THE DEPARTMENT OF ENERGY

Office of Environmental Restoration &
Waste Management

Project Performance Study

November 1993

Prepared by:
Independent Project Analysis, Inc.
Reston, Virginia

RECEIVED
JAN 12 1994
OSTI

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

gth

DISCLAIMER

"This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."

This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; prices available from (615) 576-8401, FTS 626-8401.

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161.

PREFACE

This study was commissioned by the Office of Environmental Restoration and Waste Management (EM) of the U.S. Department of Energy and is intended to measure the current status of the EM project systems and to provide a baseline for measuring improvement.¹ The scope of the study covers project development and execution, from project definition through the completion of construction.

This study systematically compares key parameters of the EM's Environmental Restoration (ER) and Waste Management (WM) project systems with the Independent Project Analysis proprietary industry Environmental Remediation and Capital Projects databases. The Environmental Remediation database consists of 233 completed (non-EM) projects conducted since 1980 by the private sector and government agencies. The Capital Projects database includes 951 waste management, construction, and process-related projects executed largely by the private sector. The key parameters in the databases include project results and other factors that were chosen based on their high correlation with project outcomes. Conclusions are drawn about the competitiveness of the EM Environmental Restoration and Waste Management project systems and recommendations are made to enhance it.

¹ This study was performed under contract #DE-AC06-92RL12396, Subcontract #92-007.

TABLE OF CONTENTS

- SUMMARY OF U.S. DOE EM PROJECT SYSTEM PERFORMANCE iii
- APPROACH 1
- DATA 13
- DRIVERS OF SYSTEM PERFORMANCE 40
- PROJECT SYSTEM OUTCOMES 79
- CONCLUSIONS AND RECOMMENDATIONS 116
- APPENDIX 126

SUMMARY OF U.S. DOE EM PROJECT SYSTEMS PERFORMANCE

The Office of Environmental Restoration and Waste Management (EM) of the U.S. Department of Energy commissioned Independent Project Analysis, Inc. (IPA) to perform this Project Performance Study to provide a quantitative analysis determining how well EM develops and executes environmental remediation and waste management projects. The approach consisted of collecting detailed data on a sample of 65 completed and ongoing EM projects conducted since 1984. These data were then compared with key project characteristics and outcomes from 233 environmental remediation projects (excluding EM) in IPA's Environmental Remediation Database and 951 projects in IPA's Capital Projects Database. The study establishes the standing of the EM system relative to other organizations, and suggests areas and opportunities for improvement.

DOE EM Project Systems Performance

The study finds a potential for considerable improvement in project system performance in EM's Office of Environmental Restoration and Office of Waste Management (WM). Compared on a consistent basis, EM ranked below industry norms in all key performance measures. The analysis controls for differences in project size, type, technology, and other project characteristics in order to ensure "apples-to-apples" comparisons. The analysis demonstrates the following:

1. DOE costs for equivalent work is significantly higher than industry norms.
2. DOE's higher costs are a function of high project management costs and project system practices.
3. Cost growth in DOE projects is a result of poor project definition.

Principle Findings

As shown in the figure on the next page:

- *DOE ER project costs are significantly higher than either the private sector or other government agencies. ER projects cost 32 percent more than private sector projects and 15 percent more than*

Summarizing Project Outcome Measures

ER COST PERFORMANCE

Private Sector
Average
= 100

COST OVERRUN

Average cost
overrun
(in percent)

SCHEDULE PERFORMANCE

Private Sector
Average
= 100

SCHEDULE SLIP

Average schedule
slip
(in percent)

1. THE BEST includes those projects with superior performance in all categories.

other government agencies. If we exclude the DOE Uranium Mill Tailings Remediation Act (UMTRA) projects this cost performance is even poorer. DOE ER project costs are 44 and 25 percent higher than the private sector and other government agencies, respectively.

- *DOE employs both Management and Operating (M&O) contractors and on-site Architectural and Engineering (A/E) firms. The resulting total project management costs are more than double the amount spent by other government agencies and nearly four times the amount spent by the private sector. This figure excludes DOE personnel and unrelated infrastructure cost components.*
- *DOE's EM project costs experienced an average 48 percent overrun from the authorization estimate. More important, the variability in estimate accuracy for the DOE project systems was greater than the average variability for any other organization represented in the databases.*
- *DOE ER projects required 18 percent more time than the private sector and other federal agency average for remedial action. DOE WM projects required 50 percent more time than comparable industry projects in the database to achieve mechanical completion.*
- *DOE ER and WM projects slipped their schedule by 52 percent from the start of engineering through completion compared to an average of 16 percent for capital projects. If UMTRA projects are excluded, the average slip increases to 69 percent.*

Overview of Project Systems

The term "Project System," means the practices, methods, and systems whereby an organization moves from a basic decision to begin preparation for a project until completion or full operation has been achieved. The EM project systems have some unique characteristics when compared to the private sector and other government project systems represented in the IPA databases. In essence, the EM project system is a collection of independent project systems run by various M&O contractors. In most cases, actual EM input and supervision on the projects evaluated for this study was minimal. The project teams, consisting of M&O and/or on-site A/E employees, executed the projects according to the procedures and practices of their respective firms, which vary across the DOE complex. The results are not being skewed by poorly executed projects at a few installations.

Principal Conclusions

1. EM projects have a poor level of project definition: The most important factor in the success of projects is the quality and level of project definition. Within EM, there are no effective, consistent guidelines for establishing the level of design or degree of project definition required for project authorization. EM projects have lower definition scores than other government and the private sector. This means that at the same project milestone, EM projects are less well defined and more likely to experience cost overruns and schedule delays than similar projects managed by other organizations.
2. EM project management costs are very high compared to other organizations. Most EM projects are using multiple primes contractors to perform project management activities. This has resulted in redundancy and a lack of control and accountability for project performance.
3. DOE uses inappropriate contracting strategies: Typical contracting at DOE installations is to have both a prime M&O contractor and a prime on-site A&E firm. Both the M&O and A&E firms work on a cost reimbursable basis. However, there are no mechanisms between the M&O and A&E firm to manage the projects in an effective manner. Therefore, the use of multiple primes and decentralized authority limits project management effectiveness. A critical aspect of the ineffectiveness of this arrangement is that there is insufficient DOE management presence to assure that proper requirements are established and that efficient decisions are made and communicated to the project teams performing environmental restoration and waste management work.

It is also typical for DOE's prime contractors to subcontract large portions of work on fixed price terms. What is unusual is that the fixed price work is actually less well defined than the work that remains in-house under cost reimbursable terms. As might be expected, in light of the poorer definition the cost growth on fixed price tasks far exceeds the cost growth on cost reimbursable tasks. Finally, the subcontracting of less well defined tasks to subcontractors is, in effect, the shifting of project risk away from the prime contractors to other parties, namely the taxpayers. In summary, DOE's contracting strategy is not set according to project objectives and is not in accord with sound practice.

