approach, the Commander of Naval Installations (CNI) has identified a family of performance measures that link cost and resource management, customer satisfaction, policies and procedures, and human capital management to the CNI's vision and strategy. The Navy SIM balanced scorecard includes the following metrics:

Customer
- Percent of customers satisfied with performance

Investment
- Program to requirements ratio
- Budget to program ratio
- Execution to budget ratio

Process
- Percent of functional areas with approved standards
- Capability achieved to capability planned ratio

Workforce
- Employee satisfaction and effectiveness

The metrics assess both past performance and planning and budgeting for the future. The ratios are used as a general indicator of the accuracy of assessed requirements, program credibility, budget accuracy, and alignment of budget and functional requirements. The Navy notes that to improve its decisions, it needs timely data that relates planning to programming decisions and provides the ability to see the results of the programming and budgeting cycle in the execution phase. These metrics provide the additional detail needed at the service level to compliment the DoD metrics discussed below.

Although APPA and the Navy both use multiple-metric BSC systems to evaluate performance and support management decisions, their objectives and approaches vary. There is no single example that the committee can recommend for DOE to follow; however, the committee notes that DOE needs to expand the number of metrics it uses and ensure their consistent use throughout the department and that these metrics should be coordinated and verifiable to support F&I management decisions at all levels.

Department of Defense Facilities Management Metrics

Prior to 2001, the Department of Defense (DoD) utilized the Backlog of Maintenance and Repair (BMAR) as the primary metric to ascertain the amount of funds required to sustain its facilities. BMAR provided a measure of what had not been done versus a measure of what should be done. Frustrated by BMAR's inability to account for the department's efforts to improve its facility maintenance, DoD developed the Facilities Sustainment Model (FSM) as a department-wide standard for measuring facilities maintenance requirements and improvements.

DoD now uses a comprehensive set of tools that includes the FSM, the Facilities Recapitalization Metric (FRM) to assess the recapitalization rate, and the Installation Readiness Report (IRR) to asses the output of its F&I programs. This set of metrics is used consistently by all defense services and used at the departmental level to validate budget planning and funding requests (DoD, 2002).

The IRR is a tool to present an annual picture of facility conditions. As such, it assists in the management of limited installation resources. The following are four ratings used in IRR:

Q-Ratings (Quality): Facilities deficiencies versus replacement plant value
N-Ratings (Quantity): Facilities assets versus requirements
F-Ratings (Combined): Overall assessment of quality and quantity (lower of N- and Q-ratings)
C-Ratings (Readiness): Relationship of the quantitative and qualitative ratings to mission readiness

FRM is expressed as the number of years it would take to regenerate a physical plant and is calculated as the ratio of the value of assets (i.e., replacement plant value) to the recapitalization programmed for the physical plant. The adequacy of the facility recapitalization budget can be assessed based on an estimated recapitalization requirement of 67 years. FRM is a macrolevel tool and is not applicable to a single facility. The application of FRM to other systems requires adjustment of the recapitalization requirement. Both FRM and FSM are dependent on adequate and correct inventories.

National Aeronautics and Space Administration Full Cost Management Model

The National Aeronautics and Space Administration (NASA) considers its real property to be an integral part of its mission and a corporate asset that requires ongoing capital investment (NASA, 2004). Beginning in FY2005, NASA will manage its facilities using a Full Cost Management Model. The model consists of new construction, revitalization/modernization, and sustainment components. The requirements in each category are determined using one of the four tools described below:

- **Facilities Sustainment Model (FSM).** Parametric model based on facility type and current replacement value (CRV) (another term used for replacement plant value or RPV). The NASA FSM is a large database of sustainment (maintenance and repair) costs adapted from the DoD FSM.
- **Deferred Maintenance (DM).** Parametric model, based on a complete "fence-fence" visual inspection and assessment of facilities, and combined performance ratings of nine subsystems divided by the facility CRV. This replaces the backlog of maintenance and repair (BMAR) as the agency metric.
- **Facility Condition Index (FCI).** A rating of 1–5 based on DM inspections.

- **Facilities Revitalization Rate (FRR).** Number of years it will take for a facility to be fully revitalized at a given rate of investment. Calculated as CRV/annual revitalization funding.

U.S. Coast Guard Shore Facility Capital Asset Management Metrics

The U.S. Coast Guard (USCG) Office of Civil Engineering has developed a suite of performance metrics to provide information needed to support shore facility capital asset management decisions (Dempsey, 2003). The objective is to link F&I decisions to mission execution while integrating their impact on the cost of doing business and the cost of total ownership. The suite of metrics includes the following:

- Mission dependency index
- Facility condition indices
- Space utilization indices
- Suitability indices
- Physical security index
- Environmental compliance indices
- Real property assessment index
- Building code indices
- Total ownership cost ratio

The metrics are developed from interviews, questionnaires, and asset data for individual buildings and sites and linked to a geographical information system (GIS) database. The combined information can be used to make USCG-wide planning decisions based on the level and urgency of needs.

The mission dependency index (MDI) was originally created by the Naval Facilities Engineering Service Center as an operational risk management metric that relates facilities and infrastructure to mission readiness. The MDI starts with a standard questionnaire to rate the criticality of the mission and of the facilities to the mission. The scores from the questionnaire are weighted and normalized on a scale of 100, which is divided into five levels of mission dependency. This measure, combined with the other measures of facility condition, suitability, and costs, can be used to support rational capital asset management decisions.

Facility Condition Index

The facilities management profession has long embraced the facility condition index (FCI) metric, which is the ratio of cost of deferred maintenance to the replacement plant value (RPV) of the facility expressed as a percentage. Building condition is often defined in terms of the FCI; for example: a rating of 0 to 5

percent FCI is good, 5 to 10 percent FCI is fair, 10 to 30 percent FCI is poor, and greater than 30 percent FCI is critical. The FCI is recognized internationally and has almost universal acceptance from facilities professionals in education, governments, institutions, and private industries. The FCI is used as an indicator of the condition of a single building, which can be combined arithmetically to assess a group of buildings or an entire portfolio of facilities, and has been used to determine the budget required to sustain facilities.

However, the FCI alone is not sufficient to assess the readiness of a facility to support its mission, as it represents the effectiveness of a maintenance program at a moment in time. The FCI is determined by the value of all the operational maintenance activities necessary to keep an inventory of facilities in good working order. It does not represent what is needed to keep existing facilities up-to-date, relevant to their mission, and compliant with current standards.

Needs Index

Using the FCI is a first logical step; however, another metric, the needs index (NI), provides for a more robust and holistic assessment than the FCI alone. The NI was first introduced in 1998 by the Association of Higher Education Facility Officers (APPA). NI is the ratio of deferred maintenance plus the value of funding needed for renovation, modernization, regulatory compliance, and other capital renewal requirements divided by the RPV. NI combines the elements of sustainment and recapitalization to provide a more holistic metric for creating a business case for facilities funding.

The concept of sustainment includes regularly scheduled maintenance as well as anticipated repairs or replacement of components periodically over the expected service life of a facility. Recapitalization includes keeping the existing facilities up-to-date and relevant in an environment of changing needs such as code compliance. Recapitalization also includes facility replacement, but does not include facility expansion or other actions that add space to the inventory. It should be noted that the NI does not include any need that is not part of an institution's current physical structure. In other words, the capital planning process is not part of the performance indicator because the future needs of an institution are not yet part of the institution's RPV.

DOE METRICS

Chapter 3 discussed DOE performance metrics in terms of their application to planning and budgeting decisions. This section discusses these metrics in comparison to a set of preferred characteristics for performance metrics and management systems.

Preferred Characteristics of Performance Measures

There are three critical concerns when considering metrics for performance assessments: (1) understanding the nature of measures from an assessment perspective; (2) selecting measures that possess certain desirable properties or attributes; and (3) selecting measures that not only provide an assessment of how the program or system is performing but also support decisions that could improve the program or system.

Four sets of assessment measures are identified in Box 4-1. Although the first three sets (input, process, and outcome) have been discussed at length in the evaluation literature, the literature is not consistent regarding their respective definitions. For this reason, Box 4-1 identifies the measures in greater detail.[2] Spending a given number of dollars on maintenance of a facility is an input measure and proceeding according to specifications is a process measure, but they may or may not affect the outcome measures of occupant attitude, occupant behavior, or achievement of the program's objectives, goals, and mission. In general, the input and process measures serve to explain the resultant outcome measures. Input measures alone are of limited usefulness since they indicate only a facility's potential, not the actual performance. On the other hand, the process measures identify the facility's performance, but do not consider the impact of that performance. The outcome measures are the most meaningful observations since they reflect the ultimate impacts of the facility on achieving the goals and mission of the programs operated in the facility. In practice, as might be expected, most of the available assessments are fairly explicit about the input measures, less explicit about the process measures, and somewhat fragmentary about the outcome measures.

The fourth set of evaluation measures, systemic measures, can be regarded as impact measures, but they have generally been overlooked in the evaluation literature. The systemic measures allow the facility's impact to be viewed from a total systems perspective. Box 4-1 lists four systemic contexts in which to view the facility's impacts. It is also important to view the facility and infrastructure in terms of the organizational context (i.e., National Nuclear Security Agency, Science, Environmental Management, Fossil Energy, Civilian Radioactive Waste Management, Energy Efficiency and Renewable Energy, and Nuclear Energy, Science, and Technology) within which it functions. Thus, the facility's impact on the immediate organization and on other organizations' needs to be assessed. The pertinent input, process, and outcome measures should be viewed over time, from a longitudinal perspective. That is, the impact of the facility must be assessed not only in comparison to an immediate period but also in the context of a longer

[2]It should be noted that, based on these measures and definitions, DOE 10-year site plans (TYSPs) can be considered from an assessment perspective.

BOX 4-1
Assessment Measures

INPUT MEASURES (WHAT?—REFLECTS POTENTIAL)
- Organizational focus (vision, mission, goals, objectives)
- Facility rationale (objectives, assumptions, hypotheses)
- Facility responsibility (principal participants, participant roles)
- Facility management (funding level, replacement value, funding consistency, sources, capitalization/maintenance/demolition)
- Facility constraints (technological, political, institutional, environmental, legal, economic, building codes, overall physical/human inventory)
- Facility plan (performance specifications, facility design, implementation schedule)

PROCESS MEASURES (HOW?—REFLECTS PERFORMANCE)
- Facility construction (design verification, construction cost)
- Facility operation (performance, maintenance, security, vulnerability, reliability, cost)
- Facility de-certification (demolition, cost)
- Work performance (external contractor, internal staff)
- Process indices (asset condition index, asset priority index, asset utilization index)

OUTCOME MEASURES (WHY?—REFLECTS NEAR TERM IMPACT)
- Occupant attitudes
- Occupant behaviors
- Contribution to achieving current and future program/site/DOE goals
- Contribution to achieving current and future program/site/DOE mission
- Contribution to achieving current and future program/site/DOE vision
- Facility availability

SYSTEMIC MEASURES (WHY?—REFLECTS SYSTEMIC IMPACT)
- Organizational (intra-organizational, inter-organizational)
- Longitudinal (input, process, outcome)
- Programmatic (derived performance measures, comparability, transferability, generalizability)
- Perspective (life cycle, policy implications)

SOURCE: Adapted from Tien (1999), pp. 811-824.

time horizon. Only in this way can a facility's condition be observed from a life-cycle perspective.

The first three systemic contexts can be regarded as focused more on facility performance, while the fourth assesses the facility results from a broader, policy-oriented perspective. In addition to assessing the policy implications, it is important to address feasible and beneficial alternatives to the program. The alternatives

could range from slight improvements to the existing facility to recommendations for new and different facilities. More importantly, whatever input, process, outcome, and systemic measures are employed, they should all be independently reviewed to ensure that they possess the following five important attributes.

