Independent Research Assessment of Project Management Factors Affecting Department of Energy Project Success

Final Report

Submitted to:
Office of Engineering and Construction Management
U.S. Department of Energy

July 12, 2004

CERF
Advancing the Design and Construction Industry through Innovation

Independent Research Assessment of Project Management Factors Affecting Department of Energy Project Success

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EXECUTIVE SUMMARY

The Civil Engineering Research Foundation (CERF) undertook a project management research study for the US Department of Energy (DOE) beginning in the fall of 2003. CERF was asked to identify key components affecting project performance, to evaluate performance factors, measures, and metrics in relation to their correlation with project success, and to make recommendations with regard to improving performance on different types of projects. The DOE Office of Engineering and Construction Management (OECM) selected 16 projects that were included in the review.

An Independent Research Team (IRT) was assembled to perform the study in collaboration with the CERF staff. This team collected data on the projects, familiarized themselves with what happened on each project, discussed the projects with DOE Headquarters personnel, and visited the sites to discuss the projects with the project teams. The data from the 16 projects were discussed by the IRT team during a meeting in Washington, and the common factors contributing to project success, or deficiencies, were ascertained. These factors were then grouped into categories and prioritized. Finally, lessons learned were listed and recommendations formulated for presentation to DOE.

The key categories and results are:

Organization and Personnel

- A critical success factor is the assembling and coordinated focus of a co-located Integrated Project Team (IPT) consisting of all key participants who are needed to perform the project as well as those who will use the deliverable when it has been completed. Both procurement and operations/facility user personnel should be on the team.
- A critical success factor is employment of an effective DOE Project Director with the right skills, including an understanding of the difference between assuming a leadership role and directing actual project execution.
- The most successful Contractor Project Managers have both technical and leadership skills.

Project Management Procedures

- The projects that performed robust front-end planning had the fewest problems during project execution.

- The risk assessment and management skills of the project team are critical determinants of eventual project success.
- Some of the projects reviewed showed an excessive reliance on the use of Earned Value Management Systems (EVMS) to monitor projects and were not using other tools at their disposal such as critical path schedule methods. Also, EVMS data problems and frequent rebaselining masked the true state of some of the projects.
- Best practices in schedule and cost control are: 1) the use of integrated, critical path project schedules and 2) trending of potential changes.
- Regular, periodic project reviews by internal and external parties are often an effective means of keeping projects on track. However, these reviews need to be coordinated and limited to those necessary to track the project.

Procurement

- An acquisition strategy should be developed during the conceptual design phase of the project and integrated with the risk management program.
- Procurement approaches should be tailored to project needs.
- Performance metrics and incentives should be used to tie contractor performance to desired business results.

Project-Specific Factors

- Reviews by technical peers from other sites can play a key role in the success of complex, first-of-a-kind DOE projects.
- Unpredictability of funding disrupts projects, lengthens schedules, and increases costs.

The complete set of recommendations for DOE is included in Section 4. The more significant items are recommendations that DOE:

- Develop a core group of highly qualified Federal Project Directors along with a defined career path to retain these individuals.
- Create opportunities for interactions and the sharing of lessons learned sharing among DOE Project Directors.
- Provide guidance on the required membership on an IPT and ensure that an IPT is appropriately identified early in the project.
- Take steps to strengthen risk assessment and risk management practices, and make the discussion of risk assessment and mitigation plans a part of all project reviews.
- Work to make Earned Value Management Systems (EVMS) meaningful management tools by improving the awareness of IPTs that EVMS are more than reporting mechanisms.
- Appropriately control the rebaselining of projects.
- Ensure that an integrated project schedule which includes all participants' work efforts is developed for projects.
- Encourage robust front-end planning.
- Establish a baseline at the 30-40% design point for large projects (over $50M) that have reached Critical Decision-1. If they are not ready to satisfy all of the requirements of

Critical Decision-2 at that point then a shortened list of requirements should be developed so that they can have a formal baseline for some portion of the work approved.

- Ensure that an *acquisition* strategy is developed at the beginning of the project.
- See that procurement staff play an integral role in the development of the acquisition strategy and become key members of the integrated project team.
- Require peer reviews for first-of-a-kind and technically complex projects at Critical Decision-1.
- Fully fund the smaller line-item projects and provide phased funding for the larger ones. The phased funding should be linked to the Critical Decision points.
- See that multi-partner teams develop Memorandums of Agreement early in the project and incorporate them in the relevant contracts.
- Develop guidelines for tailoring the requirements of the 413.3 Order and Manual to address the special conditions facing smaller and other unique programs.
- Examine the value of the PARS program reporting system to senior managers responsible for monitoring program efforts.

GLOSSARY

ACWP	Actual Cost of Work Performed
ANSI	American National Standards Institute
BCWS	Budgeted Cost of Work Scheduled
CADD	Computer-Aided Design and Drafting
CD	Critical Decision
CERF	Civil Engineering Research Foundation
CERN	Conseil Européen pour la Recherche Nucléaire (European Organization for Nuclear Research)
CM	Construction Manager
DOE	U.S. Department of Energy
DOE HQ	DOE Headquarters
DOE IG	DOE Inspector General
O 413.3	DOE Order 413.3
EIR	External Independent Review
ETTP	East Tennessee Technology Park
EVMS	Earned Value Management System
HVAC	Heating, Ventilating and Air Conditioning
IPT	Integrated Project Team
IRT	Independent Research Team
M & O	Maintenance and Operations
MOX	Mixed Oxide Fuel Fabrication Facility
NNSA	National Nuclear Security Administration
NRC	National Research Council
OECM	Office of Engineering and Construction Management
PARS	Project Assessment and Reporting System
REA	Request for Equitable Adjustment
TPC	Total Project Cost

1. INTRODUCTION

The Civil Engineering Research Foundation (CERF) undertook a project management research study for the US Department of Energy (DOE) beginning in the fall of 2003. DOE's Office of Engineering and Construction Management (OECM) has the lead responsibility for centralized project management and all associated functions, and sought ways to improve project performance. They asked CERF 1) to identify key components affecting project performance since the new 413 series of project management practices and procedures were put in place in 2000, 2) to evaluate performance factors, measures, and metrics in relation to their correlation with project success, and 3) to make recommendations with regard to improving performance on different types of projects.

The Work Plan for conducting the study included the major elements discussed below:
First an Independent Research Team (IRT) was selected to perform the study in collaboration with the CERF staff. The members of the team are:

- Dr. Allan V. Burman (President, Jefferson Solutions; formerly Administrator of the Office of Federal Procurement Policy)
- Gary D. Coxon, P.E. (Consultant; formerly, Executive of Lockheed Martin, and Bechtel)
- Lloyd A. Duscha, P.E. (Consultant; formerly, Deputy Director, Engineering and Construction Directorate, US Army Corps of Engineers)
- Dr. J. Davidson Frame (Dean, University of Management and Technology, Arlington, VA)
- Mary Ann Novak (Consultant; formerly, Executive of Parsons Brinkerhoff, Acting Assistant Secretary of DOE NE and other DOE positions)
- Dr. Clifford J. Schexnayder, P.E. (Eminent Scholar Emeritus, Del E. Webb School of Construction, Arizona State University, Retired Col. US Army Corps of Engineers)
- Dr. H. Gerard Schwartz, Jr. P.E. (Sr. Professor of Engineering, Washington University; formerly Chairman, Jacobs/Sverdrup Civil; Past-President, American Society of Civil Engineers)
- Dr. Harry Stefanou (Manager of Research, Project Management Institute)
- Dr. Michael Yates, P.E. – IRT Chair (Consultant; formerly, Executive of Fluor Corporation and Ebasco Services Incorporated)

Biographies of the IRT members are included in Appendix A. Dr. Amar A. Chaker, Director of Engineering Applications, CERF served as the Project Manager of the review project. Other CERF staff members contributing to the project included Mr. Muhammad Amer, Senior Program Manager; Ms. Amanda Goebel, Research Associate; Mr. Larry Jiang, Senior Program Manager; Mr. David Reynaud, Director of HITEC; and Ms. Susanna Sprinkel, Communications Coordinator.

Lt. General Henry J. Hatch, P.E., U.S. Army (Ret.), Chair, NRC Federal Facilities Council and formerly, Chief, US Army Corps of Engineers, and Dr. Richard L. Tucker, Joe C. Walter Professor of Engineering, the University of Texas at Austin and formerly, Director, Construction Industry Institute, served as External Reviewers of the report.

OECM selected 16 projects to be reviewed. They were selected so that a broad range of cost, scope, DOE program organizations, and sites would be reviewed, but they were *not selected randomly* and therefore do not constitute a random sample. The projects are on four different DOE sites and include projects managed by the Office of Environmental Management, NNSA, and the Office of Science. The 16 study projects are discussed in Section 2.

A key objective of the study was to understand the relationship between project management factors and project performance on different types of projects; so that best practices for DOE projects might be identified. To accomplish this objective, the data items to be collected were carefully selected. These data items documented the scope of each project, the project acquisition process used, and factors that influenced project outcomes or measured project success, addressing both tangible measures such as timeliness and cost performance, and more esoteric, but equally influential factors, such as effectiveness of communication and the nature of the working relationships among all parties.

The status of each project was critically reviewed, comparing that status against the original project plan. Particular attention was directed at project performance from approximately the year 2000 (the year the 413 Policy and Order were issued) to the present. The key Performance Parameters examined were:

- **Scope** – Was the scope adhered to as the project progressed and did DOE achieve the scope that was established at the outset of the project? Was an acceptable product produced?
- **Schedule** – Was the project completed within the originally scheduled time frame? If not, what was the final duration and what was the amount of time extension, and what were the issues that drove schedule changes?
- **Budget** – Did the project adhere to the original budget? If not, what items/issues led to budget variances?

The factors that were evaluated included:

- **Procurement Methods**
  - Type of Contract
    - design, design-build, CM, other
    - fixed price, cost reimbursable, fee structure, performance-based contracting
  - Contracting incentives— for schedule, cost, quality
  - Procurement process—number of bidders, schedule, protests
  - Contractor scope of work
  - Full and open competition or other approach
- **Organization and Personnel**
  - Roles and responsibilities – DOE and contractor, project support offices and other HQ entities
  - Points of contact
  - Flow of deliverables and decisions

  - Project management competency issues
  - Training
  - Integrated Project Team utilization
- **Project Factors**
  - Size/Complexity – Does size/complexity change the performance of players and timeliness of decisions?
  - Reasonableness of cost estimates?
  - Scope – adequacy, level of detail
  - Duration – Were there many personnel changes on either side during the project?
  - Technology –Was the technology proven/evaluated prior to the project start? If not, how was the technology proven during the project?
  - Location – Did location play a role in project success?
  - External influences (appropriations, politics, international agreements)
- **Project Management Procedures**
  - Front-end planning
  - Project control tools – adequacy, visibility, forecasting ability
  - Risk assessment and management
  - Contractor/DOE review and approval process for deliverables, contracts
  - Critical Decision approval process/ Timeliness
  - Formal reviews, such as ORRs
  - Quality process and procedures
  - Safety process and procedures
  - Use of the revised DOE 413 policy, order, and manual
  - Internal and external reviews and audits

The study was executed through the collection and review of project documents, visits to the project sites, and discussions with project and DOE headquarters personnel. The documents reviewed on each project are listed in Appendix B and the site visit schedule/project personnel contacted are in Appendix C. Appendix D provides the questionnaire that was used at the sites by the IRT to guide discussions relating to DOE 413 documents, the Program Assessment and Reporting System (PARS), and related issues.