4. EM projects experience regulatory impacts primarily during the construction phase: A quarter of the DOE projects are associated with significant regulatory impacts during the construction or remedial action phase. Nearly all regulatory impacts were a result of a lack of closure on project objectives by the project teams with

the regulators. For example, several projects failed to demonstrate the feasibility of a remedial approach to the state environmental agencies before starting the remedial action. This later resulted in changes thereby adding costs and delaying schedules.

5. Cost contingencies for EM projects are not set according to project risks: Cost contingencies are typically based on informal norms or the estimator's judgement. This leads to many contingencies being set incorrectly, costing money. Setting a contingency too high can waste money. Setting a contingency too low can also lead to wasted money by eroding cost discipline. Undesirable scope reductions and failures to adopt desirable design improvements can also result.
6. From the viewpoint of project fundamentals, the EM system is predictable: When EM projects are prepared and executed in accord with best practice, good results are achieved. This means that improvements can be readily implemented.

These findings have significant implications for EM's ability to complete its environmental cleanup mission over the next several decades. Without a more thorough and systematic approach to executing projects, EM will have difficulty improving its current level of performance. The implementation of these changes will require planning, vision, and consistency on the part of senior management.

Experience from the private sector has shown that the active engagement of senior management is the critical factor in the success or failure of achieving change and better performance. Senior management must demonstrate that they are committed to better performance by initiating action and following-up on a regular basis to check results. Without this commitment, any changes leading to better performance will be short-lived.

Recommendations

1. Overhaul Project Definition Process

- Establish a complex-wide process for defining EM projects in a uniform manner that accords with best practice and train project teams in these practices.
- Establish a project measurement program for tracking the quality of project definition for all projects.

- Hold project teams accountable for achieving well-defined projects prior to start of execution by means of the measurement program.

2. Reform Project Management Control Approach

- Discontinue the use of Activity Data Sheets as a project management system. Specific measures to make the project basis comparable across the complex must be developed.
- Set quantitative goals for project systems improvement.
- Work with field offices to measure and monitor project systems performance.

3. Change Contracting Strategy For EM Projects

- Determine target number of EM and contractor personnel necessary to perform essential owner functions for EM.
- Regain control of essential owner functions from the contractors.
- Set up contracting strategy according to project objectives and risks (e.g. fixed-price contracts for well-defined projects, reimbursable for poorly defined projects).
- Enhance project controls and eliminate redundancy by avoiding the use of multiple prime contractors.
- Place accountability of DOE and contractor managers for project performance at the project level.

OUTLINE

- **APPROACH**

- Purpose**
 - Overview**
 - Why Measure Performance?**
 - Study Goals and Products**
 - The Bottoms-Up Approach**
 - The EM Project Systems**

- **DATA**

- **DRIVERS OF SYSTEM PERFORMANCE**

- **PROJECT SYSTEM OUTCOMES**

- **CONCLUSIONS AND RECOMMENDATIONS**

PURPOSE

The purpose of this Project Performance Study is to establish a system to continuously measure and improve DOE/EM's project systems performance. The key products of the study are:

- Establishing project performance measures for Environmental Restoration (ER) and Waste Management (WM) projects,
- *Providing a baseline of DOE's Environmental Management (EM) project systems performance,*
- Comparing EM and industry project system performance, and
- Suggesting specific areas to improve or modify EM's project systems.

OVERVIEW

This study compares DOE's Environmental Restoration (ER) and Waste Management (WM) project systems performance with industry's, using several metrics, or measures. The primary objective of the analysis is to identify areas for improvement within the project systems by measuring the performance of several similar systems and evaluating each for best practices. This method, referred to as competitive position analysis, is often used by companies in the private sector to evaluate how their current project system is performing with respect to the competition.

The figure below illustrates the "Ten Steps to Quality" originally developed by Xerox, and serves as the basis for this project performance analysis. This study executes the first four critical steps, which are the most difficult and expensive for companies to execute internally.

The first step identifies what is to be studied, specifically DOE's Environmental Restoration and Waste Management (EM) project systems. A sample of completed and ongoing EM projects was taken to represent the total EM program. The second step, identifying comparative companies and organizations, has been completed by IPA in the development of extensive databases of completed environmental remediation and capital construction projects. The third step in the analysis involves data collection. EM project managers and team members completed standardized data collection packages, or worksheets. IPA staff then conducted on-site interviews for each project to gain additional insight. The fourth step, determining performance levels, is completed through statistical analyses of the collected data. Results of the analyses are documented, measures are identified to provide for continuous improvement, and recommendations for specific improvements are developed.

The remaining steps involve integration of the results and action. Integration occurs by establishing future performance levels based on the analytical results, communicating the findings, and identifying the changes needed. Action must follow: developing the action plan, implementing the plan and monitoring progress, and then recalibrating the performance measures. Continuous improvement will only result when progress is monitored, measures are recalibrated to identify the effects of the changes, and new goals are set.

THE TEN STEPS TO QUALITY

WHY MEASURE PERFORMANCE?

A quantitative analysis of system performance provides a baseline from which improvements in system effectiveness can be measured. Additionally, this baseline can be used to identify system weaknesses and set goals for improved performance. This is particularly beneficial to a young organization, such as EM, which due to its relatively short history has had little time to develop a performance baseline.

In addition to providing a baseline, a performance analysis provides information on what others are doing to improve performance in those areas. Through this type of analysis, it is possible to isolate those key drivers which contribute most to a project system's effectiveness. Once identified, focusing efforts on these critical areas will result in improved project systems performance.

WHY MEASURE PERFORMANCE?

- To understand where EM is now.
- To establish a baseline to measure change and progress.
- To discover how well EM is performing relative to other government and industry organizations.
- To identify ways to improve in very specific areas.
- To provide a basis for developing a long-term improvement strategy.

STUDY GOALS AND PRODUCTS

The study measures the performance of EM's ER and WM projects by comparing their performance with that of other companies and organizations executing similar projects.

The analysis compares projects and project systems in specific areas. These areas have been identified as key factors in measuring and predicting project and system performance. Not surprisingly, the key factors used to predict project outcomes are also the key elements of project system competitiveness. Three specific measures of project system effectiveness, or outcomes, are employed:

- **Absolute Cost** -- Refers to a comparison of the project's cost and a historical average cost for industry projects with similar characteristics (i.e., technology, contaminants, media, volume, etc.).
- **Cost Growth** -- Compares the difference between the estimated cost and the actual cost.
- **Schedule Duration** -- Contrasts the total and component schedule lengths among DOE projects and other industry participants.
- **Schedule Slip** -- Compares the difference between estimated and actual schedules.

In this study, the focus is not just on project system outcomes, but also on the key elements of competitive effectiveness:

• Project Definition	• Regulatory Coordination
• Control of Change	• Value Improving Practices
• Project Team Quality	• Industry Best Practices

A performance analysis provides management with valuable decision making tools. The study results provide a baseline from which goals can be set, improvements measured, and future goals set. This cyclical process is a means for continuous improvement of the project system. The analysis also enlightens project managers as to how others are doing business and solving similar problems. Data collected during the study are stored in a centralized database that can be used to track project system performance and measure system improvement over time.