1. **Measurability.** Are the pertinent measures well defined and specific? Are they measurable? Are they valid? Are they easy to interpret and hard to dispute? Are they available? Are they easy to obtain?
2. **Reliability.** Are the sites consistent in the way they define a particular measure? Are the measures obtained in one period or setting statistically the same as those obtained in another period or setting? Are measures that are derived from two or more other measures (e.g., percentages, averages) subject to instability (i.e., a change in the derived measure cannot be explicitly attributed)? Are the measures reliably up-to-date?
3. **Accuracy.** Are the reported measures actually measuring what they should? Have they been checked, double-checked, and perhaps even triple-checked? Are they obtained at the source? Do they suffer from transcription or instrumentation errors?
4. **Robustness.** Are the pertinent measures robust in scope (e.g., averages are not robust because they fail to capture the underlying variability in data, whereas quantile measures may be preferred since they provide a better understanding of inherent variability)? Do the measures reflect critical variability in regard to contamination, cost of clean-up, or other factors?
5. **Completeness.** Does the group of selected measures effectively describe the system's input, process, and impacts? Does the derived index or combination of indices reflect a complete picture of the system?

From a systems perspective, performance measures should be used not only to assess or provide feedback on the status or impact of a facility or site but also to support management decisions, through decision support modeling that could improve the entire system of facilities or sites. Such an integrated management system is discussed later in this chapter, with proposed metrics that are measurable, reliable, accurate, robust, and complete. The metrics included in the proposed model can be combined to provide indices that reflect performance (e.g., ACI and AUI) and impact (e.g., mission condition index), as well as serving to support critical decisions concerning performance evaluation, performance prediction, budget planning, budget allocation, life-cycle cost analysis, and location and construction of new mission-oriented laboratories.

DOE Department-Wide Metrics

DOE's Real Property Asset Management (Order O 430.1B) (RPAM) (DOE, 2003) defines two corporate-level performance measures, and departmental plan-

ning guidance has set a benchmark metric for maintenance funding. The order references requirements for performance measures that link the performance of program goals and budgets to outputs and outcomes, but development of these measures and related performance targets is delegated to the program and site offices.

DOE's department-wide performance measures include the following:

- The asset utilization index (AUI) is defined in RPAM as "the ratio of the area of operating facilities or land holdings justified through annual utilization surveys (numerator) to the area of all operational and excess facilities or land holdings without a funded disposition plan (denominator)."
- The asset condition index (ACI) is defined in RPAM as "one (1) minus the facility condition index (FCI), where FCI is the ratio of deferred maintenance to replacement plant value (RPV)."
- Departmental planning guidance sets a maintenance funding target at a minimum of 2 percent of RPV.

In the context of the preferred characteristics identified above, both the AUI and the ACI are process rather than performance measures (see Box 4-1). Furthermore, both measures lack reliability and robustness and, even coupled with the target funding measure, are not complete enough to adequately describe the F&I management system's input, process, and impacts, or to guide critical F&I decisions. For example, how does attaining an ACI of 0.95 by 2005 translate into dollars required to make it happen or relate to accomplishing DOE's missions? The committee believes that a more complete set of measures is needed as described in the integrated facility management system described below.

As discussed in Chapter 3, the committee believes that a maintenance funding target based on a rule of thumb of 2 to 4 percent of RPV is of limited value because it is not robust and does not form a complete measurement system when combined with the two process measures. The committee urges DOE to develop a metric that can assess F&I maintenance budget requirements with more precision than a range of $1.5 billion. To increase F&I planning and budget precision, DOE should develop a group, or scorecard, of six to eight measures that include input, process, outcome, and systemic measures that meet the five attributes discussed above.

Congressionally Mandated Metric

Congress requires (U.S. Congress, 2001) that an equivalent square footage of DOE excess facilities be taken down or demolished if a new facility is to be constructed. Although the intent of this mandate is admirable, there have been some less than admirable consequences. The use of a simple metric that only assesses the area of new facilities and the area of demolished facilities has driven

decisions that are detrimental to DOE's facilities and infrastructure objectives. For example, the committee is aware of excess facilities proposed for demolition based on cost without consideration of the impact on the program, such as demolishing an employee cafeteria so that a facility could be constructed at a different location on the same campus. It would have been more beneficial to DOE's objectives if a hazardous building on the same campus were cleaned up and demolished, even though the comparable expenditure would not have yielded an equivalent square footage.

If the intent of the requirement is to reduce DOE's inventory of excess real property assets and improve the department's facilities, the committee hopes that Congress will revise its requirement to address decontamination and demolition by measuring the equivalent dollar value of repair, replacement, demolition, and cleanup to be undertaken if a new facility is to be constructed. Clearly, the intent should be to get rid of hazardous facilities first, before benign facilities are demolished. Unfortunately, if Congress wants to both improve the quality of facilities and reduce the inventory, then funding will need to match the cost of demolition and disposal.

The current metric, AUI, responds to the congressional mandate but, as noted above, is insufficient for effective management of DOE assets. The AUI needs to be supplemented with a measure that addresses the impact of an excess asset on the site and on the DOE complex. This could be accomplished with a risk-adjusted AUI that factors the relative impact of the excess area or with an additional measure of the excess property liability by dividing the estimated cost for decommissioning and demolition by the RPV.

DOE Assessment Data

Timely, informed decisions cannot be made without up-to-date, accurate data. A large number of measures are collected and stored in DOE's Facilities Information Management System (FIMS), but, although the committee is impressed with the quality assurance plan for FIMS, it is unclear that the FIMS data fully satisfy the five attributes of effective metrics (measurability, reliability, accuracy, robustness, and completeness). Furthermore, as with many data warehouses, the stored data are typically not identified or defined in terms of what information is required for critical decision making. The unchecked growth of a data warehouse aggravates a condition known as "data rich and information poor" (DRIP). The DRIP problem highlights the need not only to collect decision-driven data but also to be consistent about data definitions and other data quality concerns, such as the need to integrate data before they are mined for information to support tactical and strategic decisions. The other DOE F&I data warehouse is the Condition Assessment Information System (CAIS), which contains the Condition Assessment Survey (CAS) results. Unfortunately, as noted in Chapter 3, DOE sites are not required to provide CAIS data and there is no

quality assurance plan for CAIS. As a consequence, CAIS data lack measurability, reliability, accuracy, robustness, and completeness. Moreover, the real property data elements in CAIS are not necessarily consistent with the corresponding FIMS real property data elements. Since CAS (or CAS-equivalent) results constitute an important input to the integrated approach proposed by the committee, the CAIS should become a part of FIMS and subject to FIMS quality assurance mandates. In addition, the integrated FIMS/CAIS database should require standardized and consistent data, subject to well-defined data collection and updating procedures.

INTEGRATED MANAGEMENT APPROACH

As indicated earlier in this chapter, it is important to select performance measures that provide for an assessment of how the program or system is performing, support management decisions, and provide the basis for continuing improvement of the program. The facilities management system (FMS) focuses on performance measures and management systems, which can be part of a balanced scorecard approach to program improvement. The expenditures required to establish an integrated facilities management system for DOE are justified when considering the quantity of money that the department spends each year on the operations, maintenance, repair, recapitalization, and replacement of facilities.

In order to minimize the overall costs and maximize the benefits of facilities stewardship, a systematic approach is needed to manage F&I. As discussed in Chapters 2 and 3, facilities management requires a life-cycle process of planning, designing, constructing, operating, renewing, and disposing of facilities in a cost-effective manner. It should combine engineering principles with business practices and economic theory to facilitate a more organized and logical approach to decision making. An effective FMS is composed of operational packages—including methods, procedures, data, software, policies, and decisions—that link and enable the carrying out of all the activities involved in facilities management. In others words, FMS is a logical process composed of an assembly of functional components that support the successful execution of the facilities management process. The FMS described below is intended to provide the same type of decision support information as the suite of metrics used by the U.S. Coast Guard. However, FMS is proposed as an outgrowth of DOE's current performance measurement system and therefore is a variation of the best practices described above.

FMS integration can make more effective and efficient use of scarce resources, with effectiveness as an indicator of whether a program is successful in meeting its objectives and efficiency as a measure of how well a program is using resources in achieving its objectives. The ultimate goal of FMS integration is to promote efficiency (doing things right) in order to make the program more effective (doing the right thing).

Integrated management of facilities and infrastructure has many advantages, and substantial benefits can be achieved through its implementation. The benefits include the following:

- **Free flow of information.** Integration yields greater compatibility, which allows data and information to be accessed and shared from one system to another and from one department to another.
- **Elimination of redundant data.** Duplicate efforts in data collection and storage are eliminated through data sharing and limited resources can be used more effectively.
- **Better solutions.** An integrated system allows analysis results from one system to be immediately available to others, and results among systems can be used together to achieve overall optimal decisions.
- **Cost reduction in system development and maintenance.** Effective integration will reduce the total system development costs through coordinated and standardized software coding. Department-wide standardization of software can also make future system maintenance less expensive.

System integration does not mean creating one huge and complicated system; rather it is a process where all the components of subsystems are logically linked together on a common platform with a modular approach.

The concept of an integrated management system for DOE F&I is depicted in Figure 4-1. In this system, the F&I-related vision is tied to the program mission, goals, and objectives. In turn, the higher-level decisions are supported by information derived from data in the FIMS/CAIS data warehouse and from the metrics described below. Most importantly, the measures employed to support critical F&I decisions also provide essential feedback for updating and modifying the vision, mission, goals, and objectives. Thus, the data and metrics can be used not only to assess F&I, as DOE is doing with the ACI and AUI metrics, but also to manage the F&I through decision support models.

Metrics and Decisions

This section addresses the F&I metrics and critical F&I decisions that the committee believes are the core of effective F&I management. There are other metrics and decisions that can be considered by DOE, but the purpose here is to illustrate an integrated management system that can be adapted to specific DOE applications.

Metrics

Four metrics are considered: asset condition index (ACI), mission condition index (MCI), mission effectiveness (ME), and alternative renewal strategies (S).

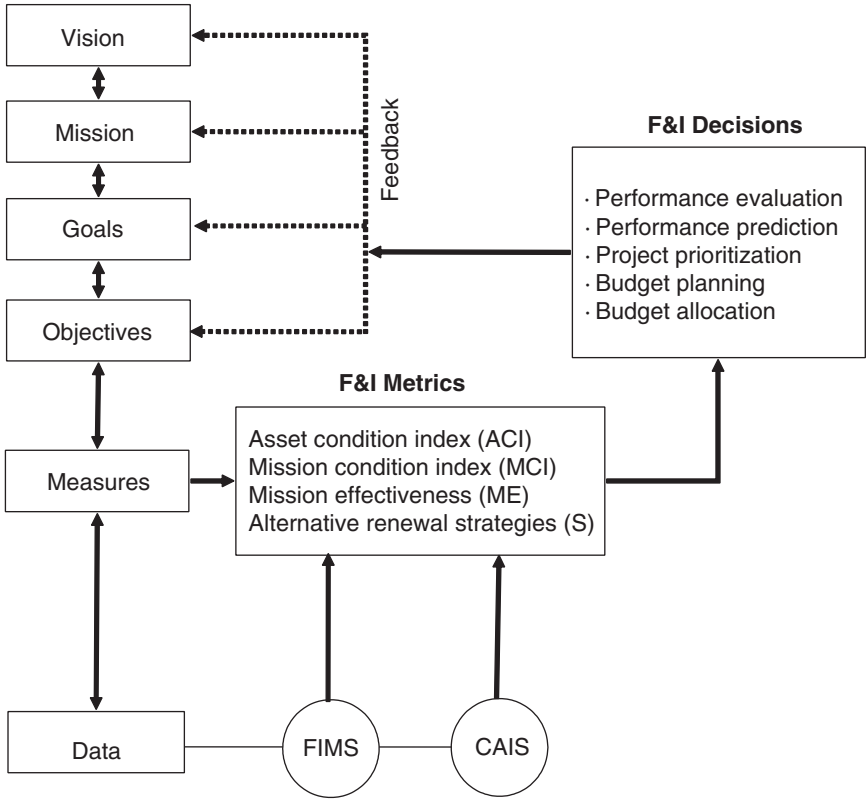


FIGURE 4-1 An integrated management approach for DOE facilities and infrastructure.