The data was analyzed to determine factors important to success and factors that created challenges on the 16 projects. The results were compared and correlated across all the projects to identify best practices and lessons learned, as well as to develop recommendations and strategies for improving project performance.

The remainder of this report covers:

- **Project Summary** – a summary of the 16 projects

- **Project Factors** – a discussion of the important factors and lessons learned from the projects, broken down into four major categories, organization and personnel, project management procedures, procurement, and project-specific factors
- **Recommendations** – actions the IRT believes DOE should take to enhance the success of its projects.

Finally, IRT comments on the updated DOE 413 policy, order, and manual can be found in Appendix E and comments on PARS are in Appendix F.

2. PROJECT SUMMARIES

The table below provides the key data on the 16 projects that were reviewed and summarizes how the IRT viewed project performance:

Three of the projects larger than $500M, namely the High Level Waste Removal and the Tritium Extraction Facility projects at Savannah River and the Spallation Neutron Source project at Oak Ridge, were baselined prior to 2000 and had undergone significant reviews, both external and internal, in the 1998 to 2002 time frame. These reviews resulted in changes in project management procedures and practices as well as in organization and personnel. The reviews were driven by issues with budgets, schedules, and personnel; Congressional concerns; and the recommendations in the 1999 NRC report (Ref. 1). Following the reviews and the establishment of new baselines, the projects have performed well, essentially on schedule and budget, and have delivered the desired products.

The Integrated Project Team for another project that is over $500M, the MOX Fuel Fabrication Facility project at the Savannah River Site, is currently preparing the Critical Decision 2 (CD-2) package that will officially set the project's performance baseline. This large unique project received CD-1 approval in 1997, prior to the implementation of DOE O 413.3 and has been in the pre- CD-2 stage for about seven years. This project has seen a cost increase of about 300% for the design and development phase and has currently spent close to $300M. It had numerous external and internal impacts as listed in the table. The IRT does not have enough data on the factors that drove these schedule delays and cost increases to include them in the latter sections of the report. However, this project is an example of one that should have been baselined some years ago so that it would have the visibility and attention of all parties. Provisions should be made in DOE 413.3 to address a project of this size that has reached CD-1 but has not achieved CD-2.

A fifth project over $500M, the Microsystems and Engineering Sciences Applications project at Sandia reached CD-2 (establishment of the performance baseline) in 2002. Its design is completed and the project is now under construction. It received an additional $100M appropriation to accelerate it from an initial 2010 completion to a 2007 completion. Work is currently ahead of schedule. The project is on budget and is 25% complete.

Of the three projects between $100M and $500M, the Compact Muon Solenoid and the Neutrinos at the Main Injector projects at Fermi Lab are on schedule, although the latter project saw a cost increase of about 25% and still has Request for Equitable Adjustment (REA) issues. The third project in the category, ETTP 3 Building D&D project at Oak Ridge experienced considerable issues at the beginning and substantial cost growth. The project has also had schedule slippage of about one year and faces REA issues. All three of these projects were baselined prior to 2000.

The eight remaining projects, with costs range from $8M to $37M, generally have been performing satisfactorily, that is, on schedule and within budget. All of these projects used straightforward technology or entailed routine maintenance or upgrades. There were several

exceptions where cost increases or schedule slippages were seen. Many of these projects reached CD-2 from 2002 on and thus were baselined after Preliminary Design was completed. The IRT concludes that the enhanced front-end planning on these projects contributed to their success.

The projects that have not been completed still have cost and schedule risks to be managed. This particularly applies to the first-of-a-kind Science and NNSA projects where the basic technology cannot be proven until all of the equipment is operational. Therefore, the fact that these projects are going well "now" does not guarantee that they will be finished successfully. However, the continued use of disciplined project management procedures will increase their chances of success. All of these projects are currently using risk assessment and mitigation techniques extensively.

Essentially all of the Integrated Project Teams (IPT) were following project management procedures and practices comparable to those required by the DOE 413.3, Order and Manual, even though many of the projects were begun prior to these requirements being issued. However, the IRT did observe differences in the amount of discipline being applied to the use of DOE 413.3. For example, one IPT had a risk management plan in place but was not using the assessments and mitigation plans on an ongoing basis, and was only updating the plan once a year. Another IPT had a cost and schedule system and was using earned value methods, but it was clear that Earned Value principles were not being followed rigorously. Those IPTs that were taking a more disciplined approach to following Earned Value, risk management, change control and other project management practices and procedures had better-run projects and their projects achieved higher levels of success.

The suite of projects evaluated covers a broad range of projects over multiple sites and DOE organizations, but does not constitute a random sample. Therefore, overall conclusions on how DOE is managing projects cannot be drawn from this study. However, the factors contributing to the successes or the problems experienced on these projects enable one to determine what is working well and what is not. Those factors, as well as lessons learned from these projects, are discussed in the next section.

SUMMARY OF THE 16 PROJECTS

Project Location DOE Organization	**Description**	**Budget**	**Schedule**	**Status**	**Major Events**
Compact Muon Solenoid Fermi Lab Science	Design and build a detector for the Large Hadron Collider at CERN.	$167M	FY 1996 to 9/30/2005	84% complete, on schedule, $14M under budget.	Large number of stakeholders involved.
ETTP 3 Bldg D&D Oak Ridge Environmental Management	Decontaminate and decommission three buildings.	$346M	8/25/1997 to 8/23/2004	92% complete, 11 months behind original schedule and $63M over original budget. Several REAs pending.	Significant contractor project management issues in beginning. Several PM changes made. DOE decision to not allow nickel recycling caused problems.
External Communications Infrastructure Modification (ECIM) Sandia NNSA	Preliminary and final design for communication infrastructure project.	$25M	2/23/1999 to 4/30/2004	Complete. On schedule and on budget.	None.
Fire Safety Improvements Argonne – East Science	Correct deficiencies of fire detection and alarm systems and related systems.	$8M	7/2000 to 11/2003	Complete. Five months behind schedule and on budget.	Delayed by funding shortfall and high bid which required re-advertising.
High Level Waste Removal Savannah River Environmental Management	Provide waste removal facilities and infrastructure to allow waste removal from waste tanks.	$1,551M	10/1/79 to 9/30/2028	Tracking individual tanks – they are generally on schedule and under budget.	Re-baselined in 2000. Site-wide project management improvements made following reviews in 1998 and 2001.
Joint Computation Engineering Laboratory (JCEL) Sandia NNSA	Construct a facility to house 175 personnel, purchase and install computer equipment.	$31M	9/26/2000 to 9/17/2004	Over 95% complete. On schedule and on budget.	None.
Mechanical Systems Upgrade Argonne – East Science	Rehabilitation and upgrade project involving drainage, HVAC, steam systems.	$9M	5/2000 to 6/6/2005	30% complete. On schedule and on budget.	None.

Project Location DOE Organization	**Description**	**Budget**	**Schedule**	**Status**	**Major Events**
Microsystems and Engineering Sciences Applications (MESA) Sandia NNSA	Preliminary and final design, construction of microsystems complex.	$518M	7/1/1999 to 4/30/2010	Preliminary and final design complete. Construction in progress. Overall 25% complete. Under budget and ahead of schedule.	Additional funding will move the completion date to 2007.
MOX Fuel Fabrication Facility Savannah River NNSA	Preliminary and final design and construction of plant to convert surplus plutonium into commercial reactor fuel.	About $1,800M	10/30/1997 to 3/31/2008	CD-2 and design completion scheduled in June 2004, 21/2 years behind the 1999 schedule. Construction start expected in 2004. The design budget is about three times higher than that planned in 1999. A total of $279M spent by August 2003 on design and development.	The project was impacted by funding shortfalls, integration of American and French technology and licensing approach, the need for NRC licensing, the need to wait for Russian action, the presence of international participants, design changes, underestimates and contractor issues.
Neutrinos at the Main Injector Fermi Lab Science	Design and build an accelerator, with detectors in Illinois and Minnesota.	$171M	3/1/1997 to 9/30/2005	90% Complete. Ahead of schedule and on budget. Significant REAs pending.	Reviewed and rebaselined in 2001, with costs increased by $33M and schedule delayed by two years. IPT lack of technical expertise and acquisition process have caused issues.
Nuclear Materials Storage Savannah River Environmental Management	Modify existing facility to allow it to be used to store plutonium from Rocky Flats and other sites.	$37M	3/25/1998 to 8/31/2004	Essentially complete. Of six phases, the first two were late, but the facility was ready to accept RF Pu on time; the latter four were on schedule. A $1M savings is forecast.	The scope has been increased several times to allow more material to be stored.

Project Location DOE Organization	**Description**	**Budget**	**Schedule**	**Status**	**Major Events**
ORNL Burial Grounds Oak Ridge Environmental Management	Provide a multi-layer cap over waste areas to minimize groundwater contamination.	$27M	9/1/2000 to 2/3/2005	65% complete. Four months behind schedule. $2M over budget. Additional REAs expected.	Suspended for 11 months in FY 2002 due to funding limitations. Most of cost overrun is due to suspension. Subcontractor performance issues.
Research Support Center Oak Ridge Science	Design and construct a multipurpose building of 50,000 square feet.	$16M	11/15/2000 to 3/31/2005	Over 80% complete. Ahead of schedule and on budget.	None.
Spallation Neutron Source Oak Ridge Science	Design and build an accelerator, multiple beam lines, instruments and facilities.	$1,412M	8/19/1996 to 6/30/2006	76% complete. Three months ahead of schedule and on budget.	Multiple reviews in 1999, resulting in significant project personnel and procedures changes. Nine months added to schedule and $80M to cost, primarily due to funding constraints.
Storm Drain, Sanitary Sewer Sandia NNSA	Upgrade the storm drain, sanitary sewer and domestic water systems.	$16M	10/1995 to 9/2004	Essentially complete. On schedule and on budget.	None.
Tritium Extraction Facility Savannah River NNSA	Design and build facilities to extract tritium from irradiated fuel.	$506M	10/1/1997 to 7/31/2007	About 70% complete. Ahead of schedule and on budget.	DOE IG report in 2002 cited numerous PM deficiencies. 18 months added to schedule and $105M to cost in 2002.

3. PROJECT FACTORS

This section discusses the factors that were found to be the most important contributors to project success or the lack of it for the studied projects. The factors are grouped into major categories.

- Organization and Personnel
- Project Management Procedures
- Procurement
- Project-Specific Factors

The discussion of each category provides details on the factors that were found to be significant and concludes with lessons learned for the category.

3a. Organization and Personnel

Project management is a people business and the foundation of project management effectiveness lies with the people involved, both individually and collectively. The essence of effective project management lies in the fitness for duty and the ability of the people on the team to become of one mind and to bond with one goal. It is not surprising that people, their capabilities and the ways they are organized, are central to the success of DOE projects. By the intent of both the 413.3 Order and Manual, and as cited by the Federal personnel involved with the DOE projects studied, people and the way they relate and work together were identified as *the major factor* contributing to project success.

The IRT noted significant aspects related to the process of organizing and designating project personnel that contributed to successful DOE projects. However, it was also observed that the handling of these aspects could be strengthened to

- Eliminate confusion,
- Ensure that issues are identified in a timely fashion and defined clearly,
- Resolve issues expeditiously and *completely,* and
- Give consideration to user/operational interests up front.

The three significant people-based contributors to project success are the Integrated Project Team (IPT), the DOE Project Director, and the Contractor Project Manager, as discussed below.