STUDY GOALS AND PRODUCTS

- **COMPARE EM** with competitors noting strengths, weaknesses, and different ways of doing business.
- Provide EM with a **SET OF MEASURES** for evaluating current and future project systems performance.
- Provide a **BASELINE** for measuring improvement.
- Provide a solid basis for **CONTINUOUS IMPROVEMENT** of the EM project systems.

PERFORMANCE MEASURES ANALYSIS - THE BOTTOMS-UP APPROACH

Typically, system performance studies are approached from the top, down, meaning the focus of the data collection effort is on an organization's system, rather than on individual projects that make up the system. Interviews and data collection are conducted with upper management (rather than project team members), whose perceptions of project-related problems and issues may not be accurate. Additionally, at the project system level, it is difficult to understand the impact of specific company practices on individual project performance. As a result, study results are implemented, in many cases, without a clear understanding of the ultimate impact on individual projects.

IPA's approach to measuring system performance is a bottom's-up approach. Data are collected at the project level, from those team members who actually participated in the project and have first-hand knowledge of the project's history, the day-to-day activities and decisions that affected the project, and the ultimate project outcome. This information, combined with a detailed knowledge of the organization's policies and practices, allows IPA to develop useful, relevant recommendations for project systems improvement.

Project Measurement The Bottoms-Up Approach

BOTTOMS.drw

THE EM PROJECT SYSTEMS

For purposes of this study, the EM project systems are defined as Waste Management and Environmental Restoration projects managed by EM-30, Office of Waste Management and EM-40, Office of Environmental Restoration, respectively. Data were collected for 65 completed and ongoing projects. All field offices, except Nevada, are represented in the sample. This sample is assumed to be representative of the ER/WM project systems.

During data collection and evaluation for environmental restoration projects, emphasis was on the remedial design and remedial action phases of the project. For the waste management projects, data collection and evaluation efforts focused on all project phases, from design through startup.

Project information was collected from various DOE field offices and installations. To some extent, each site uses independent project management practices. Hence, the sample of information represents an aggregation of several partially independent project systems. The collection of these systems represents EM's project systems.

THE EM PROJECT SYSTEMS

- Environmental restoration and waste management projects represented.
- Sample includes 65 completed and ongoing projects.
- All field offices represented, except Nevada.

OUTLINE

- **APPROACH**

- **DATA**

**Project Information Collected
Databases Used for Comparison
DOE Project Database
Normalization of Data
Innovative Technology
Project Comparisons
Defining "THE BEST"**

- **DRIVERS OF SYSTEM PERFORMANCE**
- **PROJECT SYSTEM OUTCOMES**
- **CONCLUSIONS AND RECOMMENDATIONS**

PROJECT INFORMATION COLLECTED

The results of this study are dependent on data quality. To ensure the most comprehensive data set, IPA's data collection efforts focused on completing a standardized data collection worksheet for each project, as well as conducting personal interviews with project managers and key project team members. Interviews provided supplementary data and insight to worksheet responses, and helped clarify the information provided in each worksheet. Separate worksheets are used for ER projects and WM projects, however both collect the same type of information. Use of the standardized worksheets, in conjunction with the interview process, provides IPA with over 1,000 qualitative and quantitative characteristics for each project. The ER and WM worksheets are designed to capture the following information:

ER Information

- General Information
- Assessment Activities
- Remediation Characteristics
- Technology
- Project Management
- Engineering Practices
- Estimated and Actual Schedule
- Estimated and Actual Cost
- Project Definition and Estimating Basis
- External/Regulatory Issues
- General Comments

WM Information

- General Information
- Technical Characteristics
- Project Management
- Engineering Practices
- Estimated and Actual Schedule
- Estimated and Actual Cost
- Project Definition and Estimating Basis
- External/Regulatory Issues
- General Comments

Most of the project team interviews consisted of representatives (project manager, engineers, budgeting personnel, etc.) from DOE, the M&O and/or the on-site A&E firms. In total, over 120 project team members participated in the interview process.

PROJECT INFORMATION COLLECTED

ER WORKSHEET

General Information:	Project type, size, and scope, geologic site characteristics
Assessment Activities:	Contractors, number and type of soil/water samples, regulatory delays, public involvement
Remediation Characteristics:	Waste type(s) and disposal method(s), contaminants, level of contamination, discussion of prior actions at site
Technology:	Proposed and selected technology(s), cleanup goals, innovation, contractors
Project Management:	Project team organization, turnover in key project team members, project team definition
Engineering Practices:	Process simplification, technology selection, customizing standards and specs, value engineering, and constructability reviews
Estimate Data:	Estimated cost and schedule, contingency and escalation figures, project definition items, estimating methods
Project Results:	Actual cost and schedule, cost growth, schedule slip, scope changes, design changes
External/Regulatory Issues:	Cost and schedule impact of environmental regulations, labor issues, health and safety issues, weather conditions
General Comments:	Reasons for project success or failure, lessons learned

WM WORKSHEET

General Information:	Location, product type, contractors
Technical Characteristics:	Design limits, process and production features, H&M balances, process flow sheets, technical complexity and innovation
Project Management:	Project team organization, turnover in key project team members, project team definition
Engineering Practices:	Process simplification, technology selection, customizing standards/specifications, value engineering, and constructability reviews
Estimate Data:	Estimated cost and schedule, contingency and escalation figures, project definition items, estimating methods
Project Results:	Actual cost and schedule, cost growth, schedule slip, scope changes, design changes, operational problems, major equipment breakdowns
External/Regulatory Issues:	Cost and schedule impact of environmental regulations, labor and health/safety issues, weather conditions, equipment problems
General Comments:	Reasons for project success or failure, lessons learned

DATABASES USED FOR COMPARISON

Information contained in two unique IPA proprietary databases are used to evaluate EM's project systems. The Environmental Remediation (ER) and UMTRA projects will be compared with projects in IPA's industry Environmental Remediation database, while Waste Management (WM) projects will be compared against projects in IPA's capital projects database. IPA's Project Evaluation System (PES) draws upon both databases in deriving results.

The Environmental Remediation database currently contains information on 233 (non-DOE) completed assessment and cleanup projects. Over 1,000 variables are used to describe each project. Remediation technology, cost, and schedule are among the many project attributes tracked. The projects in the Environmental Remediation database represent \$1.5 billion worth of environmental remediation work performed by the private sector and federal agencies such as the U.S. EPA, U.S. Army Corps of Engineers, and U.S. DOE. The database includes projects representing all major remedial technologies, and some innovative technologies. Project completion dates range from 1981 to 1993. Data in the Environmental Remediation database are used to evaluate DOE's environmental remediation (ER) and UMTRA projects.

IPA's Capital Project database contains information on over 551 completed and 396 on-going capital projects performed by more than 40 companies. These companies are primarily involved in the oil, chemical, pharmaceutical, and mineral industries. This database includes over 60 waste management facilities constructed by the private sector. The capital project database also includes 76 DOE Defense Program projects and 12 DOE Fossil Energy projects. For each project, over 1,000 variables describe the various parts of the project cycle, from R&D through Operations. Project sizes range from \$0.5 million to \$2.3 billion, and the level of technical difficulty ranges from minimal to cutting edge. Note that since the DOE WM projects were all under \$300 million, the comparison database was limited to projects under that amount. The average project started production design in 1988. The data in the capital project database will be used to analyze DOE's Waste Management projects.