Most of the data for these metrics are derived from data that have already been collected and that are available in the FIMS and/or CAIS databases.

Asset Condition Index The ACI (i.e., $\frac{1}{\text{FCI}}$) is a measurement of the physical and structural fitness or integrity of a facility or infrastructure, which typically deteriorates over time due to various factors such as utilization, environment, material degradation, and construction quality. Currently, DOE's ACI measurements are on a scale from 0 to 1 and are stored in FIMS. If obtained objectively and consistently, the ACI can be a good indicator of the physical condition of a facility. It should be emphasized that the ACI should be measured at the facility level in order to support such decisions as prioritizing renewal projects, and the

data need to be based on consistent assumptions and verifiable for use at the departmental level.

Mission Condition Index The mission condition index (MCI) is a measurement of the physical and structural fitness of a facility or infrastructure in fulfilling a particular mission or sub-mission. Facilities are not built simply to house equipment or people but rather to provide support for successfully completing a mission. Therefore, measuring only the physical condition is inadequate. For example, the physical condition of a facility might be perfect (i.e., ACI = 1), but if the facility cannot meet the mission needs at all, then its MCI should be 0.

A facility's MCI is related to its ACI by a factor *k,* the mission condition adjustment factor, which is defined on a scale from 0 to 1 to represent the degree to which the facility supports a particular mission or sub-mission. Thus the MCI of facility *f* for sub-mission *sm* is expressed as:

$$\text{MCI}(f, sm) = k(f, sm)\text{ACI}(f)$$

where $k(f, sm)$ is the mission condition adjustment factor of facility *f* for sub-mission *sm,* and ACI(*f*) is the asset condition index of facility *f.* Table 4-1 can be used to determine the possible values of $k(f, sm)$. If both *k* and ACI range from 0 to 1, then so does the MCI.

Mission Effectiveness Index Mission effectiveness index (ME) is a measurement of how effective a facility is in fulfilling the overall mission. The mission effectiveness of facility *f* is derived from the MCI(*f, sm*), adjusted weighting factor $w(f \rightarrow sm)$, which is the relative criticality of facility *f* to sub-mission *sm*; and $w(sm \rightarrow m)$, which is the relative criticality of sub-mission *sm* to the overall mission *m.* Assuming that all the *w* weights range from 0 to 1 (i.e., similar to the

TABLE 4-1 Determining Mission Condition and Effectiveness Adjustment Factors

Degree That a Facility Supports a Mission or Sub-mission		k, Mission Condition Adjustment Factor or $w(sm \rightarrow m)$, Mission Effectiveness Factor
Mission Condition	Mission Effectiveness	
Excellent	Critical	0.80 ~ 1.00
Good	Essential	0.60 ~ 0.79
Fair	Necessary	0.40 ~ 0.59
Poor	Optional	0.20 ~ 0.39
Very Poor	Expendable	0.00 ~ 0.19

Table 4-1 weighting scheme), then ME(f) is the product of the above three identified factors:

$$\mathrm{ME}(f) = \mathrm{MCI}(f, sm)^* w(f \rightarrow sm)^* w(sm \rightarrow m).$$

Determining Mission Condition Index and Mission Effectiveness Index Adjustment Factors DOE will need to develop a process for determining the MCI and ME factors that is consistent throughout the department. FIMS and CAIS do not currently contain all the data needed to support the proposed integrated FMS but fields could be added. Data similar to those used to determine the needs index or the USCG's suite of performance measures are needed to support adjustment factor decisions, but the process will always require the application of expert judgment. To begin with, DOE will need to develop detailed performance definitions and a cadre of trained personnel who can apply these definitions consistently throughout the department. As more data are collected over time, key performance indicators may be identified that correlate with the adjustment factors.

Alternative Strategies Alternative strategies (S) are possible strategies for the sustainment and renewal of a facility. Each alternative strategy can be defined as a possible action to be taken, together with its corresponding unit cost and expected impact on the facility. An example set of the alternative strategies for the sustainment and renewal of DOE facilities and infrastructure is provided in Table 4-2. The unit cost of the alternative strategies would be approximated by using the average cost of the specific actions in the corresponding strategy category.

Management Decisions

The committee believes that DOE should include formal analysis or model-

TABLE 4-2 Facility Renewal Strategies, Unit Cost, and Impact

Strategy (S)	Unit Cost, $C_s(f)$, \$/ft^2	Impact on Facility in Terms of ACI and k	
		ACI	k
Do nothing		No impact	0
Routine maintenance		Postpone deterioration (ΔACI = 0)	0
Minor renewal		Marginal improvement (ΔACI < 0.2)	< 0.2
Major renewal		Significant improvement (ΔACI $\geq$ 0.2)	$\geq$ 0.2
Disposal/reconstruction		New facility	1

ing processes in its management procedures so that decisions can be made in a consistent and timely manner. The committee has recommended consideration of DoD's Facilities Sustainment, Restoration, and Modernization (S/RM) construct for department-level planning and budgeting decisions. The proposed FMS considers five facility-level decisions: performance evaluation, performance prediction, project prioritization, budget planning, and budget allocation. If a consistent process is used for these decisions, they can be combined to support decisions for sites and programs, and used with the S/RM for departmental decisions.

Facility Performance Evaluation The main purpose of facility performance evaluation is to determine the current condition of a facility in order to make engineering decisions. The measures or indices for characterizing the condition of each subsystem may differ, but the general structure of the evaluation models should be consistent. It is helpful to aggregate detailed individual measures at the subsystem level into a measure to describe the overall performance at the system level. For the purpose of prioritizing facility renewal needs, both the facility's physical condition (i.e., ACI) and mission condition (i.e., MCI) should be considered in any performance evaluation model.

Performance Prediction Performance prediction is based on an understanding of the facility's life cycle and its deterioration over time. In order to plan for facility sustainment and renewal, it is necessary to predict the future condition of a facility at any given. Developing robust models to predict deterioration and performance over time is a challenging task because of the complexity of factors that affect the performance of facilities. Facility deterioration has been described as a symmetric *S*-shape curve (Lufkin, 2004). The committee developed a facility deterioration curve (FDC) model by modifying the Pearl curve, which was originally constructed for *S*-shape growth phenomena,

$$\mathrm{FDC}(f,\ t) = \frac{1+a}{a+e^{bt}},$$

where FDC(*f, t*) is the facility deterioration curve for facility *f* at time *t,* and *a* and *b* are constants to be determined through model calibration with observed data. For example, if we know that the condition of a facility, in terms of ACI, has deteriorated from its brand new condition (ACI = 1.0) to ACI = 0.75 at year 7 (i.e., $t_{0.75} = 7$) and kept deteriorating to ACI = 0.5 at year 10 (i.e., $t_{0.5} = 10$), then we have two data points:

$$(\mathrm{ACI} = 0.75,\ t_{0.75} = 7) \text{ and } (\mathrm{ACI} = 0.5,\ t_{0.5} = 10).$$

By plugging these data into the *S*-curve equation $\mathrm{FDC}(f,\ t) = \dfrac{1+a}{a+e^{bt}}$, we have:

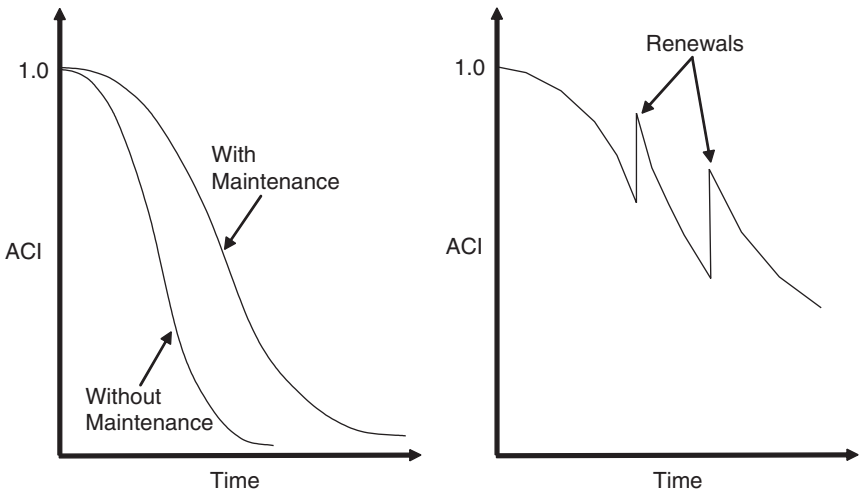
$$0.75 = \frac{1+a}{a+e^{b*7}}\ , \text{ and}$$

$$0.50 = \frac{1+a}{a+e^{b*10}}.$$

From these two equations, we can solve for the two unknown constants *a* and *b* with the following results:

$$a = 29.77, \text{ and}$$
$$b = 0.3459.$$

Four important observations can be made concerning the FDC: (1) it can be shown that for a newly constructed, mission-directed facility, its ACI over time is equal to its FDC, with a value of 1 at time 0; (2) as depicted in Figure 4-2(a) the *S*-curve for a facility with sustainment would be higher than the corresponding *S*-curve for the same facility without sustainment (i.e., maintenance tends to extend the facility's useful life); (3) as depicted in Figure 4-2(b) renewals also tend to extend a facility's useful life by raising the remaining portions of the



(a) Impact of Maintenance (b) Impact of Renewals

FIGURE 4-2 Impact of maintenance and renewals on the asset condition index.

S-curve; and (4) when considering a facility's life cycle, FDC and ACI are functions of time.

Project Prioritization In general, budgets are insufficient to fund all of an organization's facilities maintenance and renewal projects, leading to the need to prioritize the projects. The most commonly used approach is to prioritize needs over a particular time horizon (typically a year) by assessing the impact of a predefined set of renewal strategies using a predefined prioritization criterion, usually the ratio of effectiveness to cost. Such a cost-effectiveness analysis can be carried out with relative ease if the data are available to apply decision support metrics.

Budget Planning For the purpose of planning, it is necessary to know the budget needed to keep both individual facilities and the entire complex of facilities at a specified level of service. The estimated budget can serve as the basis for both budget plans and annual budget requests. Mathematically, the budget planning objective is to minimize total cost for facilities given performance constraints—for example, that the average MCI value of all the facilities should be kept above a desired target level. Budget planning models such as the DoD's S/RM are typically formulated as a linear programming, integer programming, or other optimization problem.

Budget Allocation In general, the budget received is different from (usually less than) the budget requested. As a consequence, one of the key functions for facilities and infrastructure management is to select projects from a population of planned maintenance and renewal efforts so that the budget is not exceeded. Budget allocation can be accomplished by using a wide range of methodologies, from the simplest ranking to sophisticated optimization. For budget allocation using a simple ranking process, the adjusted MCI can be used. From the perspective of optimization, the purpose of the budget allocation process is to maximize the total performance of all the facilities over a predetermined analysis period (usually the lifespan of the facilities) under a number of constraints, including, for example, that the budget is not exceeded. Again, as with budget planning, budget allocation models are typically formulated as a linear programming, integer programming, or other optimization problem.