Optimum Organization: Integrated Project Teams

Who are the members?

In the course of its visits to the project sites, the IRT encountered small, medium, and large IPTs; active and dormant ones; inclusive and exclusive ones. All were working to achieve project success, but many experienced uncertainty about their makeup, and all shifted membership over time, with both positive and negative impacts on project progress.

Some of this shifting made sense, as the project moved from the designers to the engineer constructors or from procurement to sole-sourced specialized equipment vendors. But often the shifting of personnel was the result of changing project requirements or the result of confidence

of the DOE Project Director in supporting team members. In some cases, personnel shifting resulted from a lack of clarity about the purpose of an IPT. Some groups did not call their working group an IPT, hesitating for a moment when asked by the IRT about its makeup. Others were uncertain about who should serve on an IPT, and still others claimed that no one was made available to serve on their IPT. One project IPT was made up solely of the DOE Project Director. At another site, the DOE and the contractor essentially each had their own independent IPTs. There was a sense that the makeup and purpose of an IPT was not understood, although DOE Project Directors and Contractor Project Managers affirmed that project success resulted from a team effort and nothing less. Each of these projects were successfully meeting their goals, but the principles and practices necessary for handling the challenges of the future were not yet instilled. Most IPT questions centered on 1) inclusion of the planned users/operators of the project facility, and 2) on including procurement specialists to analyze and provide advice about contracting practices.

Discussions were held on when and if to include specialized vendors. Those interviewed at several projects questioned the intent of the 413.3 Manual as to whether and when to include the contractor on an IPT, as in the early stages of a project, the IPT consists of only Federal participants. One impressive IPT consisted of the DOE Project Director, the user/operator manager of the finished facility, and the Contractor Project Manager. These IPT members formed a tight well-focused team and were able to achieve real savings and a beautiful, successfully finished laboratory because of their efforts. The IPT on a more complex project was much larger but it was highly disciplined and unified. The Team members were clearly bound to common goals under a strong DOE Project Director and an experienced Project Manager.

According to the DOE 413.3 Manual, IPTs should be composed of the project's key organizational players. The intent of forming IPTs is to bring together cross-functional teams to jointly oversee complex projects. Teammates, not strangers, produce successful projects. The measure of how integrated the Federal staff is with the contractor implementers, the client user, specialist vendors, and with other players such as community constituents or other service providers is *the leading indicator* of subsequent project success.

Competence of Members

As observed at the DOE projects studied, competence is a critical success factor. DOE needs to be careful to distinguish between two levels of competence: 1) engineering or technical competence, where a considerable number of successes, but also one failure, were seen; and 2) project management competence. DOE Project Directors, Contractor Project Managers, contractor staff, and subcontractors all need to understand good project management practice and the 413.3 Order and Manual. During most of the interviews the project team displayed a substantial depth of knowledge about the Order and the Manual. But occasionally it was necessary during site visit interviews to explain the distinction between the two types of competence, since the people being interviewed did not always appreciate the difference.

One thing DOE has done is to require project directors to go through project management certification, and the IRT understands that DOE has both a mandatory certification program and a requirement for certification through four levels. This is good in the sense that: 1) it is an

"outward and visible sign" of DOE's commitment to project management competence, 2) it forces engineers to recognize that project management competence is different from construction management competence, and 3) it requires that key players do their homework and study formal project management practices and procedures. During the team's visit to the Savannah River Site it was noticed, that in this regard, many of the project managers had been certified by the Project Management Institute (PMI) and the site was providing a regular schedule for training, as well as time and encouragement for individuals to attend. Although the PMI program was mentioned at several sites, none of the sites mentioned the mandatory DOE program noted above.

Team Continuity and Turn Over

Several projects had to surmount substantial personnel turnover during the life of the project, thereby jeopardizing trust, momentum, and consensus. All of these are necessary to meet project goals in a timely and effective manner. An effort to ensure team continuity will pay substantial dividends to DOE.

Importance of Co-location

There is a strong argument for co-location of the project team, that is, having offices in the near vicinity of one another. Co-location encourages the development of partnership relationships and fosters attention to detail. It also contributes to timely decision-making and development of solutions. Smaller projects occasionally suffered the effects of the absence of co-location, because they lacked direct, on-site support of their work efforts. Projects where procurements were handled by offsite personnel who often did not understand timing opportunities, the proper type of contract vehicle or the specialized nature of the equipment generally had problems.

DOE Project Director and Contractor Project Manager

> *Effective people do not make great decisions. They try to make the few important decisions on the highest level of conceptual understanding. They try to find the constants in a situation. They are therefore, not overly impressed by speed in decision-making. They want impact rather than technique; they want to be sound rather than clever.* Peter Drucker, *The Effective Executive.*

DOE Project Director

The DOE Project Director is by definition the project leader. The key role of this position is to shape circumstances so that project goals are met. In the DOE this means shaping circumstances so that the Contractor Project Manager can employ the best commercial practices within the safety envelope to achieve the project goals, while deepening trust within the IPT. Trust is established when partners come to see each other as reliable performers and motivation is not questioned. The DOE Project Director must be an *agent of trust* in all aspects and with all parties, internal and external. The role of headquarters has a significant bearing on project success. This fact was readily apparent as projects were evaluated during this study. The DOE Project Director often finds himself needing to champion the project both at the site and at headquarters. This requires tight coordination with upper management and that channels of communication are always open.

Implied in Order 413.3 and the Manual is the expectation that the DOE Project Director will create the IPT and be responsible for cultivating and shaping it throughout the life of the project. The DOE Project Director must clearly convey the vision and the strategy for achieving the goals necessary for a successful project.

While DOE Project Directors do not choose the Contractor Project Manager, they are responsible for balancing their own strengths with his or hers. Capabilities and skills are variable, but project management training, clear guidance, and management maturity will level individual strengths and weaknesses.

Ultimate authority and *responsibility* for the project rest with the DOE Project Director, who must strive to develop synergies and trust among all participants, above and below. Thus effective project management depends on the leadership of the DOE Project Director. When DOE Project Directors understand that this *leadership* role is their principal responsibility and recognize that directing actual project execution is the responsibility of the Contractor Project Manager, the chances of project success are greatly improved. It was clear that on projects where the DOE Project Director and Contractor Project Manager worked seamlessly, important tasks were implemented most effectively. The opposite was also true. At one site, the DOE Project Director and Contractor Project Manager were so close that the project was clearly a joint undertaking that proceeded effortlessly. At another site, a strong and capable DOE Project Director had to prod technically capable contractor personnel to pay attention to the management of their projects. Even simple chores became onerous. It was not a good situation.

The majority of projects examined exhibited strong DOE Project Directors, who were well aware of their roles. Where these Directors had strong Contractor Project Managers, it was obvious that the projects were moving toward successful completion.

It appears from the interviews that there is insufficient effort being made to cultivate DOE Project Director positions as a career path within DOE or to train a sufficient number of DOE Project Directors to handle the continuing backlog of DOE projects. This should be a major concern to DOE and will lead to major problems as the existing pool of experienced Project Directors retires. The stability of the Area or Field Office and successful project execution depends on qualified DOE Project Directors.

Contractor Project Manager

Most of the Contractor Project Managers had received formal project management training through their companies. Such a level of qualification should be made a contract requirement, along with other incentives for meeting project milestones and achieving project success. In a few instances project goals were explicitly made part of the contractor's performance measurements. The majority of Contractor Project Managers have a good understanding of their responsibility to execute the project requirements.

In general it was found that the Contractor Project Managers were not users or operators of the facilities being built. However, they did exhibit either a thorough understanding of the operational requirements or had a user/operator as part of their team. One of the most successful

and well-managed projects evaluated had the user/operator as the Contractor Project Manager, although this project is an exception as it would be rare to find an individual who possessed both strong technical and project management skills.

Interrelationships

A successful project within DOE is highly dependent on the *leadership skills* of the DOE Project Director and the Contractor Project Manager. As with any organization, those skills are variable. In the case of the projects examined, excellent DOE Project Directors and Contractor Project Managers were encountered on small, medium, and large projects. However, there was room for improvement in a number of cases. Where there was mutual respect between the DOE Project Director and the Contractor Project Manager, the working relationship produced a synergy that manifested itself in project success. The communication generated by such relationships enabled the IPT to recognize and resolve problems in a timely manner.

Lessons Learned

- DOE and Contractor IPTs are effective and vital to project success.
- Close and regular communication among IPT members is important.
- Inclusion of a user/operations representative on the IPT improves the chances of project success.
- Inclusion of an assigned, dedicated procurement person benefits the IPT's performance.
- Efficiencies achieved through "thinking with one mind" are achieved when the IPT members are co-located.
- Continuity of IPT members retains corporate memory, promotes communications, develops cohesiveness, and contributes to a results-focused approach. Excessive changing of team membership adversely affects project performance. Co-location is a project enabler.
- A competent senior management team is essential to project success. Both the DOE Project Director and the Contractor Project Manager must have leadership and management experience appropriate to the level of project complexity and difficulty.
- Technical skills do not equate to leadership and management skills.
- Project management training and certification of skills by a third party is a positive contributor to project success.
- Lack of timely certification of federal project directors could lead to problems in the talent pool for future DOE projects.
- Success in planning and concept development does not ensure success in execution. The execution team should regularly revisit concepts and planning.
- Those areas requiring DOE Headquarters concurrence need to be worked carefully to ensure that they do not become deterring factors.

3b. Project Management

A project manager must efficiently and economically deliver a quality project within a fixed time frame. Managers of large complex projects must possess a wide range of skills. They must have a combination of rigorous *leadership* principles, inventive management techniques, and sheer determination if they are to be successful. While successful projects have been accomplished with limited procedures, most large organizations tend to inject some formality into their management processes in order to establish a productive work culture and maintain relative consistency. The subtopics that follow reflect some of the major observations gleaned from the site visits by the IRT teams. All of these subtopics are important to project success; however, a paramount factor in achieving project success continues to be the character and capability of the project manager/director, as discussed above.

Front-End Planning and Baselining

The majority of the projects visited and reviewed were started before the implementation of DOE O 413.3. Many of these projects were formulated with inadequate baseline estimates due to a lack of project scope definition. As a result, baseline estimates had to be increased and/or scopes redefined. Such project revisions can be avoided with *robust front-end planning*.

Not surprisingly, the projects that received the most robust front end planning seemed to have the fewest problems during project execution. It is intuitive, and the IRT reviews confirm, that investment in a modest increase in early planning yields a big reduction in problems and surprises later during the project development. Front end planning takes many forms including Project Execution Plans, acquisition planning, and risk management. DOE's current requirements to have preliminary design completed prior to setting the performance baseline appears to be paying off, particularly for the smaller projects (less than $50 million) that were evaluated.

There were some projects that preceded DOE O 413.3 where the IPT had employed the concepts of O 413.3 during early project stages even though they were not required. Those efforts produced successful projects.

Establishing reliable baseline estimates in the early stages of a project is acknowledged to be difficult, primarily because of the many project unknowns, and the fact that project scope has not been completely defined. A rigorous risk assessment of alternative solutions under various scenarios provides a means of raising the confidence level that can be placed in early estimates. The value of such exercises cannot be overemphasized. This is particularly applicable to first-of-a-kind projects.

Risk Management

Risk management encompasses risk identification, risk analyses and evaluations, risk avoidance, and risk response. It is a difficult aspect of project management. It is even more so with DOE projects, particularly those that deal with first-of-a-kind technologies of a highly complex nature or which involve unknown factors such as those encountered in environmental remediation. Historically, applications of risk management in DOE were found not to be as effective as they should have been (Ref. 2).