Project Measures Databases

Environmental Remediation Database

- 233 completed assessment and cleanup projects representing \$1.5 billion
- Database drawn from private sector, EPA/US Army COE
- Over 1,000 pieces of information describe each project
- All major remedial technologies represented

**Used for ER and UMTRA Projects
Benchmarking**

Capital Projects Database

- Over 900 completed and ongoing projects, representing over \$40 billion
- Over 40 companies represented

**Used for WM Projects
Benchmarking**

EM PROJECT DATABASE

The EM project database used as the basis for this study includes 65 completed and ongoing ER and WM projects. The study team visited DOE facilities and completed the standardized data collection worksheets through project team interviews. The interview process enabled project team members to clarify responses to worksheet questions and provide additional insights into individual project performance.

The two primary concerns in project selection were: a) to ensure that the data required are available, and b) that the sample is representative of the organization's projects. These requirements were satisfied by utilizing three key criteria in the selection process:

1. A majority of the projects must be complete. This ensures that key project milestones have been met and fulfilled and that final project costs are known and documented. Of the 65 projects, 48 are completed and seventeen are ongoing. The study team collected information for ongoing projects to determine if current projects are similar in type and project management to past projects. It is important to note that these ongoing projects are not used in the calculation of project performance outcome measures detailed in the next section. However, they are important for gaining insight into the current state of the project systems.
2. The DOE project sample needed to represent a cross-section of the DOE complex. Project performance levels may vary extensively by installation and M&O contractor. As a result, the sample includes projects from every Field Office except Nevada, where no completed project data were available.
3. The projects should be as recent as possible in order to be representative of the current state of the project system. A secondary reason for this preference is that data on recent projects are generally more readily available from files and it is easier for the project team to recall the circumstances and events that influenced projects completed within the last several years.

Overall, the data collection packages (worksheets) were detailed and complete. The interviews were equally helpful and incisive. The cooperation exhibited throughout EM during data collection and the interviews facilitated excellent data acquisition.

EM PROJECT DATABASE

The EM project database:

- Contains 58 completed and ongoing ER projects
- Contains 7 completed and ongoing WM projects (sample is insufficient for purposes of statistical reliability; results are indicative only)
- Consists of data provided through worksheets and interviews

Project selection based on:

- Project status (majority of projects complete)
- Managing Field Office (all Field Offices represented, except Nevada)
- Project completion date (selected more recent projects)

EM PROJECT DATABASE

Collectively, the EM projects included in the sample represent nearly \$900 million dollars. Over 70 percent, or \$630 million, has already been spent by EM. The EM project sample falls into two main categories:

1. *Environmental Restoration (ER) Program:* This program is responsible for assessment and cleanup activities including remedial action and decontamination and decommissioning. Over 80 percent of the projects in the sample fall into this category. Nearly all the projects in the sample are remedial action projects. There are two important subsets of the ER Program:
 - *Uranium Mill Tailings Remedial Action (UMTRA) Program:* This program is responsible for the stabilization and control of tailings and other residual radioactive materials located on inactive uranium processing sites. The DOE sample includes 16 completed UMTRA projects.
 - *Decontamination and Decommissioning Program:* There are no facility decontamination and decommissioning (D&D) projects included in the sample.
2. *Waste Management (WM) Program:* This program is responsible for minimizing production of DOE generated waste, altering current processes to reduce waste generation, and working with the Technology Development Program to develop innovative technologies for treatment and disposal of present and future waste streams and for waste minimization. The sample includes seven waste management projects. It is important to note that the waste management sample is insufficient for purposes of statistical reliability and that the results are indicative only.

DOE PROJECT DATABASE

DOE COMPLETED ER PROJECTS					
PROJECT	START REMEDIAL DESIGN	COMPLETE REMEDIAL ACTION	PROJECT	START REMEDIAL DESIGN	COMPLETE REMEDIAL ACTION
AL: Kansas City Outfall Area	1988	1989	RF: OU 1 (881 Hillside)	1988	1992
AL: LANL Technical Area 16 Burning Ground Surface	n/a	1990	RL: 300 Area Process Trenches	1991	1992
AL: Kansas City Plant Tank Farm Closure	1986	1988	RL: 618-9 Burial Ground ERAs	1990	1991
AL: Kansas City Lagoon Site Closure	1988	1988	RL: 183-H Solar Evaporation Basins	1985	1990
AL: Kansas City North Industrial Waste Water Lagoon	n/a	1985	RL: Gable Mountain Pond Interim Stabilization	1984	1989
FN: Active Flyash Pile Controls	1991	1992	SF: Interim Storage Facility-Santa Susanna	1984	1984
FN: Pit 5 Experimental Treatment Facility	1991	1992	SF: LLNL Eastern GSA Groundwater Treatment	1990	1991
FN: Addressing VOC Contamination for RA#1	1991	1991	SF: LLNL TFC	1992	1993
OR: Bear Creek - S-3 Ponds	1987	1990	SR: M-Area Settling Basin	1987	1990
OR: Bear Creek Burial Grounds	1989	1990	SR: Mixed Waste Management Facility - 305-C	1988	1991
OR: Bear Creek - Oil Retention Ponds	1988	1990	SR: F&H Seepage Basin Closure	1988	1991
OR: Bear Creek - Oil Landfarm	1988	1989	SR: A1-Area Groundwater Remediation	1983	1991
OR: ORNL 3001 Storage Canal	1991	1992	SR: M1-Area Groundwater Remediation	1982	1985
OR: Portsmouth X-749 Closure	1990	1992			

DOE PROJECT DATABASE

DOE ON-GOING ER PROJECTS					
PROJECT	START REMEDIAL DESIGN	COMPLETE REMEDIAL ACTION	PROJECT	START REMEDIAL DESIGN	COMPLETE REMEDIAL ACTION
AL: LANL 2122 (TA-21 D&D of Buildings 3 and 4)	1992	Ongoing	INEL: Warm Water Waste Pond	1991	Ongoing
AL: LANL 1135 (TA-40 Scrap Detonation Site Closure)	1992	Ongoing	OR: Portsmouth X-735 Landfill Closure	1993	Ongoing
AL: KCP 1024 (Abandoned Indian Creek Outfall Area)	1991	Ongoing	OR: Weldon Springs Quarry Bulk Removal	1989	Ongoing
AL: Pantex 122/4 (Leaking USTs)	1994	Ongoing	RL: Hanford 1100-EM-1	1993	Ongoing
AL: Mound Leach Field	1990	Ongoing	RL: 100-BC-5 OU	1995	Ongoing
FN: Stabilization of UNH Inventories	1990	Ongoing	RL: 100-HR-1: 116-H-5 Outfall Structure	1998	Ongoing
Chicago: 1401 (800 Area Landfill)	1999	Ongoing	RL: 100-BC-1: 118-B-5 Burial Ground	2000	Ongoing
Chicago: 1402 (East Area Sewage Treatment Plant)	1999	Ongoing			