The Navy tracks the performance of its budget decisions by comparing its program to requirements, budget to program, and execution to budgets. These metrics are useful as performance improvement tools, but an FMS is needed to proactively make the best decisions.

An Example Application of an Integrated Facility Management System

The purpose of this hypothetical example is to illustrate how the integrated management approach might be applied in a static manner. When the time variable

is included, as it should be in practice, the decision problem becomes dynamic. The time variable can be included in the analysis described below by using numerical integration to calculate the average improvement in the performance measure that will result from a maintenance and repair action. The example uses a hypothetical site with five buildings and two sub-missions, and posits two strategy problems to consider within a cost-effectiveness framework. The application follows an 11-step approach.

Step 1. Identify *f*, the facility to be included in the analysis. The example is a small research site; its mission is, of course, research, and it has two sub-missions, researcher development and public education. There are five buildings: a researcher residence, an office, a storage building, and two laboratories (their respective square footage is shown in Table 4-5). The strategy being considered for each facility is either to replace or to recapitalize.

Step 2. Determine the organization's sub-missions and $w(sm \rightarrow m)$, the relative criticality of each sub-mission *sm* to the organization's mission *m*.

Step 3. Determine $w(f \rightarrow sm)$, the relative criticality of each facility *f* to each sub-mission *sm,* and then calculate $w(f \rightarrow m)$, the relative criticality of facility *f* to mission *m*, by summing the component parts.

Step 4. Determine $k_o(f, m)$, the initial mission condition adjustment factor for facility *f* to the mission *m,* by employing Table 4-1.

Step 5. Determine $\text{ACI}_o(f)$, the initial asset condition index for facility *f*, based on application of the facility deterioration curve (FDC). A plausible set of *S*-curves for the four different types of facilities is shown in Figure 4-3; they were determined by solving for the FDC curve parameters, *a* and *b*, when the condition of the facilities deteriorates to ACI 0.75 and ACI 0.5 of the original condition—that is, ACI 1.0. The parameter values are summarized in Table 4-3.

Using the storage building to illustrate how to predict performance using FDCs, the prediction model becomes:

$$\text{ACI}_{Storage\ Building} = \frac{1 + 4.451}{4.451 + e^{0.04143 * t}}.$$

With the above equation, we can predict the ACI value for a storage building at a given time since its construction. In this example, we assumed that the time since construction for the storage building was 35 years; thus:

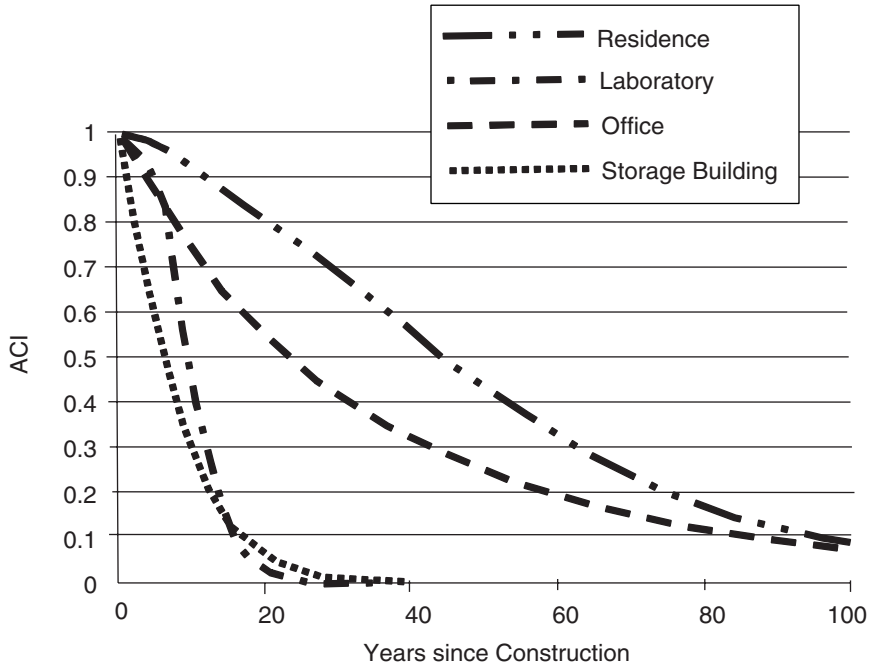


FIGURE 4-3 Example of *S*-shape curves for facility performance prediction.

TABLE 4-3 Parameter Values of Facility Deterioration Curves

	Residence	Research	Office	Storage Building
$t_{0.75}$	3.5	7	10	25
$t_{0.5}$	7	10	25	45
a	2	29.77	–0.2818	4.451
b	0.198	0.3459	0.0228	0.04143

$$\text{ACI}_{\textit{Storage Building}} = \frac{1+4.451}{4.451+e^{0.04143*35}} = 0.63\,.$$

(See Step 5 of Table 4-4 for the ACI of the other buildings in the hypothetical example.)

TABLE 4-4 Steps in an Example Application: Cost Effectiveness of Alternative Renewal Strategies

Step 1	Step 2		Step 3			Step 4	Step 5
			Facility Criticality				
Facility	Sub-Mission	Sub-Mission Criticality	*T*	*R*	*Total*	Miss. Cond. Adj. Factor	Initial Cond.
F	*sm*	$w(sm \rightarrow m)$	$w(f \rightarrow T)$	$w(f \rightarrow R)$	$w(f \rightarrow m)$ $w(f \rightarrow T)+$ $w(f \rightarrow R)$	$k_o(f, m)$ See Table 4-1	$ACI_o(f)$ Facility Deterior. Formula
Residence	T, Teaching	0.6	0.15	0	0.15	0.85	0.5
Office	T, Teaching	0.6	0.8	0	0.8	0.65	0.48
Storage Building	T & R	1	0.05	0.05	0.1	0.95	0.63
Lab 1	R, Research	0.4	0	0.95	0.95	0.65	0.5
Lab 2	R, Research	0.4	0	0.95	0.95	0.1	0.33

Step 6. Determine $MCI_o(f)$, the initial mission condition index for facility *f,* which is equal to

$$k_o(f, m) * ACI_o(f).$$

Step 7. Determine $ME_o(f)$, the initial mission effectiveness for facility *f,* which is equal to

$$w(sm \rightarrow m) * w(f \rightarrow m) * MCI_o(f).$$

Step 8. Identify S, the possible renewal strategies for facility *f*, their corresponding unit costs $C_s(f)$, their corresponding adjustment factors $k_s(f, m)$, and their corresponding asset condition indices, $ACI_s(f)$, all based on Table 4-3.

Step 9. Determine $MCI_s(f)$, the mission condition index for facility *f* after strategy *s* is applied; it is equal to

Step 6	Step 7	Step 8				Step 9	Step 10	Step 11
Initial. Miss. Cond. Index	Initial Miss. Effect.	Renewal Strategy	Unit Cost ($/sqft)	Adj. Factor Due to *s*	Condition Due to *s*	Cond. Index Due to *s*	Miss. Effect. Due to *s*	Cost Effect. of *s*
$MCI_o(f)$ $k_o(f, m)$* $ACI_o(f)$	$ME_o(f)$ $w(sm\rightarrow m)$* $w(f\rightarrow m)$* $MCI_o(f)$	*s*	$C_s(f)$ See Table 4-2	$k_s(f, m)$ See Table 4-2	$ACI_s(f)$ See Table 4-2	$MCI_s(f)$ $k_s(f, m)$* $ACI_s(f)$	$ME_s(f)$ $w(sm\rightarrow m)$* $w(f\rightarrow m)$* $MCI_s(f)$	$CE_s(f)$ $(ME_s(f)-$ $ME_o(f))/$ $C_s(f)$
0.425	0.03825	Replace	90	0.9	0.7	0.63	0.0567	0.000205
		Recap.	150	0.95	0.9	0.855	0.07695	0.000258
0.312	0.14976	Replace	75	0.7	0.8	0.56	0.2688	0.001587
		Recap.	100	0.9	0.95	0.855	0.4104	0.002606
0.5985	0.05985	Replace	50	0.95	0.75	0.7125	0.07125	0.000228
		Recap.	100	0.95	0.92	0.874	0.0874	0.000276
0.325	0.1235	Replace	250	0.75	0.6	0.45	0.171	0.000190
		Recap.	275	0.8	0.85	0.68	0.2584	0.000491
0.033	0.01254	Demo & Replace	325	1	1	1	0.38	0.001131

$$MCI_s(f) = k_s(f, m)^* ACI_s(f).$$

Step 10. Determine $ME_s(f)$, the mission effectiveness for facility *f* after strategy *s* is applied; it is equal to

$$ME_s(f) = w(sm\rightarrow m)^* w(f\rightarrow m)^* MCI_s(f).$$

Step 11. Calculate $CE_s(f)$, the cost effectiveness of applying strategy *s* to facility *f*; it is equal to

$$CE_s(f) = ME_s(f) - ME_o(f)/C_s(f).$$

The following management decisions for the five buildings are considered based on the hypothetical data.

Performance Evaluation The results in Table 4-4 for Steps 1 through 7 all

provide insight into the performance of the individual facilities. For example, it is seen that the office building has the highest mission effectiveness, while lab 2 has the least; these results are not surprising, given the underpinning values for facility criticality and mission condition adjustment factors.

Performance Prediction As indicated in Step 5, and illustrated in Figure 4-3, the facility deterioration curve is applied to the four types of facilities that are included in this example.

Project Prioritization The five facility renewal projects can be prioritized based on the cost-effectiveness values calculated in Table 4-4. The best project or strategy is the one that yields the highest cost-effectiveness value. Apparently, for the residence, office, storage facility, and lab 1, the recapitalization strategy is better than the replacement strategy. Subsequently, based on selecting the most cost-effective strategy for each facility, the five facilities can be ranked in descending order: office, lab 2, lab 1, storage building, and residence. This prioritized list is summarized in Table 4-5.

Budget Planning With the area of each facility and the unit cost for the selected strategy, the total cost for implementing the selected strategies can be calculated. The budget required for this example can then be determined based on the ranking and calculated costs. To complete the renewals for all five of the facilities, a total of $68.75 million would be required. However, if one decides to carry out the renewals for only the top three ranked facilities, the required total budget would be $48.75 million, as indicated in Table 4-5.

Budget Allocation For a given level of available budget, the allocation can be

TABLE 4-5 Illustration of the Ranking, Budget Planning, and Budget Allocation

Facility	Cost-Effect.	Ranking	Unit Cost ($/ft^2)	Space (ft^2 ×1000)	Total Cost ($ million)	Budget Planning ($ million)	Budget Allocation ($ million)
Office	0.002606	1	100	50	5.00	5.00	5.00
Lab 2	0.001131	2	325	50	16.25	16.25	16.25
Lab 1	0.000491	3	275	100	27.50	27.50	
Storage Building	0.000276	4	100	20	2.00		2.00
Residence	0.000258	5	150	120	18.00		
Total					68.75	48.75	23.25

done by selecting projects in accordance with their cost-effectiveness ranking until the budget is exhausted. For example, if the total available budget is $24 million, then the office, lab 2, and storage building would be selected for renewals, as shown in Table 4-5.

DETERMINING WHETHER TO REPAIR, RENOVATE, OR REPLACE

The decision process for facility sustainment and recapitalization begins with an objective assessment of the role of a specific facility in enabling mission objectives. This initial step in DOE's planning process is taken during the development of the 10-year plans for each site. The critical question that must be answered is whether a facility and its related infrastructure support a critical DOE mission. The answer to this question can help determine the *k* factor used in the integrated facility management model discussed above and serve as the starting point for the decision-making process illustrated in Figure 4-4. This process will determine whether the facility is placed on a *disposal* or *retention* track.