The study team paid particular attention to risk management in its review of the 16 projects and generally found substantial use of accepted risk management techniques. However, the team did encounter some projects with inadequate risk management procedures, and the lack of attention to possible risks caused those projects to suffer in their early stages. The scope of the risk management plans of these projects varied with those for the more complex projects covering a wider range of risks. At the same time, risk management plans for some of the smaller projects were more elaborate than expected reflecting the deeper experience of the DOE Project Director and the Contractor Project Manager. For instance, a risk identification exercise for one project surfaced an earlier unhappy experience with subcontractors. This led to the implementation of a policy for pre-qualifying subcontractors.

To be effective, risk management plans must be addressed in the earliest stages of project development, during front-end and acquisition planning, and plans must be reviewed frequently and adjusted as necessary. Perhaps the most important aspect is the development of potential contingency plans (scenarios) to mitigate or provide optimal paths to overcome identified risks. Risk assessment and mitigation must be an integral part of ongoing project management. The managers of the best projects formally reviewed their risk mitigation strategies monthly, while using them also to guide day-to-day decisions. At some projects that have had problems, the IPT was updating their plans quarterly or yearly and was clearly not using the plans as an active mechanism to manage the projects.

Although there are many tools available to assist in the execution of effective risk management, experienced judgment in their use is essential. While Monte Carlo simulation is an excellent tool, exclusive reliance on it over other factors could lead to false conclusions. The assignment of time and dollar contingencies should evolve from a risk analysis of individual work packages after approaches to eliminate risk have been fully worked.

One project IPT with an excellent risk management approach not only identified risk and possible consequences but also sought ways to eliminate project risk by:

- Using different contracting methods,
- Utilizing outside knowledge as to construction methods, and
- Studying the experiences of similar projects within DOE.

Earned Value Management Systems

In accordance with DOE O 413.3 guidance, the American National Standards Institute (ANSI) EIA-748 “Earned Value Management System,” (EVMS) must be used for all projects with a total project cost (TPC) exceeding $20M for control of project performance during the execution phase. The team found that EVMS, in some form, was being applied, even to projects costing less than $20M. The self-initiative to apply this methodology to smaller projects is commendable, as it provides an opportunity for gaining understanding and training on how to employ EVMS. Use of EVMS for tracking engineering and design progress was also noted and is to be commended.

The IRT notes the need for a better understanding of and better use of earned value-oriented accounting methods before the EVMS process becomes a truly versatile and valuable tool for project management purposes. Collection of actual cost data (ACWP) for each task in a timely manner surfaced as a problem on several projects. Having the EVMS system validated will contribute to obtaining a truer and more uniform picture of project status.

As it stands, the cumulative EVMS graphs often do not convey the true status of the project because periodic baseline changes that adjust the curve mask the variances. To provide a true picture of project status, the original baseline (BCWS) should be maintained. As a result of adjusting the baseline, the cost and schedule performance indices generally fall in a narrow range around 1.00, making it appear that the projects have not encountered problems.

There were mixed indications whether the encountered variances were being analyzed. While there were examples of good analysis, it is unclear whether all projects were receiving sufficient analyses to forestall or mitigate potential impacts. The NRC 2001 Assessment (Ref. 2) addresses this issue in more detail.

The IRT observed an excessive reliance on the use of EVMS alone to monitor projects and on certain projects to measure progress. The more successful IPTs used good schedule practices, risk management, change control, and other methods in addition to EVMS to manage their projects.

Schedule Practices

One of the best practices observed during the project visits was the use of integrated schedules, that is, schedules that accommodated permitting, engineering, design, procurement, construction, commissioning, and operations activities in one integrated schedule. This practice allows the project team members to look beyond their scope of responsibility and anticipate what the next group will need to do to keep the project on schedule.

The most pro-actively managed projects that the IRT evaluated looked at both critical path and near-critical path items frequently, so that corrective actions could be taken before items delayed the project schedules.

Change Control

Processes for baseline change control appeared to be in effect—albeit to different degrees of formality. It was evident that some rigor had been inculcated into the culture, stressing that changes must be controlled. This was evidenced by such actions as concentrating on project definition, freezing design, and making timely technical decisions. Many of the projects were trending potential changes as a way of bringing management attention to them and of allowing mitigation plans to be put in place to avoid them.

Reviews

Peer reviews of various types are an accepted part of doing business in the engineering/construction industry. This is also true in the government. DOE has instituted a vigorous program to review technical, schedule, and cost performance. The latter appears to be the area producing the most problems. Individuals with roles in project management by and large

find the reviews beneficial, especially at those locations where subject matter expertise was lacking on the project team. The strongest support for the reviews seemed to emanate from the stronger DOE Project Directors. In addition to the Headquarters scheduled reviews, there were instances of ad hoc reviews being performed to resolve particular issues.

Reviews are also a good risk management tool, and for more complex projects should be part of the risk management process. One area that should receive more attention across DOE is the greater use of peer reviews, using knowledgeable individuals from other DOE sites to review projects, as discussed further in Section 3.d.

Lessons Learned Programs

Developing a successful lessons-learned program has proven to be a challenge in both the public and the private sector. Evidence of attention to this matter was noted at Headquarters and field sites. Particularly good practices were noted where like facilities (tank cleanup) on a site were being handled in sequence using lessons learned on preceding units. As similar facilities exist at other sites, it should be assured that those lessons are being communicated across sites as well. Management at one examined project demonstrated a proactive stance by comparative application to similar facilities on site. On another project the contractor incorporated a foreign firm having experience in a unique facility. To aid in transferring lessons learned, one site has a project management group that holds ad hoc meetings, while at another site the Project Directors and Project Managers for all projects met monthly to share experiences.

DOE Headquarters has responsibility to assure that such lessons are being transferred across sites with similar facilities. Sharing lessons learned needs aggressive attention; without it valuable savings are lost and frustrations compounded. Lessons learned are useful for mitigating risk and providing training material for project directors/managers.

Contingency Analysis

According to the DOE definition, contingency is that portion of the project budget that is available to deal with uncertainty within the project scope. Determining the contingency and control of the contingency appears to have the appropriate attention of the managers running the projects that were examined. There was ample evidence that good practice methodologies were being employed and that contingency determination was largely probability-based rather than assumptive. Tracking of remaining contingency and analysis of trends were carried out on a number of projects. There was also evidence of restrictions on management reserve and more contingency control by DOE.

Lessons Learned

- Robust front-end planning with sufficient scope definition and design is necessary before reliable performance baselines can be established.
- Risk assessment and *management* must be actively pursued. Mitigation plans for identified risks are important as they allow the project to proceed, as risks become reality.
- Frequent meetings between the contractor and the DOE Project Director are effective for resolving problems and maintaining management discipline.

- An aggressive "lessons learned" program is useful to mitigate risk, save costs, and train project managers.
- An integrated critical path schedule that includes operations activities is required so that all project activities are coordinated.
- Both critical and near critical path activities should be continually monitored.
- Earned Value systems need to be used more effectively.
- External Independent Reviews have proved to be valuable and should be continued, and a peer review system is seen to be beneficial.
- Design tools, such as CADD, cost/schedule, and earned value systems need to be established early to ensure compatibility across the project.
- Frequent changes to the baseline can hide the true status of the project's Earned Value metrics

3c. Procurement

In the site visits, the IRT examined procurement procedures used by the various project offices to acquire goods and services. Contracting techniques and the types of contracts employed can have a significant effect on the ability of the DOE to acquire what is needed and on the schedule of when projects are operational. These techniques, however, constitute only one element in a broader acquisition process that extends from defining a mission need to closing down a completed project. From a project management standpoint, procurement staff working in partnership with other members of the project team assures that the right things are acquired and that the agency is getting real value for its money. When observers weigh project success, they frequently consider only whether the contract was well-designed and the contractor performed as desired. Many factors, however, contribute to these outcomes. These include:

- Was an effective acquisition strategy developed early on that addressed risks as well as alternative contracting approaches?
- Did the procurement staff work in partnership with program and technical staff as part of an Integrated Project Team?
- Was the level of risk specifically considered in establishing whether fixed price or cost reimbursement contracts would be used, or whether the management and operating contractor or another contractor would be best suited for performing the work?
- Were performance metrics and incentives used in seeking to align contractor and DOE expectations regarding desired business results?
- Was an effective contract management/contract administration approach employed to oversee contractor performance?

The following sections describe the IRT's findings with regard to each of the above areas:

Acquisition Strategy

DOE Order 413.3 stresses the importance of performing effective acquisition planning from the very beginning of a project. Although many of the 16 studied projects were begun well before the implementation of this order, the IRT found that a number of the IPTs had in fact followed this approach. The ones that proved most effective were those that treated acquisition plans as

living documents, updating and revising them (particularly their risk management elements) on a regular basis.

At one site these acquisition plans were the focus of monthly meetings with a specific set of actions identified to respond to anticipated problems. On another project, the acquisition strategy had been thoroughly vetted with DOE headquarters, resulting in strong support from the chain of command to ensure that the project received the resources and backing necessary to keep it on track.

A major element of one plan aimed at ensuring that subcontractors were well-qualified for performing the work by seeing that only pre-qualified firms could be selected. These firms were pre-qualified based on their track record for performing similar work. Often, past safety performance was an element of the pre-qualification review. Effective acquisition plans helped the project staff avoid problems that could have adversely affected project progress.

Other project teams, however, made little effort to analyze these types of issues in advance, or failed to continually update and use their plans as contract management tools. In the case of a project with subcontractor-caused problems, little effort had been made to pre-qualify subcontractors or evaluate that they could effectively self-perform the work. In another case the project team failed to anticipate in advance the type of oversight needed for the particular kind of service being acquired. In both of these instances, major delays in the schedule resulted from this lack of good advance planning.

Role of Procurement Staff

Including procurement staff as key players on the IPT and in the project management process helped a number of projects avoid significant pitfalls that could have resulted from a failure to anticipate contracting problems. This was particularly true in those cases where collaboration among laboratories was needed to accomplish the project, as with some of the large Science projects. Having procurement staff at the various laboratories assigned directly to the project helped ensure that services were provided properly and equipment scheduling priorities were met. Initially, project leadership failed to link these staff to the project and a number of difficulties were encountered in getting materials when they were needed.

Risk and the Contracting Approach

For many of the projects reviewed there was considerable uncertainty associated with how best to perform the work. For example, removing high-level waste from storage tanks at the Savannah River Site involved many unknowns, including in some cases even the internal configuration of the tanks. In one instance a component had been inserted into the tank to perform testing but its existence was not identified in the tank documentation.

Using subcontractors on a fixed price basis for performing this type of work creates two types of problems:

- Given the unknowns, it is impossible to identify in advance all of the costs needed to clean out the tanks. Fixed price contracts should be used only when the risks are known and manageable, and this would clearly not be the case here.

- Bringing in new subcontractors to perform this type of clean-up work in this particularly demanding environment requires a learning curve as the subcontractor gets up to speed on how best to conduct the work.

Other projects the IRT reviewed had major fluctuations in scope and/or major perturbations in funding that were impossible to anticipate fully in advance. Again, fixed price subcontracts proved to be inappropriate for these types of efforts.

While developing an effective risk mitigation plan up front would help somewhat to deal with these problems, the basic lesson here is that no "one size fits all" approach should be used. In some cases, taking advantage of the inherent flexibility afforded by a management and operating contract offers the best chance for success.