DOE PROJECT DATABASE

DOE COMPLETED UMTRA PROJECTS					
PROJECT	START REMEDIAL DESIGN	COMPLETE REMEDIAL ACTION	PROJECT	START REMEDIAL DESIGN	COMPLETE REMEDIAL ACTION
Burrell	1985	1987	Roper Yard	1984	1987
Canonsburg	1983	1986	Riverton	1987	1989
City Market	1987	1987	Salt Lake City	1984	na
Durango	1985	1989	Shiprock	1984	1986
Lakeview	1985	1989	St. Mary's Hospital	1986	1987
Mesa County Courthouse	1986	1989	Steelco	1986	1988
Mesa County Shops	1986	1988	Surplus City	1986	1987
Race Track	1986	1987	Veterans Administration Hospital	1986	1987

DOE WASTE MANAGEMENT PROJECTS					
PROJECT	START OF DETAILED ENGR.	COMPLETE	PROJECT	START OF DETAILED ENGR.	COMPLETE
CH: Brookhaven-Detector Station Construction	1989	1991	RL: Hanford-Construction of Effluent Retention Basins	1989	Constr. - 1992 Startup - Ongoing
INEL: Liquid Effluent Treatment and Disposal Facility	1987	1993	SR: Construction of ITP Facility	1985	Constr. - 1988 Startup - Ongoing
OR: K-25 Site-Refurbishment of 7 Vaults	1991	Constr. - 1993 Startup - N/A	SR: Construction of Replacement High-Level Waste Evaporator	1989	Ongoing
OR: ORNL White Oak Creek Embayment	1990	Constr.- 1992 Startup - N/A			

NORMALIZATION OF DATA

To make valid comparisons between the estimated and actual project cost and schedule data, all of the data must be normalized to a common basis. In addition, projects must be measured from a comparable baseline. For ER projects, the start of remedial design (or Title I/II design work) is considered the project start, and completion of remedial action (or Title III/Construction) is considered the project end. Cost and schedule for WM projects are measured from the start of detailed engineering through startup (or construction in those cases where there is no startup).

When normalizing the data, the first adjustment is to the scope of the project. If a change in scope has occurred, the associated increase or decrease in cost and schedule is added to or removed from the estimates. Design modifications required to meet the original objectives of the project are not considered scope changes. It is believed that interpretation of such modifications as scope changes undermines the integrity of a project system.

In addition, adjustments for unforeseeable events and regulatory changes are made to the estimated cost and schedule as part of the data normalization process. Unanticipated events, such as labor strikes, inclement weather, and changes in environmental or safety and health regulations, can have a tremendous impact on project performance. These events, which cannot be anticipated by the estimator, must be accounted for in the data analysis through data normalization procedures.

Next, all project costs are normalized to constant 1992 dollars. For both estimated and actual costs, the dollars are adjusted from the year in which they were spent or estimated to be spent, using either the solid waste, Engineering News Record, and Chemical Engineering indices. Any "built-in" escalation was removed from the cost estimates before normalization.

NORMALIZATION OF DATA

- Adjust estimated project cost and schedule to account for scope changes
- Adjust all costs to constant U.S. 1992 dollars
- Remove effects of unforeseeable events from actual project cost and schedule

INNOVATIVE TECHNOLOGY

The technologies listed below are considered innovative, per US EPA's, Innovative Treatment Technologies, Semi-Annual Status Report (Fourth Edition), October 1992.

- Ex situ Bioremediation
 - In situ Bioremediation
 - Chemical Treatment
 - Dechlorination
 - In situ Flushing
 - In situ Vitrification
 - Soil Vapor Extraction
 - Soil Washing
 - Thermal Desorption
 - Other (In situ Air Sparging and Contained Recovery of Oily Wastes (CROW))
- Contaminants are converted to less hazardous compounds through chemical reactions.

The chart below summarizes technologies used at the ER and UMTRA projects. Technologies were grouped into the following categories:

<u>Technology</u>	<u>Includes:</u>
Excavation/Disposal/Storage	Excavation, drum/tank removal, on- and off-site disposal, temporary storage, and stabilization.
Containment	Containment, stabilization, and capping.
Non-Innovative Treatment	Non-innovative treatments such as air stripping, incineration, and carbon adsorption.
Other Treatment	First-of-a-kind use of existing technology, and innovative technologies as defined by EPA.

The majority of the completed ER projects used one or more established remediation technologies. Only 11.1 percent of the projects used a first-of-a-kind technology, and none used innovative technology. Innovative technologies were selected for approximately 25 percent of 676 Superfund projects (ROD signed between 1982-1991) reviewed by EPA. Ongoing ER projects are primarily excavation projects with some containment and treatment, but no first-of-a-kind or innovative technology.

ER Projects Primarily Using Excavation/Containment Strategies

- Completed projects include ER and UMTRA and non-UMTRA projects.
- Projects may use more than one technology.

PROJECT COMPARISONS: ER PROJECTS TO THE INDUSTRY DATABASE

IPA's industry Environmental Remediation database contains data on 233 completed (non-DOE) environmental remediation projects, with remedial action costs ranging from \$0.08 million to \$90.8 million (1992 dollars). The majority of the 43 completed ER and UMTRA projects fall within this range. Only one project is outside of the range; this UMTRA project had a remedial action cost of \$98.6 million. On average, ER project costs are larger than other projects. The average ER project cost is \$10.5 million compared to industry's average of \$6.5 million.

ER's ongoing projects have an average estimated remedial action cost of \$9.1 million. This is similar to the average cost for ER's completed projects. Like the completed projects, the estimated costs for the ongoing projects are well within the range of the Environmental Remediation database.

By looking at ER's ongoing projects, in addition to completed projects, it is possible to provide an accurate illustration of not only where ER's project system has been, but where it is going.

PROJECT COMPARISONS: ER PROJECTS TO THE INDUSTRY DATABASE

COMPLETED PROJECTS

Project Class	Number of Projects ¹	Project Costs (Remedial Action)		
		Average	Median	Range
ER Database	43	\$10.5	\$2.8	\$0.1 - 98.6
Industry Database	233	\$6.5	\$2.1	\$0.08 - 90.8
TOTAL	276	\$7.9	\$2.6	\$0.08 - 98.6

PROJECTS IN PROGRESS

ER Database	15	\$9.1	\$8.8	\$0.6 - 22.9
-------------	----	-------	-------	--------------

All costs are expressed in millions of 1992 dollars

¹ Completed projects only.

PROJECT COMPARISONS: WM PROJECTS TO THE CAPITAL PROJECT DATABASE

The Capital Projects database used in this study contains information on 440 completed projects under \$300 million. To allow for more applicable comparisons, industry capital projects over \$300 million were excluded from the analysis. Nearly 60 of these projects were waste management facilities built by the private sector. The average cost of these projects is \$30.5 million, significantly higher than the average WM project cost of \$11.7 million (1988 dollars). Costs for projects in the database range from \$0.3 million to \$278.4 million, and WM project costs range from \$0.2 million to \$29.5 million. Although the average project costs differ significantly, the WM sample falls well within the range of capital project sample, allowing for meaningful comparisons of the two data sets.