Disposal Track

If an existing facility is not needed for a critical mission, the next logical question is whether it is needed for other DOE missions or programs. If affirmative, the facility is put on the retention track. If no existing or planned DOE mission or program needs the facility, then it can either be disposed of as surplus federal property or demolished. In both cases, the facility will no longer be part of the DOE inventory and will not require sustainment or recapitalization by the department. However, if the facility contains toxic or hazardous materials, it must be stabilized or remediated before its ultimate disposition.

Retention Track

If the facility enables a critical program or mission need, then it should be evaluated to determine the appropriate long-term sustainment or recapitalization strategy. If the facility's existing condition is satisfactory, then sustainment of the desired condition is all that is necessary. If the current condition is unacceptable, then the question becomes whether to relocate, recapitalize, or replace. The answer will be determined in part by logistics, economics, and the prevailing and expected regulatory climate. For example, it would probably not be feasible to relocate laboratory facilities that are integral to future production activities even if they were in poor condition and an acceptable substitute was available at another site. Similarly, surrounding communities or regulators might not want to construct a certain type of facility new, but an existing facility could be restored to acceptable condition. If the facility were critical to the program mission, then

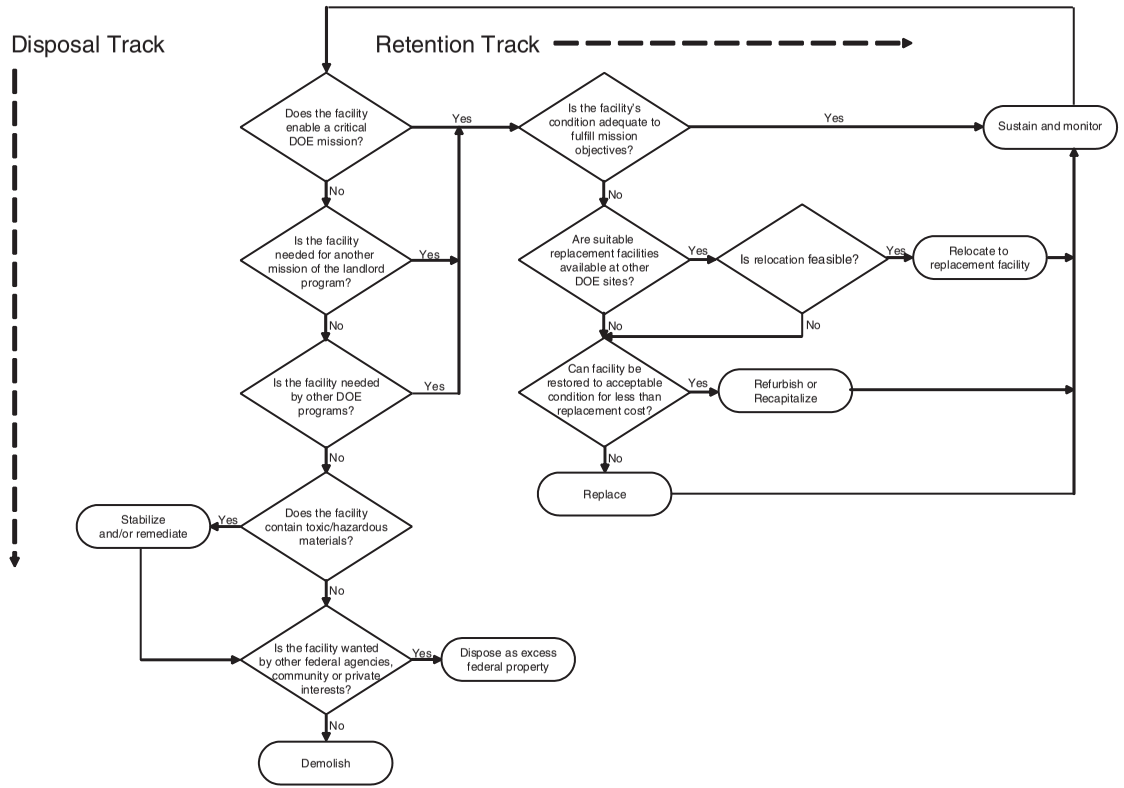


FIGURE 4-4 Process for decision making to repair, renovate, or replace.

recapitalization would be the appropriate option. Finally, detailed economic analyses of all alternatives are required so that a comprehensive assessment can be made. In all cases, once an appropriate strategy is developed, there must be a commitment to sustain the facility over its lifetime.

FINDINGS AND RECOMMENDATIONS

Finding 4a. The current metrics defined by RPAM are inadequate for the size and complexity of DOE's facilities. The committee has identified metrics that have been successfully used by other organizations (the Association of Higher Education Facilities Officers' Strategic Assessment Model, the Navy's balanced scorecard approach, the Department of Defense sustainment and recapitalization model, the National Aeronautics and Space Administration's full cost management model, and the U.S. Coast Guard's capital asset management approach) and suggests an integrated management system derived from the current DOE metrics, but there is at present no single example that clearly defines the suite of metrics that should be used by DOE.

Recommendation 4a-1. DOE needs to select the most promising metrics from the many alternatives, populate them with real DOE data, and conduct pilot programs to determine the best alternatives. Selected metrics should be agreed to by the responsible parties and the senior managers that will use the data for decision making.

Recommendation 4a-2. DOE should require a consistent set of measures and procedures for departmental decision-making processes. DOE should consider using the National Nuclear Security Administration Ten-Year Comprehensive Site Plan (TYCSP) guidance document (DOE, 2004) throughout the department and should incorporate a set of metrics for an integrated system to proactively manage the sustainment and renewal of F&I. DOE's suite of measures should include input, process, outcome, and systemic measures that possess the critical attributes of measurability, reliability, accuracy, robustness, and completeness.

Finding 4b. The congressional mandate that DOE must reduce its inventory of excess facilities is admirable, but the metric eliminating one square foot for every square foot of new facility constructed has led to the demolition of benign facilities rather than hazardous facilities that affect the quality of the site.

Recommendation 4b. The mandate for elimination of excess facilities should continue; however, the metric for elimination of excess capital assets should be revised to reflect the impact on full liability of excess property including sustainment, security, and environmental safety costs.

Finding 4c. Performance measures need to support decisions, provide an assessment of the status of F&I and of how well the management system is performing, and provide direction for continuous process improvement.

Recommendation 4c. DOE should establish goals to support continuous improvement for F&I management. The development of a suite of measures to manage F&I process improvement should be considered. Regardless of the specific group of measures, it should include metrics that assess performance for the following aspects of F&I management:

- Financial
- Customers external to the F&I management organization
- People internal to the F&I management organization
- Organizational internal processes

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5

Conclusion

Congress, the U.S. Government Accountability Office (GAO), and DOE have long been aware of DOE's aging and deteriorating facilities and infrastructure and of their threat to the department's ability to successfully complete its missions (DOE, 2003a; GAO, 2003a, 2003b, 2003c, 2001; U.S. Congress, 2001). DOE's real property assets are extensive, diverse, and dispersed across the nation and among the department's program secretarial offices (PSOs). The consequences of years of failed F&I stewardship of the DOE complex cannot be quickly reversed. Dedicated leadership and committed federal managers and contractors at all levels, as well as the continuing support of Congress, will be required to effectively sustain and recapitalize the department's real property assets. Long-term improvement will also require cultural and organizational changes, improved planning and budgeting procedures, and the development of improved performance measures. The process has begun with the promulgation of departmental policy Real Property Asset Management (O 430.1B) (RPAM) (DOE, 2003b), but much remains to be accomplished if DOE is to fully implement the RPAM approach to asset management and achieve the ultimate objective of having effective and efficient facilities and infrastructure that support the department's missions.

Improvement of F&I stewardship at DOE needs to begin with the recognition in the department's strategic plan of the importance of facilities and infrastructure. The strategic plan should include a definitive statement recognizing the critical role of facilities and infrastructure in mission accomplishment as well as prioritized goals and the time frame and actions needed to accomplish these goals. When considering the life cycle of facilities that span decades and transcend

administrations, policies and procedures for managing facilities and infrastructure need to be developed and maintained with a long-term outlook and resilient process.

The stewardship of DOE F&I is inconsistent across program secretarial offices and from site to site. In order to eliminate this inconsistency, the committee believes that DOE needs strong and involved senior leaders, beginning with the deputy secretary; well-defined authority, responsibility, and accountability at all levels of DOE staff and M&O contractors; and a strong central F&I authority to lead the implementation of RPAM, transfer best practices across the department, and ensure consistent, disciplined planning and budgeting for life-cycle stewardship of facilities and infrastructure.

RPAM was issued September 24, 2003, but full compliance was not required until September 30, 2004. Implementation of RPAM has been delegated to the PSOs with OECM in an advisory role, resulting both in an inconsistent interpretation of the order and in the development and application of diverse procedures to achieve the RPAM objectives. The committee believes that the size and diversity of DOE's missions should not be used as an excuse for not having consistent, disciplined processes. The best-performing large and diverse organizations manage facilities at the corporate level to ensure that assets support their mission and provide an appropriate return on annual expenditures. Private industry uses profitability as the key outcome, but government agencies are faced with the more difficult task of measuring how well facilities support their intended mission. When best-performing organizations allow field organizations the flexibility to develop the most effective procedures for implementing policies, they also have procedures to identify the best approaches and implement them throughout the enterprise.

DOE facilities are government-owned, contractor-operated complexes; DOE's role is thus that of a contract manager. The department manages contractor performance through performance-based incentive fees and ensures efficiency through periodic competition of management and operations (M&O) contracts and market competition of subcontracted services. The result of using market competition is an environment that discourages both the transfer of lessons learned and the diffusion of best practices for managing facilities and infrastructure across the department. The committee has observed that this impediment has been diminished in addressing environmental safety and health issues and believes that a similar philosophy should be applied to the management of facilities and infrastructure. The committee has also observed the success of the Financial Management Systems Improvement Council (FMSIC), which has brought contractors together to help improve variety of financial management systems across the department. The council encourages the free exchange of ideas and the transfer of best practices among DOE and contractor management and professionals. A similar council for facilities management systems, working in conjunction with FMSIC, could be effective in improving F&I stewardship practices.

The committee believes that benchmarking activities, such as the study undertaken by Ernst and Young for Sandia National Laboratories, should be regularly applied throughout the department. The committee believes that all contracts should include significant incentive fees that are tied to the stewardship of facilities using metrics that target the condition of F&I and F&I support of the site's mission. DOE's goal should be for all contractors to earn their full incentive fee for facility stewardship.

The performance measures currently used by DOE are consistent with industry practices, but the size and complexity of DOE's F&I require a more complete set of robust measures. The development of effective performance measures is a difficult task. There is a tendency to use input and process measures because these data are easier to obtain; however, accurate output measures are needed to guide management decisions. There are no simple, easily adaptable measures that fill DOE's needs. The complexity of F&I management decisions requires the use of multiple metrics to support decisions that address immediate needs, long-term requirements, and continuous process improvement. Development of effective performance measures will require the department's ongoing effort.

The committee recognizes that some significant issues that affect the quality of DOE F&I are outside the purview of this committee. These issues include the selection of appropriate capital asset acquisition strategies, the balancing of program priorities with the availability of resources to sustain, recapitalize, and demolish facilities and infrastructure, and the question of whether DOE facilities and infrastructure are configured appropriately to achieve current and anticipated future missions. The committee has been able to address the core issues that determine DOE's ability to plan, budget, and manage its F&I now and in the future.