Performance Metrics and Incentives

Incentives were used for a number of contracts to align contractor performance with project mission goals. In some cases these were adopted, after the fact, once significant problems were encountered with earlier contracting efforts. In the case of one contract, for example, liquidated damage provisions were included to try to force the contractor to hold to the established schedule. That has proven to be an effective tool although the project office now believes that the liquidated damage provisions could have been more robust. Other contracts have used strong incentive provisions related to safety of operations to ensure that the contractor remains focused on this high priority DOE objective.

While a number of projects have used incentives to focus the contractor on meeting performance and/or safety goals, some have argued that a new approach, tying incentives to site-wide earned value management performance, fails to offer the same kind of targeted benefits as when these incentives were more directly linked to specific project performance. From a performance-based contracting standpoint, one would prefer that performance metrics be established at relatively high levels. However, the more they focus on the key elements of project success, the more the contractor can be held accountable for getting the job accomplished.

Contract Management/Contract Administration

A major concern, in all types of contracting actions, is the level of oversight afforded the contractor. Frequently, considerable effort is given to identifying the appropriate contracting vehicle and seeing that the procurement is conducted fairly and with competition. For the projects the IRT reviewed, competition was generally used to acquire contractor services, except in those cases where it made more sense for the management and operating contractor to self-perform the work. Even then, competition and fixed price subcontracts were frequently used to select those best able to perform the work, particularly where standard construction tasks were needed that did not involve significant learning curve issues.

However, one issue that the team identified is the need to have technically qualified staff overseeing contractor performance. Moreover, how best to perform this role should be considered early during the project development phase. In one instance, for example, there were serious deficiencies in the capacity of the IPT to perform this role. The problem in this case was that while those overseeing the particular type of construction work had both contract

management and project oversight expertise, they had no real technical experience with the type of work. As a result, major problems were encountered that might have been avoided if the right team with the right skill sets had been in place.

Lessons Learned

- An acquisition strategy should be developed during the conceptual design phase of the project and integrated with the risk management program. The risk management program should include a full review of potential risks as well as plans for mitigating them. The acquisition strategy should be a living document and continually referred to, updated and acted upon.
- Procurement staff should play an integral role in the development of the acquisition strategy and be key members of the Integrated Project Team.
- Risk and uncertainty should be explicitly addressed as part of the acquisition strategy and contract vehicles and approaches should be determined in light of this level of risk.
- Procurement approaches should be tailored to project needs and conditions and not based on a "one size fits all" strategy.
- Performance metrics and incentives should be used to tie contractor performance to desired business results.
- Contract management/contract administration strategies should be developed in advance to ensure effective oversight of contractor performance.
- Cost reimbursement contracts are usually the correct vehicle to use for high risk, complex, uncertain scope projects.

3d. Project-Specific Factors

This section deals with some factors that were unique to certain types of projects or factors that had an overall influence on projects. The ones that were seen as most significant were peer reviews, funding, and multi-laboratory partnerships.

Peer Reviews

Peer reviews were effectively utilized on several Science and NNSA projects. IPTs that used them felt they added real value, and provided project-to-project and site-to-site sharing of lessons learned. Peer reviews should be more widely encouraged and used on most Science, Environmental Management, and NNSA projects, particularly those that are first-of-a-kind or which involve technical complexity or unknowns.

Funding

Unpredictable funding and unexpected changes in project funding profiles have a large negative impact on every project that experiences them. The corollary is that those projects fortunate enough to that have full funding are almost always more efficiently executed, and have a much greater likelihood of being completed on time and within budget. The IRT found many cases where funding changes had seriously disrupted projects, both delaying schedules and increasing costs. In fact, funding changes impacted more than one-quarter of the 16 projects evaluated.
Project rescissions, however small, are at a minimum disruptive and time consuming. Predictability of funding over the life of a project facilitates on time and within budget project

completions. Most government projects are cost driven, i.e., they have an annual funding allowance. In the private sector, most projects are schedule driven, i.e., within reason the least cost is usually achieved by completing the project as fast as possible. The Office of Environmental Management has taken a major step towards funding projects this way through its accelerated cleanup programs. Science and NNSA may be able to cut their project costs by taking a similar approach.

Multi-lab Partnerships

Multi-lab project partnerships were part of several projects studied. These partnerships had issues with the flow of funding, responsibility, and accountability. The more successful projects had common characteristics:

- The Project Director was a strong integrator with both technical expertise and leadership skills;
- Memorandums of Understanding were signed between the participants, clearly outlining commitments and responsibilities in detail;
- The commitments were formalized in the various laboratory contracts; and
- Frequent communications and coordination were employed.

Lessons Learned

- Peer reviews are a valuable addition to first-of-a-kind and technically complex projects.
- Projects that experience unpredictable funding and unexpected changes in funding experience a large negative impact.
- When a project involves multiple partners, a clear definition of roles and responsibilities is essential. This definition should be codified through Memorandums of Agreement and spelled in the Project Execution Plan providing scope, schedule, budget and quality requirements. Integrated schedules and regular communications are also important.

4. RECOMMENDATIONS

By reviewing the underlying reasons behind project success and the sources of project difficulties, the IRT believes the recommendations provided below will improve the performance of DOE's project teams in delivering quality projects on time and on budget. Most of these items are covered in the DOE 413.3 Order or Manual, but need more emphasis on projects. Where those documents don't cover an item, that fact is noted.

Organization and Personnel

- DOE should provide focused training for its Project Directors, and those who aspire to be Project Directors. Specific training funds should be set aside for this purpose. A core group of highly qualified project directors should be developed along with a defined career path to retain these individuals.
- DOE should ensure that those selected to be Project Directors and Contractor Project Managers have the management, leadership and technical skills to enable them to perform on the project.
- DOE should create opportunities for interactions and the sharing of lessons learned among Project Directors.
- DOE should provide guidance on the required membership on an IPT and should ensure that an IPT is appropriately identified early in the project.

Project Management Procedures

- DOE should take steps to strengthen risk assessment and management practices, making discussion of risk assessment and mitigation plans a central part of all project reviews. Risk management should be addressed in the earliest stage of every project and should be actively reviewed and modified frequently.
- DOE should maximize the use of lessons learned across the complex by proactively encouraging the sharing of such information.
- DOE should work to make Earned Value Management Systems a meaningful management tool and improve IPT understanding that it can and should be more than a reporting mechanism. It must be recognized that the real value of EVMS lies in analyzing variances to foresee trends and take appropriate action. To accomplish this end, more in-depth training is necessary.
- DOE should continue its program to ensure that all Earned Value Management Systems currently being used are validated.
- DOE should develop guidelines that appropriately control the rebaselining of projects.
- An integrated project schedule which includes all participants' work efforts should be developed for projects.
- Robust front-end planning must be encouraged and minimum guidelines should be established that foster adequate front-end planning.

Procurement

- DOE should ensure that an acquisition strategy is developed during the conceptual design phase of the project and integrated with the risk management program. The risk management program should include a full review of potential risks as well as plans for mitigating them. The acquisition strategy should be a living document and continually referred to, updated and acted upon.
- Procurement staff should play an integral role in the development of the acquisition strategy and be key members of the Integrated Project Team.
- Risk and uncertainty should be explicitly addressed as part of the acquisition strategy and contract vehicles and approaches should be determined in light of this level of risk. Approaches should be tailored to project needs and conditions and not based on a "one size fits all" strategy.
- Performance metrics and incentives should be used to tie contractor performance to desired business results.
- Contract management/contract administration strategies should be developed in advance to ensure effective oversight of contractor performance.

Project-Specific Factors

- DOE should require peer reviews for first-of-a-kind and technically complex projects at Critical Decision-1. These reviews are now optional.
- DOE should fully fund the smaller line-item projects and provide phased funding to the larger ones. The phased funding should be linked to the Critical Decision points.
- Multipartner teams should develop Memorandums of Agreement early in the project and incorporate them in the relevant contracts.
- DOE should provide the control of the funding allocations to the responsible Federal Project Director for all participants of multi-partner teams.

In addition to the categories covered above, the IRT also reviewed the knowledge and use of the DOE 413 Policy, Order and Manual and evaluated the usage and usefulness of the Program Assessment and Reporting System (PARS). The discussion on these items is contained in Appendices E and F, respectively. The recommendations that were derived from these evaluations are:

- DOE should develop guidelines for tailoring the requirements of the 413.3 Order and Manual to address the special conditions facing smaller and other unique programs.
- DOE should provide training at DOE sites on the 413.3 Order and Manual to all participants, including government and contractor personnel, who have decision making responsibilities on DOE programs.
- DOE should examine the value of the PARS program reporting system to senior managers responsible for monitoring program efforts.
- DOE should ensure that all projects larger than $5M are detailed in PARS from Critical Decision-1 on. Cost information should be included for those projects between $5M and $20M, as that information is currently not required.
- DOE should enhance PARS by requiring schedule analysis and the analysis of issues as well as make the data timelier.

- DOE should see that the original baseline (BCWS) is maintained in PARS.

An additional recommendation derived from the evaluation of the MOX FFF project is:

- Large projects (over $50M) that have reached Critical Decision-1 should have a baseline established at the 30-40% design point. If they are not ready to satisfy all of the requirements of Critical Decision-2 at that point then a shortened list of requirements should be developed so that they can have a formal baseline for some portion of the work approved.

REFERENCES

Ref. 1 National Research Council, *Improving Project Management in the Department of Energy*, Washington, DC: National Academy Press, 1999.
Ref. 2 National Research Council, *Progress in Improving Project Management at the Department of Energy, 2001 Assessment*, Washington, DC: National Academy Press, 2001.

APPENDICES

Appendix-A: Independent Review Team Bios
Appendix-B: Bibliography
Appendix-C: Project Visit Schedule and Contacts
Appendix-D: Questionnaire for Use by IRT on DOE Site Visits
Appendix-E: DOE Policy 413.3, DOE Order 413.3, and DOE Manual 413.3
Appendix-F: Program Assessment and Reporting Systems (PARS)

APPENDIX A: INDEPENDENT RESEARCH TEAM BIOGRAPHIES

Dr. Allan V. Burman is President of Jefferson Solutions (Solutions), a division of the Jefferson Consulting Group, LLC. Under his leadership, Solutions has provided change management services and/or acquisition reform training to many Federal departments and agencies. Since 1994, Dr. Burman has provided strategic consulting services to private sector firms doing business with the Federal government as well as to Federal agencies and other government entities. He also has advised firms, Congressional committees, and Federal and state agencies on a variety of management and acquisition reform matters. He has served under Presidents Reagan, Bush and Clinton as Administrator for Federal Procurement Policy in the Executive Office of the President. He regularly speaks to groups on acquisition reform and change management topics. Dr. Burman graduated Summa Cum Laude, Phi Beta Kappa from Wesleyan University in Middletown, Connecticut, was a Fulbright Scholar at the Institute of Political Studies, University of Bordeaux, Bordeaux, France, has a Master's Degree from Harvard University and a Ph.D. from The George Washington University.