The ongoing WM projects in the sample have an average estimated cost of \$119.6 million (1988 dollars). This is significantly higher than the average cost for the non-WM projects, but still well within the non-DOE project cost range. As with the ER projects, the ongoing WM projects will be reviewed to ensure the results reflect, to the maximum extent possible, the current WM project system.

PROJECT COMPARISONS: WM PROJECTS TO THE CAPITAL PROJECT DATABASE

COMPLETED PROJECTS

Project Class	Number of Projects ¹	Project Costs (in millions)		
		Average	Median	Range
WM Database	5	\$11.7	\$6.9	\$0.2 - \$29.5
Capital Project Database	440	\$30.5	\$11.6	\$0.3 - \$278.4
TOTAL	445	\$30.2	\$11.5	\$0.2 - \$278.4

PROJECTS IN PROGRESS

WM Database	2	\$119.6	--	--
-------------	---	---------	----	----

All costs are expressed in millions of 1988 dollars.

¹ Completed projects only.

PROJECT COMPARISONS: EM PROJECTS EXECUTED IN COMPARABLE TIME PERIOD

To derive valid observations from the study, it is necessary to get a view of a project system over a period of time. This enables the researcher to look for trends in project behavior. Questions such as "Is the project system learning over time?" or "Is this learning being passed on to subsequent projects?" are posed and empirical data collected to support (or refute) any hypotheses. For this analysis, EM data covering a 10-year period was collected.

The figure below compares the span of time for the EM projects with the period covered by the other projects in the databases. The EM sample includes ER and WM projects. The actual start year of design refers to the start of detailed engineering for WM projects and the start of remedial design for ER projects. The Other Government and Private Sector bars shown represent environmental remediation projects only, and the Capital Projects bar represents only capital construction projects. The range of years for the EM projects is comparable to that of the other projects. The median year for each project group is almost identical.

TIMING OF PROJECTS

19## is Median Year

TIMING.DRW

IPA, Inc.

PROJECT COMPARISONS: BASIC COST COMPARISONS - ER PROJECTS

The chart on the following page shows that the project cost distributions for the ER and non-DOE samples are similar. This is necessary in order to draw useful conclusions based on the comparison of the two samples.

The ER sample of completed projects is made up of non-UMTRA and UMTRA projects. The non-UMTRA projects range in cost from less than \$1 million to greater than \$20 million, with the majority of the projects costing less than \$5 million. The UMTRA project costs are concentrated at the ends of the cost scale, with approximately half of the sample less than \$5 million, and half greater than \$20 million. In total, more than 60 percent of all ER projects cost less than \$5 million. Similarly, the majority of non-DOE projects also have a total cost less than \$5 million.

Cost Distribution - DOE ER Projects

1992 Million U.S. Dollars

PROJECT COMPARISONS: BASIC SCHEDULE COMPARISONS - ER PROJECTS

The schedule distribution for the ER and non-DOE samples is similar. The chart on the following page shows that the majority of the remedial actions in both samples took less than 24 months. Most of the non-DOE projects took between one and two years, while many of the ER projects took 6 months or less. A number of projects in the ER sample are interim actions, which explains in part why over 30 percent have a schedule of less than 6 months. Approximately 2 percent of the projects in both the ER and non-DOE samples took more than 4 years to complete.

Basic Schedule Comparisons - ER Projects

DEFINING "THE BEST"

For a number of measures, three sets of data are used to compare EM's performance:

- IPA's Environmental Restoration and Capital Project databases,
- the EM project database, and
- the "Best" projects in the industry.

The "Best" projects are a subset of projects chosen from IPA's databases for their individual project performances. These projects have managed to closely control the cost and schedule outcomes in their respective ventures. The subset requires the following:

- Good Cost Performance
- Good Schedule Performance
- Meeting the Cost Estimate
- Meeting the Planned Schedule

The "Best" projects must do better than the industry average in terms of either absolute cost or schedule, and must fall one standard deviation better than the average in terms of meeting estimated cost and schedule. ***The "Best" projects meet all four criteria.*** If a project fails any one criterion, it is not included in the group. This keeps the "Best" category free from projects where schedule was sacrificed for total cost or vice versa. Additionally, projects with "inflated" schedules or estimates, and projects that suffered major problems during startup (where project operability was sacrificed), are excluded. It is important to note that the "Best" projects are not the "Easiest" projects. Many are highly innovative projects that incorporated best practices to produce superior project performance.

Defining the "Best"

The Same Group of Projects Demonstrating Superior Performance

Superior Cost Performance

(Costs less than Industry average)

and

Superior Schedule Performance

(Takes less time than Industry average)

and

Superior Cost and Schedule Control

= The Best

OUTLINE

- APPROACH
- DATA
- **DRIVERS OF SYSTEM PERFORMANCE**

**Approach
Project Definition
Regulatory Coordination
Major Design Changes
Project Management
Best Practices**

- PROJECT SYSTEM OUTCOMES
- CONCLUSIONS AND RECOMMENDATIONS

THE APPROACH--LINKING INPUTS AND OUTPUTS

The approach consists of measuring key project input and outcome measures, and relating these by the use of parametric statistical methods. The key project input measures have been determined by a rigorous statistical analysis of their relationship to project outcomes. The key project outcomes include absolute cost performance, cost growth and the reasons for cost growth, schedule length, and schedule slip.

The key project input factors include the amount and kind of project definition; the degree of regulatory coordination; the number of major design changes; project management practices including contracting strategy; and use of industry "best practices."

Project definition or project definition is the most important factor in understanding cost and schedule risks. Project definition includes the amount of engineering completed, the amount that is known about the site and extent and magnitude of contamination, status of regulatory reviews, and the level of participation and buy-in of all functions in the project system.

The degree of regulatory coordination is particularly important for environmental cleanup projects. Regulatory coordination means understanding all applicable and relevant regulations and coming to closure on project objectives prior to project start.

Major design changes are expensive whether they result from changes in scope or the discovery of unanticipated contamination. Most major design changes indicate relatively loose project goals, insufficient project definition, or lack of "buy-in" from the responsible parties or regulators. If detected during early design phases, these changes are much less costly. In later stages, such as during remedial action, major design changes are much more expensive.

Project management includes such items as the make-up of the project team, the amount of turnover in key project positions, and the use of appropriate contracting strategies. Participation and buy-in from all functions with a stake in the project reduce the chance of late, expensive design changes. Turnover in key positions during the course of the project often produces schedule delays. Use of appropriate contracting strategies is a pre-requisite for containing costs and adequate project control. Finally, the analysis examines the degree to which EM project teams are using sound project practices or industry "best practices."

Project Outcomes are Related to Key Characteristics

PROJECT DEFINITION -- ER PROJECTS

Project Definition is the process by which an organization develops a detailed definition of the scope for meeting specific objectives. Put simply, project definition is the process of defining what will be done, how it will be done, who will do it, when it will be done, and what resources will be needed. The higher the quality and thoroughness of this process, the more accurate the cost and schedule estimates are likely to be. Environmental remediation projects are riskier than other types of projects because they are a relatively new class of projects and the inherent uncertainties associated with subsurface conditions. Project definition is critical in reducing the cost and schedule risks for this class of projects.