The committee provided, in its February 2004 letter report (NRC, 2004), an assessment of DOE's F&I programs based on seven attributes that characterize the maturity of such programs. The committee noted that:

> The success of any organization depends on the quality of its leadership at all levels. The committee believes that success in DOE depends on a shared vision and continuous, consistent leadership from DOE headquarters, DOE site offices, and site management and operations contractors. To create an organization that demonstrates the attributes of maturity and quality in facility management, DOE will need more than written policies. It will have to transform policies into a culture that recognizes the value of facilities and infrastructure to DOE missions. This change in culture will be achieved with excellence in implementing the seven attributes discussed [in the letter report].

The seven attributes of successful F&I programs are:

1. Cultural realization and communication of the strategic role that facilities and infrastructure play in achieving site missions and program objectives.

2. Shared understanding between headquarters and field operations that facility and infrastructure management and renewal are linked with site missions in ways that are clear both to headquarters and to field operations.
3. Clear operational guidance for field sites that links facility management and infrastructure renewal actions to management's expectations for achieving program objectives.
4. Consistent integration across programs and sites of corporate goals, site activities, and the budget process in a manner that balances maintenance and renewal of facilities and infrastructure with the programmatic mission.
5. Formal structures to develop and implement corporate best practices in facility management and to facilitate the transfer of lessons learned among programs and sites.
6. Performance metrics and indicators that use consistent and accurate data to measure meaningful outcomes department-wide.
7. Open communication channels, both vertical and horizontal, to convey guidance and reduce feedback time.

The committee confirms its initial assessment that "DOE has issued policies that if adequately and consistently supported by meaningful practices and procedures will improve the quality of facility management and will lead to better allocation of resources for the effective support of DOE's missions. Successful implementation will require timely and effective leadership, communication, and guidance from headquarters, site offices, and management and operations contractors to ensure consistent stewardship of facilities in DOE" (NRC, 2004). The committee expects that the recent planning guidance issued by the deputy secretary, establishing a minimum target for spending on F&I sustainment, will help reverse the increasing trend of deferred maintenance and that DOE, with the help of Congress, can establish a program of full sustainment and recapitalization to make DOE facilities effective and efficient now and in the future. However, DOE needs to develop a more rigorous and consistent F&I management system in order to plan and develop departmental sustainment and recapitalization budgets and to ensure the quality of planning decisions and their implementation. The committee has noted examples of procedures and processes used both within DOE and in other federal agencies that, if adapted and adopted for department-wide use, can provide effective life-cycle stewardship of DOE's facilities and infrastructure.

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Appendixes

Appendix A

February 27, 2004, Letter Report

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

Division on Engineering and Physical Sciences
Board on Infrastructure and Constructed Environment

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February 27, 2004

The Honorable Spencer Abraham,
Secretary of Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Re: Preliminary Assessment of DOE Facility Management and Infrastructure Renewal

Dear Mr. Secretary:

The National Research Council has completed its initial assessment of the Department of Energy's (DOE's) policies and procedures for managing facilities

and infrastructure renewal and their implementation at selected sites assigned to the National Nuclear Security Administration, Office of Science, and Office of Environmental Management. The review was ordered by the 107th Congressional Committee of Conference on Energy and Water Development (House Report 107-112).

This preliminary assessment was conducted by the Committee on the Renewal of Department of Energy Infrastructure under the auspices of the National Research Council's Board on Infrastructure and the Constructed Environment. The committee's 13 members have expertise in a variety of disciplines, including construction and project management, corporate and strategic planning, capital programming and budgeting, land use and site planning, commercial real estate, and facility engineering and management. A list of committee members is appended to this letter. The group incorporates experience in large-scale strategic planning in the corporate environment, as well as facility planning and management within government, higher education, and other large institutions. The committee was established to address the following statement of task:

1. Assess DOE's facilities and infrastructure management practices and initiatives and provide recommendations for areas requiring additional focus;
2. Identify or develop "best practice" tools and techniques for DOE real property asset management in such areas as site planning; maintenance and recapitalization planning; space and land utilization; disposal strategies; information technology applications; and financing, cost allocation, and cost recovery strategies to improve life-cycle performance and mission support;
3. Develop guidelines for deciding when to repair, renovate, or replace DOE buildings and other facilities based on factors such as agency mission objectives and return on investment; and
4. Define performance metrics that integrate budget with expected outcomes and ensure accountability.

This letter report is submitted pursuant to an agreement between DOE and the National Research Council for an interim report 6 months after initiation of the study. This interim report is not intended to address all aspects of the committee's assigned tasks. More specifically, it transmits the committee's preliminary assessment of DOE facility management policies and procedures and ongoing facility management and infrastructure renewal activities.

The committee's assessment is based on briefings by DOE headquarters staff in August 2003 and on site visits conducted in October and November 2003, which included briefings by DOE and contractor staff at Lawrence Berkeley, Lawrence Livermore, Oak Ridge, Sandia, and Los Alamos National Laboratories, as well as at the National Nuclear Security Administration Y-12 site and the Savannah River Site. The committee reviewed *Real Property Asset Management* (Order O 430.1B), the DOE-wide Condition Assessment Survey and Facilities

Information Management System database, and site-specific 10-year plans and facility management tools. The committee appreciates the cooperation and support of the Office of Engineering and Construction Management and the DOE program offices, site offices, and site contractors referred to above in providing background information and facilitating the site visits. The committee recognizes that at most locations DOE and contractor personnel contributed significant time, effort, and enthusiastic support, thus enabling the committee to address its assigned tasks.

Interim Assessment of DOE Facility Management Policies, Procedures, and Day-to-Day Practices

In developing its interim assessment, the committee applied seven broad-based attributes that it believes characterize the level of maturity and quality of an organization's policies, procedures, and day-to-day practices for facility management. These seven attributes are listed below, followed by the committee's initial observations and assessment.

1. Cultural realization and communication of the strategic role that facilities and infrastructure play in achieving site missions and program objectives.

It has been broadly recognized, both within DOE and among external stakeholders (e.g., advisory boards, contractors, and Congress), that reinvestment in DOE facilities and infrastructure is generally inadequate to sustain an acceptable level of performance:

> DOE's infrastructure problems and their effect on operations are well known. For example, DOE noted in its 2000 Strategic Plan that the poor condition of its facilities adversely impacts the safety, cost, and continuity of research activities and hurts laboratories' ability to attract and retain highly qualified scientists to work on important mission needs. DOE's Inspector General has also reported on the poor condition of the department's infrastructure, noting that conditions are deteriorating at an "alarming pace." Facilities in poor condition are costly to maintain and difficult to keep in regulatory compliance. In a September 2000 report, the Inspector General said that the deteriorating conditions are causing some Nuclear Weapons Stockpile Stewardship milestones and goals to slip, restoration costs to increase, and future nuclear weapons production work to be at risk. (General Accounting Office, 2003, *Major Management Challenges and Program Risks*, Department of Energy, GAO-03-100, p. 25)

Recognition of the strategic importance of facilities and infrastructure is necessary to provide the impetus to increase their visibility in operating plans and budgets. Although DOE's strategic plan (DOE, 2003, *Protecting National, Energy, and Economic Security with Advanced Science and Technology and*

Ensuring Environmental Cleanup, Washington, D.C.: U.S. Department of Energy) states that it should be "providing world-class scientific research capacity," an April 2001 report on the Office of Science laboratory modernization plans indicated that DOE allocated about 0.7 percent of replacement plant value for maintenance of the science laboratories, as compared with the generally accepted target of 2 percent to 4 percent of replacement plant value (DOE, 2001, *Infrastructure Frontier Report: A Quick Look Survey of the Office of Science Laboratory Infrastructure*). Although the department has begun to address these issues through policies and procedures such as O 430.1B and the use of department-wide tools (the Condition Assessment Survey and the Facilities Information Management System) to measure and track maintenance requirements, deferred maintenance, and the need for recapitalization, a definitive statement regarding the strategic importance of facilities and infrastructure as a key intermediate objective is absent from the DOE strategic plans or comparable policy documents.

The committee believes that DOE's efforts to incorporate projected facility needs and deferred maintenance in 10-year site plans are appropriate, but finds that the implementation of facility management and infrastructure renewal efforts varies widely across programs and from site to site. While some programs and sites examined by the committee recognized facility management problems and took proactive corrective measures even before O 430.1B was drafted, others are just beginning to develop policies and procedures to implement the order, and some have not yet initiated meaningful action. The committee notes that the order was issued September 24, 2003, and while full compliance is not required until September 30, 2004, every effort should be made to expedite the earliest full compliance with O 430.1B.

2. Shared understanding between headquarters and field operations that facility and infrastructure management and renewal are linked with site missions in ways that are clear both to headquarters and to field operations.

The committee found that DOE has historically pursued program objectives as a first priority, a focus that is commendable but that has often resulted in inadequate funding for the facilities maintenance and renewal needed to support these ongoing missions as well as the timely decontamination and demolition of obsolete facilities. Although most DOE staff and DOE contractors recognize the link between program mission and facility condition, funding limits and competitive pressure to minimize overhead costs have led some sites to underfund fulfillment of their facility requirements.

In response, the Facilities and Infrastructure Recapitalization Program was developed to address the backlog of deferred maintenance in the National Nuclear Security Administration and appears to be working effectively. The program has strong central direction and is linked to a 10-year comprehensive site plan and 5-year funding plans. The Facilities and Infrastructure Recapitalization Program

is intended to reduce deferred maintenance to industry norms by 2009 (Office of Management and Budget, 2003, performance evaluation, available online at http://www.whitehouse.gov/omb/ budget/fy2004/pma/facilitiesinfrastructure.pdf). The committee is concerned, however, that other DOE program offices do not have similar facility recapitalization programs and hopes that provisions in the recently deferred energy bill will be reintroduced, leading to a stable source of funding for such programs.

A source of predictable, adequate funding is necessary to plan for and implement facility maintenance and recapitalization to meet DOE's program mission objectives and should be addressed. The committee is also concerned that there are no programs to adequately address the full burden of decontamination and demolition of contaminated excess facilities, such as the Bevatron at Lawrence Berkeley National Laboratory, Fast Burst Reactor at Oak Ridge National Laboratory, Van de Graaff accelerator at Los Alamos National Laboratory, and the Biological Science Building at the National Nuclear Security Administration Y-12 site—a legacy that is not being addressed by the Office of Environmental Management and that impinges on the sites' functional quality.

3. Clear operational guidance for field sites that links facility management and infrastructure renewal actions to management's expectations for achieving program objectives.

The committee commends DOE for issuing O 430.1B as a comprehensive description of its expectations for the management of DOE facilities and infrastructure by DOE site offices and site management and operations contractors. However, the committee found wide variance in the level of readiness of DOE field offices to implement the order. This is probably because the order describes what is expected but does not provide direction on how to achieve the desired results. From the committee's visits, it appears that several sites, Lawrence Livermore and Sandia in particular, have already integrated major elements contributing to a successful facilities management program. Other sites have not achieved similar progress. Although the committee believes that contractors should have some flexibility in implementing O 430.1B, it also believes that some procedures known to be effective should become standard practice department-wide. Consistency in implementation of procedures such as condition assessment and facility planning and management is also needed as a basis for evaluating performance across the DOE complex. The rollout of O 430.1B has been delegated to the program offices, and the committee has seen no evidence of a plan for DOE-wide implementation of O 430.1B.

The committee believes that DOE headquarters should provide implementation guidelines that incorporate the best practices currently employed at DOE sites and by other organizations in government and industry. DOE should consider developing a facility management manual—one similar to *Project Management*

for Acquisition of Capital Assets (Manual M 413.3-1), which guides implementation of the program and project management policy (Order O 413.3)—and a training program for facility managers similar to the Project Management Career Development Program.

4. Consistent integration across programs and sites of corporate goals, site activities, and the budget process in a manner that balances maintenance and renewal of facilities and infrastructure with the programmatic mission.