Gary D. Coxon, P.E., is a seasoned, senior executive with a solid track record of achievement in developing substantial new business opportunities, in managing worldwide, multibillion projects and in executing highly successful initiatives with measurable, bottom line impact. He has broad, substantive leadership experience in the services industry in highly critical roles and with significant spans of control, and a notable reputation for starting new business operations and for meeting strategic business targets. Currently, Mr. Coxon is serving as an executive consultant where he assists small businesses with government contracting, business development and corporate strategy, and serves as the leader for teams of companies pursuing large government contracts. Prior to working as a private consultant, Mr. Coxon served as a Senior Executive and Program Manager with Lockheed Martin and Bechtel. Mr. Coxon has a B.S. in Civil Engineering from the University of Arizona. He also attended the Senior Leadership Institute for Lockheed Martin Corporation, and the Tuck Executive Program at Dartmouth College.

Lloyd A. Duscha, P.E., has over 40 years experience, 25 years in executive management positions, with the U.S. Army Corps of Engineers culminating as the ranking civilian. He has been involved in all phases – from planning to operations – of water resource projects, military construction projects, and work for other agencies. His experience includes policy development, organizational management, programming, planning, design and construction, project management, environmental restoration, cost estimating, and contract administration. As an independent consulting engineer since 1990, Mr. Duscha has been involved in varied assignments for public and private sector clients. Activities spanned the business, managerial, governmental and technical aspects involved in the engineering-construction industry on the domestic and international scene. He also served on teams addressing engineering and construction issues for the National Research Council, National Institute of Standards and Technology, United Nations and World Bank. Mr. Duscha is a member of the National Academy of Engineering and received the University of Minnesota Board of Regents Outstanding Achievement Award.

Dr. J. Davidson Frame, PMP, is currently the Academic Dean to the University of Management and Technology in Arlington, Virginia. Prior to this he served a number of positions at the George Washington University in Washington D.C., including Chairman of the Department of Management Science, Director of the Program on Science, Technology, and Innovation, and Director of the Project Management Program. He also spent six years as Vice President and Director of Computer Horizons, Inc.'s Washington Office. Additionally, Dr. Frame has published ten books on Project Management, eight chapters to other books, and more than 30 scholarly articles in various academic journals. He earned his B.A. from the College of Wooster in Ohio and his M.A. and Ph.D. from American University.

Mary Ann Novak has been involved in Department of Energy/National Nuclear Security Administration activities for over 20 years. She worked at the DOE for 10 of those years, serving as Counselor to the Deputy Secretary of Energy, as well as Acting Assistant Secretary, Office of Nuclear Energy, and Principal Deputy Assistant Secretary for Nuclear Energy, and as Special Assistant to several Assistant Secretaries. Subsequently, Ms. Novak became a vice president at the consulting engineering firm of Parsons Brinckerhoff, responsible for overseeing their work with DOE/NNSA. Since 1997, Ms. Novak has been consulting with diverse corporations and contractors doing business with the DOE, FEMA, Homeland Security and the Department of Defense. Ms. Novak has extensive contacts within the Executive Branch and Congress, and provides expertise on policies, programs, procurements, technologies and approaches to doing business with the Federal Government. Ms. Novak received a B.A. from Mundelein College of Loyola University in 1970 and a Masters Degree from Georgetown University.

Dr. Clifford J. Schexnayder, P.E., is Emeritus Eminent Scholar at Del E. Webb School of Construction at Arizona State University. He has also held a number of positions at other prominent Universities, including Universidad de Piura in Peru, the U.S. Air Force Academy in Colorado, the Virginia Polytechnic Institute and State University, Louisiana Tech University, and Purdue University in Indiana. Dr. Schexnayder's expertise in teaching and research include Construction Engineering, Construction Equipment and Techniques, Heavy Construction Estimating, Construction Estimating, and Geotechnical Engineering. Prior to entering the academic sector, he was the Chief Engineer, for the Nello L. Teer Company, Durham, North Carolina where he had direct line responsibility for the coordination and supervision of both the estimating and construction of major Heavy/Highway and Environmental projects. Dr. Schexnayder is also a retired Colonel of the U.S. Army Corps of Engineers and has more than 30 years of military experience. He is a registered professional engineer in Arizona, Georgia, Louisiana, North Carolina, South Carolina, and Texas, and he has published and reviewed numerous industry-related papers, editorials, and conference proceedings. He earned his Ph.D. in Construction Engineering and Management from Purdue University in 1980, his M.S. in Civil Engineering in Construction from the Georgia Institute of Technology in 1972, and his B.S. Civil Engineering, from the Georgia Institute of Technology in 1967.

Dr. Henry G. Schwartz, Jr., P.E., is an internationally recognized leader in the civil engineering field, specializing in major infrastructure programs. After receiving his B.S. and M.S. in Civil Engineering at Washington University in St. Louis and his Ph.D. at the California Institute of Technology, Dr. Schwartz joined Sverdrup Corporation. At Sverdrup he served as project manager and project executive for a wide variety of major water, wastewater, and transportation programs. In 1993, he became President and later Chairman of Sverdrup/Jacobs Civil, Inc., one of the nation's largest, most respected civil engineering firms. Dr. Schwartz served as President of the Water Environment Federation and was the founding Chairman of the Water Environment Research Foundation. He is the immediate Past President of the American Society of Civil Engineers and created ASCE's Critical Infrastructure Response Initiative to address the nation's infrastructure security needs following the events of September 11, 2003. Recipient of many awards, Dr. Schwartz was inducted into the National Academy of Engineering in 1997. Today, he is a Senior Professor in civil and environmental engineering at Washington University.

Dr. Harry Stefanou is a research manager at the Project Management institute where he leads the technical research program and the Market Research and Environmental Scan functions. Dr. Stefanou has extensive experience in the management of research and development, commercial development, and total quality management. He also has considerable experience with customer relationship management, sales and marketing, strategic planning, environmental, health and safety direction and control, program and project management, and employee development. He has proven expertise in budgeting, financial reporting, performance evaluations, and research analysis. During his career, Dr. Stefanou has been instrumental in making significant contributions that have facilitated multi-million dollar cost savings, while building sales and revenue. He promotes team-oriented practices and multi-functional teams to foster diversity and reduce cycle times to implementation. He earned a B.S. in Chemistry from City College of New York in 1969, and a Ph.D. in Physical Chemistry/Polymer Physics from City University of New York in 1973.

Dr. Michael K. Yates, P.E., has over 30 years of diverse engineering, construction, operations and project management experience. This includes more than 20 years of involvement as a Project Manager or at the Corporate Executive level in the planning, negotiation, management, and execution of large, complex, environmental, nuclear, and power projects. Dr. Yates' power experience includes managing the Louisiana Power and Light $2.8 billion Waterford 3 Nuclear Plant Project and serving as Manager of Projects for several thousand megawatts of gas fired combined cycle and cogeneration plants. His environmental experience includes serving as Executive Vice President for both DOE's Fernald and Hanford projects and as Program Manager for EPA's REM III Program. Dr. Yates earned his B.S. in Engineering Physics from the University of Illinois, Urbana, and his Ph.D. in Nuclear Engineering from the University of California, Berkeley. Additionally, he attended the Advanced Executive Management Program at the University of Pennsylvania, Wharton School.

APPENDIX B: BIBLIOGRAPHY

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APPENDIX C: PROJECT CONTACTS & VISITS

SCHEDULE OF SITE VISITS

Project Name	Site	Office	Dates of Site Visit	IRT Members	CERF Staff
Compact Muon Solenoid	Fermi	SC	Feb 25	Duscha, Frame	Muhammad Amer
ETTP 3 Bldg D&D	Oak Ridge	EM	Mar 31	Coxon, Schexsnayder	Susanna Sprinkel
Ext. Comm. Infrastructure Mod. (ECIM)	Sandia	NNSA	Feb 11-12	Coxon, Duscha, Frame	Susanna Sprinkel
Fire Safety Improvements	Argonne	SC	Feb 24	Duscha, Frame	Muhammad Amer
High Level Waste Removal	Savannah River	EM	Mar 10-11	Burman, Yates	David Reynaud
Joint Comput. Engineering Laboratory (JCEL)	Sandia	NNSA	Feb 4-5	Novak, Schwartz	Susanna Sprinkel
Mechanical Systems Upgrade	Argonne	SC	Feb 24	Duscha, Frame	Muhammad Amer
Microsystems and Eng. Sciences Applications	Sandia	NNSA	Feb 4-5	Novak, Schwartz	Susanna Sprinkel
MOX Fuel Fabrication Facility*	Savannah River	NNSA	Dec 17	Yates, Novak	Amar Chaker
Neutrinos at the Main Injector	Fermi	SC	Feb 23-24	Burman, Yates	Amar Chaker
Nuclear Materials Storage	Savannah River	EM	Mar 10-11	Burman, Yates	David Reynaud
ORNL Burial Grounds	Oak Ridge	EM	Feb 12-13	Burman, Yates	Amar Chaker
Research Support Center	Oak Ridge	SC	Mar 30	Frame, Coxon	Susanna Sprinkel
Spallation Neutron Source	Oak Ridge	SC	Feb 11-12	Burman, Yates	Amar Chaker
Storm Drain, Sanitary Sewer	Sandia	NNSA	Feb 11-12	Coxon, Duscha, Frame	Susanna Sprinkel
Tritium Extraction Facility	Savannah River	NNSA	Feb 18-19	Novak, Coxon, Schexsnayder	Susanna Sprinkel

[*] *A presentation was made in Washington, DC, but there was no visit to the Savannah River site, as the project is still at the design stage.*

SCHEDULE OF MEETINGS W/ DOE PROJECT SUPPORT OFFICES (GERMANTOWN, MD)

Office	Date	DOE Staff	IRT Members	CERF Staff
EM	Dec. 10	Stephanie Short, Judson Lilly	Mary Ann Novak	Amanda Goebel, Larry Jiang, Amar Chaker
SC	Dec. 18	Kin Chao, Caryle B. Miller, Steve Meador, Steve Tkaczyk, Barry Sullivan	Mike Yates, Mary Ann Novak, Harry Stefanou, Lloyd Duscha, David Frame	Amanda Goebel, Larry Jiang, Amar Chaker
NNSA	Jan. 8	Roland Frenck, Arnold Epstein	Lloyd Duscha, David Frame, Mike Yates	Amanda Goebel

COMPACT MUON SOLENOID

Name	Position	Telephone	E-mail
Jim Hanlow	Project Manager		
Pepin Carolan	DOE Project Director	630.840.2530	pepin.carolan@ch.doe.gov

ETTP THREE-BUILDING DECONTAMINATION AND DECOMMISSIONING

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Karen Deacon	Alt. Cor/DOE-AU	865.576.4878	deaconke@oro.doe.gov
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EXTERIOR COMMUNICATIONS INFRASTRUCTURE MODERNIZATION

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Ivan Rose	Federal Project Director, NNSA/SSO	505.845.4195	crose@doeal.gov
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William Tierney	SNL/10824	505.845.0633	wjtiern@sandia.gov

FIRE SAFETY IMPROVEMENTS-PH IV

Name	Position	Telephone	E-mail
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Jug Uppal	Program Manager	630.252.7757	juppal@anl.gov

HIGH-LEVEL WASTE REMOVAL FROM FILLED WASTE TANKS

Name	Position	Phone	E-mail
Ricky Doniphan	Project Owner TCP/PO	803.208.3568	rdoniphan@srs.gov
George Vozniak	Project Engineer/Design Sources	803.208.3520	
Randall Fortt	Lead Eng/Design Sources	803.208.2294	rfortt@srs.gov
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APPENDIX D: QUESTIONNAIRE FOR USE BY IRT ON DOE SITE VISITS

Each site visit team used the attached questionnaire as a framework to enable them to conduct their interviews consistently. The questionnaire was divided into five sections. Each section examines a specific aspect of DOE field operations in respect to DOE 413 procedures. The sections are:

Section A. The Project and Program Management Process
This section contains a series of questions that have respondents identify the extent to which they follow 413.3 procedures in respect to critical decision reviews. The questionnaire items contained in this section reflect project management requirements explicitly listed in DOE O 413.3.