Project definition for environmental remediation projects is concerned with having a complete understanding of the scope of the project, the design and engineering specifications, and the site conditions. Project definition is performed during the assessment (Remedial Investigation/Feasibility Study or RCRA Facility Investigation/Corrective Measures Study) and remedial design phases of a cleanup. However, completing an assessment does not guarantee a well-defined project. The tasks performed during an assessment are often oriented toward meeting objectives other than developing a detailed project scope (i.e., human health risks, ARARs identification). Therefore, organizations can (and often do) spend considerable resources on assessments and still have projects with poor project definition.

Project definition is the most controllable aspect of a project system. Better project definition leads to better projects (the effect of project definition on cost contingency requirements will be discussed later in this report). Cost estimates can be more accurate and reliable, which leads to better management decisions and investment of funds. Better project definition also leads to lower project costs because the work can be better organized, reducing the need for premium time to attack items that unexpectedly appear on the critical path and lessening the amount of rework.

Good project definition benefits a project at any stage: at pre-design to support the development of detailed design and engineering; during design to support completion of design as well as to provide information that may be necessary to execute design changes; and at post-design to ensure that the construction project team has complete understanding of the design and site conditions. Benefits of good project definition include concise understanding of the project, proper allocation of resources to the project, and correct cost and schedule expectations.

WHAT IS PROJECT DEFINITION?

- The process by which an organization develops a detailed project scope.
- It defines what will be done, how it will be done, who will do it, when it will be done, and what resources will be needed.

WHY IS IT IMPORTANT?

- The most important input in understanding cost and schedule risks.
- The most controllable aspect of a project system.
- A prerequisite to better project performance.

PROJECT DEFINITION -- ER PROJECTS

COMPARISON OF PROJECTS

The ER project definition index is a numerical index that evaluates the quality and level of information available to the estimator at the time of the estimate on the following items:

- Design basis;
- Understanding of transport and pathways of contaminants;
- Status of project execution planning;
- Understanding on volume of contaminated materials requiring disposal or treatment.

The level of project definition for ER projects at completion of design is lower than the average for private industry and for other government projects and the best class of projects. ER's lower project definition scores are attributable to several factors:

1. There are no guidelines in place for achieving minimum levels of project definition prior to project start. Projects teams often started projects without a thorough understanding of site conditions and without obtaining closure with the regulators on project objectives.
2. In many cases, the emphasis during the assessment phase was on quantifying health risks as opposed to characterizing site and subsurface conditions and developing a detailed project scope. This same phenomenon is true to some extent for other government agencies and the private sector. However, in general, ER teams performed less work than other parties in defining and developing the project scope, resulting in significantly lower project definition.
3. In some cases, ER projects were driven by tight schedules to meet compliance dates. In order to meet these schedules, the project team cut back on the early-on characterization and engineering work to start construction sooner. While this method is a "quick-fix," it almost always results in changes and substantial problems during remedial action.

ER Project Definition at Completion of Design

ER has Lower Project Definition for Environmental Remediation Projects than Other Organizations

PROJECT DEFINITION -- ER PROJECTS

COST GROWTH IS RELATED TO PROJECT DEFINITION

Based on the data, project definition is a strong indicator of cost growth in DOE ER projects. The vertical axis shows the cost growth for ER projects (constant 1992 dollars). The horizontal axis shows the level of project definition at the completion of design. There is a statistically significant relationship between cost growth and the level of project definition in the ER project system ($r=-0.71$).¹ Although not a perfect relationship, the statistical analysis shows that project definition accounts for 50% ($r^2 = 0.50$) of the cost growth variance. This relationship is statistically significant at the 0.0001 level. That is, the probability of the relationship occurring due to chance is less than one in ten thousand.

Better definition reduces the potential for costly design changes and provides a firmer basis for the cost and schedule estimates. While ensuring good project definition is the most reliable method for generating reliable estimates, other factors such as technical, waste, and site complexities can also affect estimate accuracy.

¹The correlation coefficient (r) measures the strength of the relationship between two variables. For the relationship described above, the correlation coefficient is -0.71 . A correlation coefficient of 0 would indicate that there is no relationship between the two variables. A correlation coefficient of 1.0 would indicate a perfect linear relationship between the two variables.

ER Cost Growth is Related to Project Definition

PROJECT DEFINITION -- WM PROJECTS

THE PROJECT DEFINITION INDEX COMPONENTS

IPA's Capital Project definition Index used for WM projects is a scale composed of three equally weighted parts:

- The degree of work completion on a set of site related items:
 - unit configurations and plot plans,
 - soils and hydrological work,
 - site-specific health and safety requirements, and
 - site-specific environmental regulatory requirements;
- The status of project execution planning; and
- The status of project engineering for the facility.

The average project definition score for WM projects was below the industry average. As indicated in the figure, WM project definition is far from best practical levels. Project definition scores for the WM projects varied dramatically from project to project. For example, at the end of conceptual design, some projects had the best practical level of definition while others were undefined. Very few WM project definition scores fell within these two extremes.

The less complex projects tended to have better project definition scores. Construction projects, which represent the least complex projects in the database, had best practical levels of project definition. WM process facilities had very poor project definition, and in some cases were completely undefined. Poor project execution planning and low engineering status were consistent factors in poor project definition scores.

WM Project Definition at Authorization

WM Projects Have Lower Scores Than Industry
Indicating Poorer Project Definition

Project Definition

PROJECT DEFINITION -- WM PROJECTS COST GROWTH IS RELATED TO PROJECT DEFINITION

Although the WM sample is too small for statistical reliability, the figure below clearly indicates that there is strong relationship between project definition scores and cost growth for WM projects. The vertical axis shows the actual cost growth figures for WM projects in constant dollars. The horizontal axis shows the project definition scores, ranging from best practical to undefined. While the WM sample is limited, the figure below demonstrates that WM projects behave in the same manner as the rest of industry. This has some important implications for EM. It means that when EM projects are prepared and executed in accord with industry "best practices," good results are achieved.

WM Cost Growth is Related to Project Definition

REGULATORY COORDINATION

Most environmental restoration projects require coordination with several regulatory groups. In addition to the responsible parties (such as DOE), these groups could include Federal regulators, State regulators, local citizen groups, and perhaps other federal agencies. Although not all regulatory impacts can be avoided, a commonly held belief is that if the regulatory groups are included early on, then the probability of a significant impact will be reduced.

A regulatory impact is defined as a change in project scope, objectives, or remedial technology, due to either lack of understanding on the regulatory requirements or a change in a regulatory standard. For the ER projects in the sample, nearly all regulatory impacts were a result of a lack of closure by the project teams with the regulators on project objectives. For example, several projects were forced by the state environmental agencies to demonstrate the feasibility of a remedial approach after the start of remedial action thereby causing schedule delays and added costs. It is important to note that in only one non-UMTRA ER project did a scope change occur during remedial action due to a change in the regulatory standards.