The committee observed inconsistency from site to site in the integration of corporate goals, site activities, and the budget process. Overhead charges seem to vary from site to site, with one site assessing a fee for the space assigned to a program and another assessing a fee as a percentage of the payroll costs. The committee believes that of the two approaches, facility charges based on assigned space are more likely to promote efficient facility management decisions; however, either approach could be adjusted to adequately fund facility and infrastructure requirements. On the basis of the apparent level of underinvestment in DOE facilities and infrastructure as observed by the committee, an appropriate balance has generally not been achieved.

5. Formal structures to develop and implement corporate best practices in facility management and to facilitate the transfer of lessons learned among programs and sites.

As noted above, the committee has observed examples of highly effective facility management and infrastructure renewal at some DOE sites. Congress has authorized pilot projects to provide models for improving DOE facilities and infrastructure. The pilot program on site planning and facility maintenance management conducted by Lawrence Livermore National Laboratory is one example. The committee believes that DOE should have a rigorous program to take full advantage of opportunities to transfer expertise and the application of effective practices and tools to all sites. The size of the DOE complex provides a unique opportunity to identify and apply at all sites the best of the best solutions. Common practices applied department-wide may provide an opportunity to leverage DOE's size for more cost-effective procurement of facility maintenance and capital renewal.

The committee learned of informal efforts at some DOE sites to share lessons learned and best practices, and there was also some indication of infrequent meetings of facility directors within program offices. However, there was no indication of a formal process to identify lessons learned and to facilitate the adoption of best practices department-wide, a process that the committee believes could return large dividends for a modest investment. The committee notes the success of the excellent Web-based lessons-learned programs for environmental

safety and health operations at DOE sites and believes that facility management and infrastructure renewal could benefit from a similar program.

DOE should take a collaborative approach across its sites and programs to recognize best practices and principles and to promote their adoption at all levels. The committee observed that DOE sites have a culture that values independence, which when coupled with competition among the sites seems to diminish enthusiasm for collaboration and sharing knowledge. The committee believes that DOE could also benefit from benchmarking its programs for facility management and infrastructure renewal across DOE sites and programs and also benchmarking against the performance of similar programs in other federal agencies and in industry.

6. Performance metrics and indicators that use consistent and accurate data to measure meaningful outcomes department-wide.

The committee is impressed by the robustness of the Condition Assessment Survey and the Facilities Information Management System and by the ability of some DOE sites to integrate these department-wide systems with each site's facility management systems. However, the committee is concerned about the effectiveness of the quality control system for condition assessment and data collection in ensuring the accurate and consistent application of criteria across the complex. The committee is also concerned about DOE's reliance on the Asset Utilization Index and the Asset Condition Index to determine facility management performance, because the committee believes that both indices oversimplify the parameters of effective facility stewardship. Metrics are needed that show how the investments in DOE facilities support program objectives, as well as address the deferred maintenance backlog plus requirements for modernization, plant adaptation, and compliance with regulatory requirements.

More robust metrics are also needed to assess management of the elimination of excess facilities. Current metrics track only the floor area of facilities demolished without taking into account the level of contamination, the impact on the site, or the impact on the overall program mission. An apparent result has been the demolition of excess facilities that present little risk, rather than prioritizing and removal of such facilities on the basis of their impact on the program objectives and the site. Although it generally supports linking the demolition of excess facilities to new construction, the committee believes that effective elimination of excess property is focused on achieving the optimal space required for meeting overall DOE program office or departmental objectives.

7. Open communication channels, both vertical and horizontal, to convey guidance and reduce feedback time.

Facility management and infrastructure renewal of DOE sites are controlled by the site management and operations contractors. At most of the sites visited by

the committee, the contractors' senior managers were actively involved and facility issues were integrated into management procedures. At some sites, communication included active engagement with program directors and scientists to ensure an appreciation of the strategic nature of the facilities and the infrastructure. The involvement of personnel at all levels should be encouraged across the DOE complex.

DOE oversight of contractor performance is undertaken by site offices communicating directly with and accountable to DOE headquarters. The committee observed a generally high level of partnering and communication between the facilities' contractor personnel and DOE site office personnel. The committee believes that such close interactions are conducive to efficient operations so long as the roles and responsibilities of the owner and contractor are clearly understood. DOE site office personnel assigned to managing facilities and infrastructure are responsible for setting objectives and providing the means for the contractor to carry them out. The contractor is responsible for ensuring that the owner's objectives for the site are achieved.

Summary Comments

The success of any organization depends on the quality of its leadership at all levels. The committee believes that success in DOE depends on a shared vision and continuous, consistent leadership from DOE headquarters, DOE site offices, and site management and operations contractors. To create an organization that demonstrates the attributes of maturity and quality in facility management, DOE will need more than written policies. It will have to transform policies into a culture that recognizes the value of facilities and infrastructure to DOE missions. This change in culture will be achieved with excellence in implementing the seven attributes discussed above.

In summary, the level of recognition of the importance of facility stewardship and the synergy between the quality of facilities and the achievement of program objectives are inconsistent across DOE program offices and sites. This disparity is manifested in the level of funding and passion for facility-oriented programs and the planning and managing of facilities for current and future program requirements. The committee's initial assessment is that DOE has issued policies that if adequately and consistently supported by meaningful practices and procedures will improve the quality of facility management and will lead to better allocation of resources for the effective support of DOE's missions. Successful implementation will require timely and effective leadership, communication, and guidance from headquarters, site offices, and management and operations contractors to ensure consistent stewardship of facilities in DOE. As it continues its work toward developing its final report, the committee will address opportunities and methods to facilitate implementation of improved DOE policies and procedures consistently across DOE programs and sites.

The committee appreciates this opportunity to be of service to DOE and looks forward to assisting the department in its continuing efforts to improve facility management and infrastructure renewal programs.

Respectfully submitted,

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MARGARET P. KINNAMAN, University of Maryland, Baltimore
PETER MARSHALL, Burns & Roe Services, Virginia Beach
LINDA NOZICK, Cornell University, Ithaca, New York
DOUGLAS SARNO, The Perspectives Group, Inc., Alexandria, Virginia
JAMES TIEN, Rensselaer Polytechnic Institute, Troy, New York
ZHANMIN ZHANG, University of Texas, Austin

Staff

RICHARD G. LITTLE, Director, Board on Infrastructure and the Constructed Environment
MICHAEL D. COHN, Program Officer
DANA CAINES, Financial Associate
PAT WILLIAMS, Senior Project Assistant

Appendix B

Biographies of Committee Members

James M. Braus, *Chair,* is a retired general manager of engineering at Shell Oil Company. In this position, Mr. Braus was responsible for the management of technical support, engineering, and construction of all refineries, plants, pipelines, and facilities in the United States. Over his 34-year career with Shell, he held various positions, including general manager of the Deer Park, Texas, manufacturing complex and general manager of the Products Research Division. Mr. Braus is an active member of the National Academy of Construction, the Construction Industry Institute (CII), and the American Institute of Chemical Engineers (AIChE). For his service with CII he was awarded the Carroll H. Dunn Award of Excellence in 1992. Mr. Braus has a BS in chemical engineering from the University of North Dakota.

David A. Cain is assistant vice president of Administration and Finance, Capital Assets and Services, at Northern Arizona University (NAU). In this position Dr. Cain provides leadership and is responsible for the management of strategic planning, capital programming, design and development, construction, operation, maintenance and safety of NAU facilities and infrastructure. He also serves as an adjunct professor in NAU's Construction Management Department, where he is developing a curriculum for a certificate in facility management. Prior to joining NAU Dr. Cain was executive facilities director at Illinois State University. He is the major contributing author for the *Strategic Assessment Model* of the Association of Higher Education Facilities Officers (APPA). He has also contributed over 50 professional publications, including *Benchmarking in Higher Education: Promise or Fad,* International Association of Management, Montreal, Canada,

1997; *Creating a Learning Organization Environment for the Facilities Professional,* APPA, 2000; and *Assessment and Continuous Improvement,* APPA, 2000. Dr. Cain was an active member of the Midwest Association of Physical Plant Administrators (MAPPA) for 13 years and of Rocky Mountain Association (RMA) for the last 3 years. Dr. Cain is currently serving APPA as a founder of the Center for Facilities Research, a member of the Professional Affairs Committee, and liaison to the NRC Federal Facility Council. Dr. Cain was the recipient of APPA's Pacesetter Award in 2000 and the President's Award in 2000 and 2002. He has a BS from Illinois State University, an MS from Iowa State University, and a PhD in higher education from Illinois State University with an emphasis in law and finance, strategic planning, and statistical analysis.

Charles Davidson is a retired chairman, president, and chief executive officer of J.A. Jones, Inc. His career with J.A. Jones spanned more than 35 years and a rise in responsibility from project manager to president to chief operating officer to chief executive officer. He was responsible for various operating divisions of J.A. Jones, including its multiple construction divisions. Currently, Mr. Davidson is president of Moorland Consulting Group. He holds a professional engineering license from the District of Columbia and has a BS in civil engineering from Lehigh University.

J. Clay Dean, P.E., provides program management consulting support to the Naval Facilities Engineering Command (NAVFAC). He has worked as a senior IT program manager providing IT services to the federal government and airport sectors. He served as CTO/CKO at a major defense firm in the Washington area. Mr. Dean's 29-year Navy career included assignments as the commanding officer of Public Works Center Washington, the staff of the Vice President's National Performance Review, and the staff of the Secretary of Defense. His experience as a public works officer and asset manager spans 16 years. He was a Department of Defense acquisition professional and Level III contracting officer. He was the chairman of the Development Committee for the Contract Services Association of America and a senior consultant to ICASIT at George Mason University, providing KM information services to metropolitan Washington, D.C. Mr. Dean received the Vice President's Hammer Award for customer service in 1996. He holds an information technology certificate from George Washington University and completed the Industrial College of the Armed Forces and the Executive Program at the University of Michigan. Mr. Dean received a BS from the Naval Academy and a BS and an MS in civil engineering from the University of Colorado. His publications include articles in *The Military Engineer* and the *ASCE Journal of Construction Engineering and Management,* and extensive publishing of various topics on the Web. He was a contributing writer for Department of the Navy CIO publications on e-learning, knowledge management metrics, and communities of practice.

Donald V. Freiert, Jr. is vice president of corporate real estate for Nationwide Insurance. He is responsible for the strategy, portfolio planning, and management of Nationwide real estate worldwide. Prior to joining Nationwide in 2002, Mr. Freiert was senior vice president of Enterprise Services for Cardinal Health in Dublin, Ohio. In that role, he was responsible for corporate real estate services, corporate aviation, corporate procurement/sourcing, and methods improvement. Prior to joining Cardinal Health in 1999, Mr. Freiert was senior vice president and director of Corporate Real Estate Services at Bank One Corporation with responsibility for all real estate activities nationwide. Mr. Freiert was also senior vice president at NationsBank (now Bank of America), serving as national manager of general bank real estate acquisition and disposition services and regional manager of real estate services for the bank's mid-Atlantic region. Prior to that, Mr. Freiert was senior vice president and manager of the Corporate Services Division for MNC Financial (acquired by NationsBank) in Baltimore, Maryland. Mr. Freiert is a graduate of Loyola College in Baltimore, with a BA in accounting, and is a certified public accountant. He has also completed the executive management programs in finance and marketing management at the Stanford University Graduate School of Business. He is a member of the Financial Advisory Committee of CoreNet Global and a past member of the NACORE International board of directors.