Section B. PARS Database System
In any enterprise, management decisions are based on information. The better the information, the more likely good decisions can be made. Section C attempts to determine the value DOE managers place on PARS data.

Section C. The Contractor
According to DOE O 413.3, contractors have specific requirements they must fulfill when implementing capital asset projects. The questions contained in this section of the questionnaire cover *all* contractor requirements specified in DOE O 413.3. Responses to this set of questions by DOE personnel will provide insights into whether contractors are compliant with the Order.

Section D. The 413.3 Manual
DOE M 413.3-1 (the manual) provides more detailed guidance on implementing project management practice at DOE than DOE O 413.3 (the order). The importance of this Manual is captured in a statement in the Manual's transmission memo, indicating that future editions of the 413 Order will attempt to capture some of the Manual's content. The cover memo also states that if there is any conflict between the content of the Order and Manual, the Manual's perspective should prevail!

Preliminary interviews with DOE personnel suggest that while they see value in the Order, they are not happy with the Manual, which, in their view, is too detailed. The questions in Section D of the questionnaire attempt to identify the degree to which DOE personnel in the field: 1) find the Manual to be helpful; 2) implement the guidance contained in it; and 3) have taken steps to make sure people in the field are familiar with its content.

Section E. The Players
DOE O 413.3 identifies specific players who have a role to play on capital asset projects at DOE. The roles of each of these players are defined in the document. This section of the questionnaire attempts to identify the extent to which these players help DOE projects to move forward successfully. NOTE: This portion of the questionnaire should be filled out after the interview has been completed, so as not to put interview subjects in a tough spot.

SITE VISIT QUESTIONNAIRE

A. The Project and Program Management Process

1. Following are the critical decision "prerequisites" associated with CD-0 (Approve Mission Need). Using a check mark, indicate the adequacy of each of the prerequisite items that are listed below as they relate to the project.

Justification of Mission Need document
Acquisition strategy
Pre-conceptual planning
Mission Need Independent Project Review

2. Following are the critical decision prerequisites associated with CD-1 (Approve Preliminary Baseline Range). Using a check mark, indicate the adequacy of each of the prerequisite items that are listed below as they relate to the project.

Acquisition plan
Conceptual Design Report
Preliminary Project Execution Plan and baseline range
Project Data Sheet for design
Verification of mission need
Preliminary Hazard Analysis Report

3. Following are the critical decision prerequisites associated with CD-2 (Approve Performance Baseline). How were these items handled on the project?

Preliminary Design
Review of contractor project management system
Final Project Execution Plan and performance baseline
Independent cost estimate
NEPA documentation
Project Data Sheet for construction
Draft Preliminary Analysis Safety Report
Performance Baseline External Independent Review

4. Following are the critical decision prerequisites associated with CD-3 (Approve Start of Construction). How were these items handled on the project?

Update PEP and performance baseline
Final design and procurement packages

Verification of mission need
Budget and congressional authorization and appropriation enacted
Approval of safety documentation
Execution Readiness Independent Review

5. Following are the critical decision prerequisites associated with CD-4 (Approve Start of Operations or Project Closeout). How were these items handled on the project?

Operations Acceptance Review and Readiness Report
Project transition to operations report
Final safety analysis report
Post CD-4: Project closeout report

B. PARS Database System

1. How heavily do you review data supplied in PARS to monitor your project's progress?

2. On your project, how accurate is the data supplied in PARS?

3. On your project, how timely is the data supplied in PARS?

4. On your project, how useful is the data in PARS in helping you manage your project efforts?

C. The Contractor

1. Does the contractor implement a validated earned value management (EVM) process during the project execution phase (applicable to projects with a total project cost of $20 million or greater)?

2. In implementing its EVM, does the contractor provide accurate and timely data?

3. During the execution phase of the project, does the contractor supply monthly cost, schedule and performance reports that identify variances, predict trends, and suggest corrective action for potential problems?

4. Has the contractor developed and provided DOE with an Acquisition Plan that complies with FAR requirements (applicable on M&O/M&I contracts)?

5. Does the contractor provide technical performance analyses for variances to the project baseline objectives resulting from design reviews, component and systems tests, and simulations?

6. Does the contractor maintain a critical path schedule and project master schedule?

7. Does the contractor employ formal cost estimating procedures in the development of cost baselines, budget requests, and estimates of project costs at project completion?

8. Does the contractor implement a formal risk management process that identifies potential risk events and suggests mitigation strategies to deal with them?

9. Does the contractor employ a validated configuration management process to manage changes on the project?

10. Does the contractor employ a formal value engineering process to identify areas where project costs can be reduced?

11. Has the contractor established a quality assurance program that is followed throughout the life of the project?

12. Has the contractor developed and implemented an Integrated Safety Management plan?

Section D. The 413 Manual

1. How thoroughly have you studied DOE M 413.3-1?

2. How useful is the guidance provided in DOE M 413.3-1(the manual) in offering insights in how to achieve the project management goals and practices set out in DOE O 413.3 (the order)?

3. To what extent do you try to employ the guidance contained in DOE M 413.3-1 when working on your project?

4. At your site, how much effort has been made to familiarize personnel with the contents of DOE M 413.3-1 (example, through training)?

5. To your knowledge, is your contractor familiar with the contents of DOE M 413.3-1?

6. To your knowledge, is your contract employing the guidance contained in DOE M 413.3-1 in managing your project?

E. The Players (Note: IRT interviewers should exercise judgment on whether they want to raise these questions directly with interview subjects, or indirectly. In the latter case, they should fill out the questionnaire after the interview is completed.)

1. To what extent have the players listed below provided your project with important support that directly contributes to the achievement of your project's objectives?

Acquisition Executive
PSO
Project Management Support Office
Program Manager
Operations/Field Office Manager
Federal Project Director
OECM
Contractor project manager

2. To what extent have the players listed below served as bottlenecks that have affected the achievement of your project's objectives?

Acquisition Executive
PSO
Project Management Support Office
Program Manager
Operations/Field Office Manager
Federal Project Director
OECM
Contractor project manager

APPENDIX E: DOE P 413.3, DOE O 413.3, DOE M 413.3

In its review of project management practices at the Department of Energy, the IRT restricted its examination to practices that have been developed specifically for the Department. These practices are described in the following documents:

DOE P 413.1 (Approved 10 June 00)
Title: *Program and Project Management Policy for the Planning, Programming, Budgeting and Acquisition of Capital Assets*
Function: To provide a simple statement indicating that Federal Managers at DOE will consciously apply project management perspectives and tools in acquiring capital assets. The document is only two pages long.

DOE O 413.3 (Dated 13 October 00)
Title: *Program and Project Management for the Acquisition of Capital Assets*
Function: To provide high level DOE direction for the acquisition of capital assets on time, within budget, and in accordance with mission need requirements.

DOE M 413.3-1 (Approved 28 March 03)
Title: *Project Management for the Acquisition of Capital Assets*
Function: To provide guidance on implementing project management procedures at DOE at a finer level of detail than offered by DOE O 413.3. The cover memo, issued by Kyle E. McSlarrow, indicates that there is nothing in the Manual that establishes new requirements above and beyond what is indicated in DOE O 413.3. The cover memo also indicates that the upcoming revision of DOE 413.3 will incorporate some of the principles incorporated in DOE M 413.3-1.

The Policy, Order, and Manual were developed as a direct outcome of criticisms raised in the 1990s of the Department's lack of effective project management processes. (See, for example, NRC, 1999.) Poor project management was cited as a major contributor to the dramatic failures of a large number of Department projects. For the Department to carry out its large, difficult projects successfully, it would need to strengthen its project management discipline.

In this Appendix, the IRT reports its findings about views on the 413 series of documents held by Federal Project Directors and contractor project managers working on sixteen DOE projects. During site visits to these projects, IRT members raised a number of questions that directly pertained to compliance with 413 requirements, knowledge of these requirements, and their perceived value. Responses to key questions are covered here:

- *What value do you find in the 413 series of documents?*
  The expressed views of Federal Project Directors and contractor project managers were generally positive. Most stated that the 413 series simply codified processes that they had been carrying out for years. For example, they had been working with critical decision points and their prerequisites prior to the introduction of DOE O

413.3 in 2000. Consequently, they were comfortable with the Order's focus on having projects go through critical decision reviews.
Most agreed that the discipline inherent in the 413 documents is necessary if the Department hopes to manage complex projects effectively. One individual was quite hostile to the 413 series, suggesting that they bureaucratized the project management process excessively, but he was an exception.

In some cases, Federal Project Directors suggested that the Order, coupled with clear signals from the Department's top management that effective project management is a high priority item (e.g., as evidenced in the creation of the Office of Construction and Engineering Management), has given them more authority in their dealings with contractors. For example, one Federal Project Director related how prior to the Order, he found his contractor to be unresponsive to basic requests he made for project updates. However, when it became clear that the Department would not tolerate business-as-usual at the Laboratories after the release of the new Order, the contractor quickly became cooperative.

- *How familiar are you and your project staff with the 413 series of documents?*
  Virtually all Federal Project Directors and contractor project managers were quite familiar with the Order. Some indicated that they required the next level of managers below them to study it as well, while others believed that there was no need for lower level managers to master this material.

  Familiarity with the contents of the Manual was spotty. When first asked about it, most Federal Project Directors and contractor project managers said they were familiar with it. However, after further discussion, it became clear that many had only the vaguest sense of its content. To a certain extent, knowledge of the 413 series of documents was tied to the communication efforts at different sites. At some sites, hundreds of people were given training on the Order and Manual. At other sites, little or no training was provided. This is worrisome, because the future revision to the Order will incorporate much of the project management guidance contained in the current Manual, yet knowledge of the Manual appears to be weak.

  One contractor took a creative step to conveying the Manual's content to its employees without burdening them with having to study the official government directive. It developed a set of project management processes that incorporated the key points of the Manual, included them in its corporate project management process handbook, and then trained its project staff on the processes they must follow. Although these project staff never took a course on the 413 series of documents, they still applied the principles of 413 by following their organization's project management processes.

- *To what extent do you follow the requirements contained in the 413 Order?*
  Federal Project Directors and contractor project managers reported universal adherence to the Order. (We were unable to validate these assertions independently

but have no reason to feel they were false.) For example, they all reported adhering to the following requirements contained in the Order:

- They developed an Acquisition Plan
- They had established baseline change control processes
- They had experienced External Independent Reviews (EIR)
- They had experienced Independent Project Reviews (IPR)
- They employed independent cost estimates
- They engaged in formal risk identification and analysis exercises
- They established detailed Project Execution Plans (PEP)
- They conducted value engineering exercises

An interesting finding is that several Federal Project Directors indicated that the level of thoroughness of adhering to project management paperwork requirements grew dramatically after the Order was issued in 2000. This fact was illustrated dramatically at one site where two similar construction projects were carried out at different times: one before the Order was issued, and the other after. While both projects entailed the same general level of effort, the PEP for the second project was far more detailed than that for the first. When asked whether they believed that the additional work in producing the post-Order PEP was worthwhile, both the Federal Project Director and the contractor project manager answered "yes." They even provided specific examples of how the careful planning effort carried out on the second project enabled them to identify and handle risks that they would have missed otherwise.