Angelo Giambusso has over 40 years of experience in the electric energy field in the application of nuclear technology, with extensive service in both government and industry. He has over 20 years of service as a corporate officer with Stone and Webster Engineering Corporation (S&W). He has served as manager of the Washington, D.C., office, interacting with government agencies and Congress, and as deputy director of the International Operations Department. Before his retirement in 1999, he had been working on Asian business development and U.S. nuclear export policies, issues, and procedures, dealing with the Nuclear Regulatory Commission, DOE, and the Commerce and State Departments. Prior to Mr. Giambusso's service with S&W, he had a distinguished government career with the Atomic Energy Commission (AEC) and its later incarnations—the regulatory commission, the Energy Research and Development Administration (ERDA), and DOE. In these agencies, he played a key role in developing the nuclear licensing process, including the development of the Environmental Impact Statement for nuclear reactors. Since his retirement from S&W, Mr. Giambusso has provided a variety of consultancy services including assessments of the Hanford Office of DOE and the implementation of all-inclusive standards at LLNL. He has also been involved in a critique of the design and methodology of the DOE Yucca Mountain Project. Mr. Giambusso has a BS in mechanical engineering from MIT.

James H. Johnson, Jr., is professor and dean of the College of Engineering,

Architecture, and Computer Science at Howard University. Dr. Johnson's research interests have focused mainly on the reuse of wastewater treatment sludges and the treatment of hazardous substances. Currently, he serves as associate director of the Great Lakes and Mid-Atlantic Center for Hazardous Substance Research and as a member of the Environmental Engineering Committee of the U.S. EPA Science Advisory Board, the National Research Council's Committee on Remediation of Buried and Tank Wastes, and the Board on Radioactive Waste Management. Dr. Johnson is a registered professional engineer in the District of Columbia, a diplomate in the American Academy of Environmental Engineers, and a fellow of the American Society of Civil Engineers. He received a BS from Howard University, an MS from University of Illinois, and a PhD from the University of Delaware.

Margaret P. Kinnaman is currently the director for business administration and support services within the Facilities Management Division at the University of Maryland, Baltimore. She is responsible for the financial tracking of and budgeting for over $30 million dollars annually and the provision of construction project accounting for over 400 projects annually. Ms. Kinnaman has taken the lead on numerous special projects, including creating a space management system and chairing a systemwide Capital Renewal Deferred Maintenance Task Force. She has been active in the Association for Higher Education Facilities Officers (APPA) at all levels for the past 20 years, most recently serving as APPA's International President. She is also chair of APPA's Strategic Assessment Model (SAM) Task Force as well as co-chair of a newly developing Center for Facilities Research. Ms. Kinnaman has contributed numerous articles to APPA's *Facilities Manager Magazine* and has been a contributing author to two Strategic Assessment Model publications. Additionally, she has spoken before audiences all over the United States, Australia, and the United Kingdom.

Peter Marshall is vice president of operations at Burns and Roe Services Corporation after a distinguished career in the Civil Engineer Corps of the US Navy. Prior to joining Burns and Roe, his experiences included 2 years as a senior vice president with Parsons Brinckerhoff Construction Services Corporation. He was responsible for major project development and project operations. Transitioning from the Navy in 2000, RADM Marshall's experience in the Civil Engineer Corps of the Navy included increasingly responsible positions with the Naval Facilities Engineering Command, from commanding officer of the Navy Public Works Center in San Francisco to fleet civil engineer of Naval Forces Europe to commander of the 22nd Naval Construction Regiment and Pacific Division of NAVFAC to vice commander of NAVFAC. With strengths in infrastructure planning, program management, field and contingency engineering, facilities management, and business unit reorganization, he has successfully delivered a wide range of facilities projects and programs to his clients. Some of RADM

Marshall's accomplishments include operation of a $280 million environmental restoration contract at a former Department of Defense (DoD) bombing range and development and implementation of a $1 billion capital improvement program for all naval facilities throughout Europe. RADM Marshall is a fellow of the Society of American Military Engineers and a licensed professional engineer in Virginia and California with a BS in civil engineering from Tufts and an MS in ocean engineering from the University of Rhode Island.

Linda Nozick is a professor in the School of Civil and Environmental Engineering at Cornell University, where she also serves as a director of graduate studies for systems engineering. While on sabbatical from Cornell, Ms. Nozick was a visiting professor in Operations Research at both the Naval Postgraduate School and General Motors Global Research and Development. Ms. Nozick is a recipient of the Presidential Early Career Award for Scientists and Engineers (PECASE) and the CAREER Award from NSF. She has been published extensively on issues in transportation, optimization, and decision making under uncertainty. Ms. Nozick is a member of two committees of the NRC's Transportation Research Board and of a National Cooperative Highway Research Program panel. She is a member of numerous professional organizations dealing with operations research and transportation research. Ms. Nozick has a BS in systems analysis and engineering from George Washington, and an MS and a PhD in systems engineering from the University of Pennsylvania.

Douglas Sarno is a principal with the Perspectives Group in Alexandria, Virginia. He has over 15 years' experience promoting and implementing public participation throughout the United States and the world. He regularly advises and provides training to government and not-for-profit organizations in areas including public participation, public education, communication, decision making, group dynamics, media relations, and strategic planning, and he has written and spoken widely on these subjects. He designed and implemented the Certification Course in Public Participation of the International Association for Public Participation (IAP2) and wrote the public participation guidance for the Nuclear Regulatory Commission. Mr. Sarno holds a BS in civil engineering from the University of Virginia and an MBA from the University of Maryland. He is a member of the NRC Board on Infrastructure and the Constructed Environment.

James M. Tien (NAE) is chair and professor in the Department of Decision Sciences and Engineering Systems at Rensselaer Polytechnic Institute. Dr. Tien was elected to the National Academy of Engineering in 2001 for his work in improving public services and engineering education through systems engineering methods. Dr. Tien joined the Rensselaer faculty in 1977 in the Department of Electrical, Computer, and Systems Engineering and was acting chair of the department in 1986-1987. In 1988, he was the founding chair of the Department of

Decision Sciences and Engineering Systems. He twice served as acting dean of engineering at Rensselaer, from 1992 to 1994 and from 1998 to 1999. Prior to joining the Rensselaer faculty, Dr. Tien worked at the Bell Laboratories and the RAND Corporation. He was also a lecturer at MIT. Dr. Tien is on the IEEE board of directors and is an IEEE vice president in charge of the IEEE Publication Services and Products Board. He is a fellow of IEEE and a member of INFORMS, IIE, and many other professional and academic organizations. He has received numerous research and education awards and has published numerous peer-reviewed articles on decision modeling and systems engineering. Dr. Tien earned his BS in electrical engineering from Rensselaer and a PhD in electrical and systems engineering from MIT.

Zhanmin Zhang is an assistant professor in transportation engineering at the University of Texas (UT) at Austin. He joined the Center for Transportation Research at UT as a research associate upon receiving his doctoral degree and has conducted research in the engineering and management of infrastructure systems and the applications of advanced database and information systems to infrastructure management for more than 15 years in the United States and abroad. His current research interests include infrastructure systems analysis and management, behavior and performance simulation of pavements and infrastructure systems, large-scale database and information systems, application of advanced technologies, and intelligent infrastructure systems. Dr. Zhang serves as an executive member of the U.S. Department of Transportation's Southwest University Transportation Center (SWUTC). He is also a member of the technical panel for the Research Management Committee 1 of the Texas Department of Transportation. Dr. Zhang is a member of two technical committees of the National Research Council's Transportation Research Board: A2B01-Pavement Management Systems and A2F09-Application of Emerging Technology. In addition, Dr. Zhang has frequently served as a technical reviewer for prestigious journals such as *Transportation Research*, the *Journal of Transportation Engineering*, the *Journal of Infrastructure Systems,* and the *Transportation Research Record*. Dr. Zhang earned a BS in civil engineering from Chang'an University and an MS and a PhD in civil engineering from the University of Texas at Austin.

Appendix C

Committee Fact-Finding Activities

August 11–12, 2003	Committee meeting, National Academy of Sciences, Washington D.C.
	Overview of DOE Facilities and Infrastructure Management Programs: Jim Rispoli, Director, Office of Engineering and Construction Management (OECM) Eduard Dailide, Deputy Director, OECM Facilities and Infrastructure
	Overview of National Nuclear Security Agency (NNSA) Facilities and Infrastructure Management Programs: Bruce Scott, Director, NNSA Infrastructure and Facilities Management
	Overview of Office of Science (SC) Facilities and Infrastructure Management Programs: Leah Dever, Associate Director, SC Laboratory Operations and Environmental Safety and Health John Yates, Supervisory Program Analyst, Laboratory Infrastructure Division

	Overview of Environmental Management (EM) Facilities and Infrastructure Management Programs: Bill Levitan, Physical Scientist, Office of Operations Oversight
October 14, 2003	Delegation site visit and briefings, Lawrence Berkeley National Laboratory, Berkeley, California
October 15, 2003	Delegation site visit and briefings, Lawrence Livermore National Laboratory, Livermore, California
October 20, 2003	Delegation site visit and briefings, Oak Ridge National Laboratory, Oak Ridge, Tennessee
	Delegation site visit and briefings, NNSA Y-12 Site, Oak Ridge, Tennessee
October 21, 2003	Delegation site visit and briefings, Savannah River Site, Aiken, South Carolina
November 5, 2003	Delegation site visit and briefings, Sandia National Laboratories, Albuquerque, New Mexico
	Delegation site visit and briefings, Los Alamos National Laboratory, Los Alamos, New Mexico
December 9–10, 2003	Committee meeting, Keck Center, Washington, D.C.
	Roundtable discussion on DOE polices and procedures, and facility management and infrastructure renewal for NNSA, SC, and EM. Topics include: • Implementation of O 430.1B, accountability and performance evaluation • Reliability and verification of CAS and FIMS • Assessment of deferred maintenance backlog • Apportioning capital renewal funds • Determining appropriate actions and priorities for surplus facilities • Internal and external benchmarking • Identifying and sharing best practices and lessons learned

	Roundtable participants: Jim Rispoli, Director, Office of Engineering and Construction Management (OECM) Eduard Dailide, Deputy Director, OECM Facilities and Infrastructure Bruce Scott, Director, NNSA Infrastructure and Facilities Management John Yates, Supervisory Program Analyst, Laboratory Infrastructure Division Bill Levitan, Physical Scientist, Office of Operations Oversight
	Roundtable discussion on infrastructure management and infrastructure renewal benchmarks, best practices, tools, and resources in government and industry.
	Roundtable participants: Eugene Hubbard, Director, Facilities Engineering Division, National Aeronautics and Space Administration Robert L. Neary, Jr., Associate Facilities Management Officer, Office of Facilities Management, Department of Veterans Affairs Harvey H. Kaiser, Principal, HHK Associates Don Sapp, Project Manager, Plexus Scientific
January 7, 2004	Delegation briefings, E.I. du Pont de Nemours and Company, Wilmington, Delaware
February 11, 2004	Delegation briefings, Naval Facilities Engineering Command, Washington, D.C.
February 17, 2004	Delegation briefings, Office of the Deputy Under Secretary for Defense for Installations and Environment, Arlington, Virginia
February 18, 2004	Delegation briefings, Commander Navy Installations Command, Arlington, Virginia

March 17, 2004 Committee meeting, Keck Center, Washington, D.C.

Roundtable discussion on DOE polices and procedures, and facility management and infrastructure renewal for NNSA, SC, and EM. Topics include:

- Implementation of O 430.1B
- Executive Order 13327 issues
- DOE facilities planning and budget policies and procedures
- Facilities management personnel training and qualifications

Roundtable participants:

Eduard Dailide, Deputy Director, OECM Facilities and Infrastructure

Bruce Scott, Director, NNSA Infrastructure and Facilities Management

Leah Dever, Associate Director, SC Laboratory Operations and Environmental Safety and Health

Barry Sullivan, General Engineer, Laboratory Infrastructure Division

Karl Goodwin, General Engineer, Office of Environmental Management