- *To what extent do you follow the guidance contained in the 413 Manual?*
  As mentioned above, the IRT found that knowledge of the Manual was spotty for both Federal Project Directors and contractor project managers. Some managers indicated that while they had not studied it systematically, they used it as a reference document to make sure they were not violating Department project management policy. Thus if they had questions about a particular procedure, they would see how the Manual said it should be dealt with.

  The IRT found that even when recommended guidance was followed by all the projects, it was pursued in inconsistent ways. For example, the Manual emphasizes the central importance of Integrated Project Teams (IPTs) in providing access to experts and in serving a steering committee function on Department projects. Managers for all projects reviewed indicated that they employed IPTs. But in two projects, the IPTs contained only federal employees, with no representatives from the contractor organization. On another project, the Federal Project Director indicated "I am the IPT's sole member." On still other projects, IPTs were organized as intended in the Manual, and were comprised of members from both the Federal and contractor sides.

  Is the inconsistent application of the Manual's guidance bad? Not necessarily. It may simply reflect the "tailoring" of the project structure to meet a project's unique needs. (Note that the Order recognizes that tailoring may need to occur on projects.) However, in the case just mentioned, discussions with the Federal Project Directors

and contractor project managers made it clear that these people did not understand the role of IPTs as they have been implemented across many organizations (including the Defense Department) over the past decade. When they established IPTs, they were simply making up their own rules on how it should function.

- *To what degree has tailoring been used to adapt the requirements of 413 to your project?*
  The IRT found that everyone who was interviewed was aware that the Order allows for tailoring of the approaches that projects can take to implementing the 413 series of documents. Yet it appears that no one is really sure what tailoring entails. On the one hand, it makes sense to reduce paperwork requirements for smaller projects. On the other hand, excessive tailoring can lead to sloppy management and inconsistency.

  At present, it appears that little tailoring is actually occurring. In fact, the IRT found instances where "reverse tailoring" has occurred. For example, although Department policy maintains that projects whose budgets are less than $20 million dollars are not required to implement earned value management discipline, every smaller project we examined was implementing earned value management. This is not necessarily bad, since earned value management provides managers with good insights into project status. However, it shows that even when a conscious attempt is made to reduce administrative burdens on smaller projects, in practice all projects tend adopt the same cookie cutter approach.

  The IRT also found that EIRs may discourage tailoring. It appears that in reviewing project efforts, the EIR team goes through a checklist to see what practices are being followed. On one small project, an EIR criticized the project team for not developing a work breakdown structure dictionary (this is usually a requirement for large projects and is bypassed on small projects). Ultimately, the project team complied with the EIR suggestions, but it is not obvious that this compliance led to better project work. Certainly, it added to administrative effort.

  The management on many projects acknowledged that the order permitted tailoring but that attempts at tailoring met resistance at Headquarters. No effective tailoring has been seen by the projects that the IRT reviewed. After reviewing some of the documents produced for the smaller projects, the IRT believes that there is room for decreasing the volume of detail without jeopardizing the essential requirements of the document. Necessarily the degree and type of tailoring will vary depending on the scope and complexity of the project.

Recommendations

The IRT believes that the 413 series of documents have had a healthy effect on the improvement of project management at the Department. Federal Project Directors and contractor project managers overwhelmingly indicated that the Department needs a consistent and disciplined approach to pursuing project management, and that the 413 documents support the move towards

consistency and discipline. They also pointed out that the 413 series of documents simply codified practices that the Department had been promoting for years.

The IRT also recognizes that documents and procedures alone do not drive good practice. Ultimately, good practice derives from senior management support. While interviews with Federal employees and contractors at sites as well as at Department headquarters indicated that the journey toward effective project management is far from complete, no one questioned the seriousness of senior management in its attempts to strengthen project management. The creation of the Office of Engineering and Construction Management (OECM) is one tangible example of this seriousness. Enforcement of requirements to use External Independent Reviews (EIRs), Independent Project Reviews (IPRs), independent cost estimates, and explicit risk assessments demonstrates a commitment in the senior ranks to make sure that recently developed policies and procedures are actually implemented.

Following are IRT recommendations regarding implementation of the Policy, Order, and Manual:

- *Pertinent personnel across the agency should undergo training on the rationale, content and application of the 413 series of documents*
  As mentioned above, the IRT found that at some sites, systematic training on the 413 series of documents was extensive, while at others it did not occur. Not surprisingly, sites where project staff received formal exposure to the Order and Manual had personnel who were more knowledgeable about their rationale, content, and application than sites where there was no formal exposure.
- *Attention should be directed at determining how "tailoring" of the 413 requirements can be implemented effectively*
  Areas where tailoring may be appropriate include:
  - Small vs. large projects (Premise: Small projects do not warrant the same level of paperwork as large projects)
  - Research intensive vs. construction intensive projects (Premise: Research intensive projects have much higher levels of uncertainty than standard construction projects)
  - Domestic vs. international projects (Premise: On international projects, international players will impose their own requirements and will be reluctant to follow some US requirements)

  OECM should lead an initiative to clarify what tailoring is, and what can and cannot be done through tailoring practices.

APPENDIX F: PROJECT ASSESSMENT AND REPORTING SYSTEMS (PARS)

One of the issues the IRT investigated during each site visit was use of the Project Assessment and Reporting System (PARS). Federal Project Directors and contractor project managers were asked about their views on PARS. For example: How accurate are the data going into the system? How timely is it? Who enters the data? How burdensome is it to maintain the system? How useful is PARS in managing projects? The IRT *did not* conduct an extensive review of the system and its architecture. One of our recommendations is that such a review be implemented to determine whether PARS is a good as it should be.

PARS emerged from a 1999 Department of Energy initiative to reform its project management processes. Its primary goal is to establish a Department-wide project management tracking and control system. A working PARS was rolled out in 2001. At first, only major projects were entered into the database. Then non-major projects were included as well. In January 2003, a revised version of PARS was implemented, called PARS 3.0. This is the version of PARS employed at the time of the IRT's review of the Department's project management practices.

Use of PARS at DOE Sites

Following is a summary of the responses to the questions raised about PARS usage:

- *How accurate are the data going into the system?*
  Both Federal Project Directors and contractor project managers reported that it is as accurate as can be, given what data they have available. One frequently stated comment is that the earned value data put into the system each month can be from four to six weeks old, because of lag times required in capturing actual cost figures. (See comments below.) Another comment is that the actual cost figures are quite rough, because there is no accounting system that ties actual cost figures directly to earned value (BCWP). This can lead to reporting distortions, e.g., actual cost figures may reflect purchase of materials that have not yet been employed on the project effort, creating the impression of a cost overrun.
- *How timely are the data going into the system?*
- There was universal agreement among Federal Project Directors and contractor project managers that the data going into the system are not timely owing to lags associated with data collection. Thus monthly earned value reports appearing in PARS reflect project status that can be one or two months out of date. It should be recognized that delays in capturing earned value data are inevitable, because inherent complexities in developing accurate actual cost figures. But in some instances, delays were triggered by contractors not following good financial accounting procedures. In one case, for example, the IRT encountered a major science project that often needed to wait several months before it could determine actual costs, because university partners would delay for many months invoicing the project for work performed.
- *Who enters the data?*
  Several Federal Project Directors on smaller projects indicated that they entered the monthly data themselves, because it was too much of a hassle to train others to serve a data entry function. All Federal Project Directors indicated that they reviewed the entered

data – regardless of who entered it – before it was officially logged into PARS. This is a requirement of PARS maintenance.

- *How burdensome is it to maintain the system?*
  The general view of Federal Project Directors and contractor project managers was that maintaining PARS was part of their job. They expressed an appreciation for the need to submit progress data to headquarters. However, several complained that PARS 3.0 is difficult to use and preferred the usability of earlier reporting systems. Also, on smaller projects, the *relative* burden of submitting monthly data into PARS is greater than for larger projects.
- *How useful is PARS in managing projects?*
  There was universal agreement that PARS was not useful as a project management resource at the sites. Federal Project Directors indicated that through close communication with contractor project managers via meetings, phone calls, and written reports, they always had up-to-the-minute insights on project status. The PARS data, in contrast, was out of date and did not offer them the level of detail they needed to keep track of projects. Most Federal Project Directors and contractor project managers acknowledged that managers at DOE headquarters might find the PARS reports useful, since it provided them with project status information in a consistent fashion across all Department projects.

  In reviewing earned value data for the sixteen sites, the IRT noted a significant deficiency in the reporting of earned value status over time. The earned value graphs consistently pictured projects where cost and schedule variances were small – even on projects that had known problems in the past. It appears that when troubled projects are re-baselined, only the re-baselined information is portrayed, hiding, in effect, past problems. Certainly, PARS should be adjusted to archive performance on earlier baselines so that managers can develop an accurate sense of a project's history, but the original BCWS should be maintained on the system and portrayed on the graphs.

  In addition, only sketchy data is available for some projects in PARS. This in almost universally true of the smaller projects (less than $20M), where little cost information is included. One large project, the MOX FFF project currently has only very limited data available in PARS even though the project has already spent almost $300M.

  Other shortcomings the IRT noted in PARS was the almost complete lack of critical path schedule analysis and the lack of information regarding issues and issue resolution on projects.

Recommendations

In view of the many critical comments we encountered about PARS, we recommend that a study be conducted to determine the merits of its architecture as well as its value to a broad range of users. We believe that the underlying premise for establishing PARS is sound: the Department must have an agency-wide project monitoring and control system that provides senior managers with the information they need to understand what is happening on agency projects and to make

informed decisions. Our chief concern is whether PARS is as effective a management information system as it should be. Specific questions that need answering include:

- *Is the system sufficiently friendly to encourage the proper full compliance of authorized personnel to enter high quality data?*
  The IRT found that all Federal Project Directors met the requirement to update portions of PARS on a monthly basis. However, many noted that they found the effort cumbersome due to constraints in the system and that they were merely "punching a ticket." They acknowledged, however, that the data served a useful function in keeping Headquarters informed of project progress.
- *Is the system fully integrated and well-designed?*
  Some Federal Project Directors indicated that if changes need to be made to the PARS database, they need to be entered into more than one field. The IRT was unable to confirm the accuracy of this point. However, it is clear that if the database is structured in such a way that different modules do not "communicate" with each other, data entry into multiple locations can create errors and inconsistencies.

In addition, the IRT recommends that PARS be adjusted to maintain information on earned value performance in accordance with the original baseline, as well as subsequent baselines. At present, only the current baseline information is displayed, and this can lead to a distorted view of a project's history.

Also, more information should be entered on schedule analysis and discussion of issues and resolution.

All large (over $5M) projects should be detailed in PARS from CD-1 on. Cost information should be included for those between $5M and $20M, as that information is currently not required.

The IRT also recommends that a brief survey be conducted of senior Department personnel to see how useful they find PARS to be in helping them make decisions. The IRT only examined PARS's value at the project level and found a universal consensus that PARS was not employed to assist in decision making or providing insights into project status. Consequently, the IRT can make no comments about the value of PARS at higher levels of the Department. In view of the substantial amount of energy required to support PARS, it is important to assess its benefits.

Finally, the IRT recommends that an effort be undertaken at the Department to see how data reporting requirements at the sites can be tailored to reflect different conditions facing projects. For example, can reporting requirements be reduced for smaller projects to lower the administrative burden the Federal Project Directors and contractor project managers encounter?

Reference Document
Project Assessment and Reporting System (PARS), User Manual, version 3.0, June 25, 2003.