As illustrated, Other Government agencies oversee projects that have the highest percentage of regulatory impacts. However, most (27 percent) of these impacts occur during the assessment of remedial design phase of the project life cycle. During remedial action, or the construction phase, the frequency of a regulatory impact has declined to approximately 14 percent. ER projects experience the opposite trend. During the assessment or design phases, only 7 percent of projects experience a significant regulatory event. Almost 25 percent of ER projects have regulatory impacts during the construction phase.

REGULATORY COORDINATION - ER

ER EXPERIENCES REGULATORY IMPACTS LATE IN CYCLE

MAJOR DESIGN CHANGES CHANGES THAT OCCUR LATE ARE EXPENSIVE

Major design changes are expensive whether they result from changes in scope or the discovery of unanticipated contamination. Most major design changes indicate relatively loose project goals, insufficient project definition, or lack of "buy-in" from the responsible parties or regulators. If detected during early design phases, these changes are much less costly. In later stages, such as during remedial action, major design changes are much more expensive.

Cost effective decision-making is maximized early in a project's life cycle, when project commitments are low. The figure below illustrates the cost influence due to major design changes. In the early project evaluation stage, the cost impact of scope changes is low. As the project proceeds (through remedial design, remedial action, and into the operations and monitoring phases), the cost impact of changes gets progressively higher.

Major design changes are defined as changes in project objectives, treatment/containment strategy, or a design adjustment due to unanticipated contamination. Overall, approximately 36 percent of EM projects experience major design changes. However, the frequency of design changes is not by itself an indication of a project system's effectiveness. Much more important is when the design change occurs. In a maturing industry, one may expect serious consideration of new and innovative technologies.

Exploring the feasibility of many alternative approaches is a sign of a healthy project system. However, major design changes should not occur late in the project's life cycle.

COST EFFECTIVE DECISION MAKING

MAJOR DESIGN CHANGES (ER) - WHEN THEY OCCUR

Although more costly, major design changes are occurring more often during remedial action for ER projects. This is primarily a reflection of poor definition and lack of closure with the regulators. An objective for all industry participants would be to limit the frequency of major design changes during remedial action.

Private sector projects realize the lowest frequency of major design changes in all project stages while the Other Government category experiences the greatest frequency. It should be noted that the majority of ER projects in the sample used excavation/disposal or containment remedial strategies. One would expect these projects to experience less design changes than treatment strategies given that there is less opportunity for such changes compared to a treatment process.

MAJOR DESIGN CHANGES (ER) CHANGES OCCUR LATE IN PROJECT

MAJOR DESIGN CHANGES (WM) - WHEN THEY OCCUR

Design changes associated with waste management projects occur at various stages, with no consistent pattern for all owner categories. For "The Best" projects, design changes occur more frequently during the definition phase and the least often during construction. As mentioned earlier, this pattern of decreasing the frequency of design changes during later project phases is much more efficient.

The Industry as a whole indicates a relatively high number of major changes occurring in both the design and construction phases. Although the WM data are based on a small sample, there remains a high frequency of design changes occurring during construction and fewer during project definition.

MAJOR DESIGN CHANGES (WM) MORE CHANGES OCCUR DURING CONSTRUCTION

PROJECT MANAGEMENT: CONTRACTING STRATEGY

There are similar contractual arrangements across DOE sites. Sites utilize Management and Operating (M&O) contractors to provide operational support and administer activities. The use of M&Os dates back to the very beginning of DOE activities when efforts were focused on nuclear power and weapons production. The basic philosophy was that private sector contractors would be more efficient at operating and maintaining large production facilities. These practices have continued today and the actual number of DOE employees are vastly outnumbered by contractor employees. DOE is very dependent on contractor support. Cost reimbursable contracts establish the relationship between DOE and the M&Os. In a large sense, the M&O is comparable to the private sector owner. Work done by the M&O is comparable to the private sector doing work in-house.

However, DOE also contracts directly with many other firms. For example, many DOE sites utilize on-site architectural and engineering (A&E) firms. Typically these contractual relations are also cost reimbursable. Both the M&O and A&E contractors routinely hire subcontractors to perform various functions. The subcontracts are usually fixed-price arrangements. The following chart illustrates typical arrangements.

Please note that several of the following charts that relate to contracting strategy exclude the UMTRA projects. In general, the UMTRA projects were performed on a cost-reimbursable basis without multiple primes.

CONTRACT STRATEGIES -- TYPICAL ARRANGEMENTS

PROJECT MANAGEMENT: THE USE OF MULTIPLE PRIMES WEAKENS PROJECT CONTROL

It is common for there to be more than one prime contractor on DOE projects. For example, during the remedial action phase of an environmental restoration project, the M&O contractor may be responsible for various elements of project management and are working directly for DOE through their cost reimbursable contract. In addition, the on-site A&E firm will be responsible for implementing the remedial design and is also working under cost reimbursable contract terms. Based on the sample of data, the use of multiple prime contractors occurs 61 percent of the time.

The difficulty arises because there is no mechanism between the M&O and A&E firm to manage the project in an effective coordinated manner. Hence, the approval of change orders and other project management functions become decentralized through different parties. DOE's contracting strategy has diluted project control and authority. Each party feels responsible, but lacks effective authority.

DOE CONTRACTING STRATEGY

MULTIPLE PRIME CONTRACTORS ARE COMMON*

*Excludes UMTRA projects.

PROJECT MANAGEMENT -- TURNOVER

Best practice is to minimize project manager turnover. Changes in key project personnel are disruptive, particularly when they are not anticipated and carefully planned. Discontinuity within the project team can lead to mis-communication between disciplines and untimely changes.

Among environmental restoration projects (excluding UMTRA projects), 43 percent of DOE projects had project manager turnover. For waste management projects, the comparable M&O project manager turnover rate is over 70 percent. Although the DOE WM sample is relatively small (7 projects) it is indicative of a potential problem. "The Best" waste management projects realize only 32 percent turnover while the industry average is 38 percent.

Sufficient data do not exist to characterize the ER industry with respect to project manager turnover. However, it could be argued that turnover in the WM industry should be representative of the ER industry. Comparing ER turnover of 43 percent to the Capital Projects industry average of 38 percent indicates less of a problem.

Project management turnover leads to schedule delays. Although it is not yet possible to establish a quantitative relationship between project management turnover and schedule delays for EM projects, such a relationship has been identified for private sector waste management projects. Based on data in the IPA Capital Projects database, it has been determined that project manager turnover during detailed design or construction is correlated with an average increase of 4 months in project schedule.

PROJECT MANAGEMENT TURNOVER EM PROJECTS HAVE MORE TURNOVER

PROJECT MANAGEMENT: DOE CONTRACTING STRATEGY NOT RELATED TO PROJECT DEFINITION

At the time of contract award, project definition is actually higher on cost reimbursable work than for fixed-price assignments. This outcome runs counter to expectations. The less defined the task, the more appropriate are cost reimbursable arrangements. Using fixed-price contracts on poorly defined projects leads to changes during construction thereby increasing costs and schedules. The graph reports non-UMTRA environmental restoration (ER) projects and waste management (WM) projects.

Ideally, the cost reimbursable prime contractors should keep in-house only those tasks where project definition is relatively low and subcontract fixed-price tasks where project definition is high. On average, just the opposite is occurring. This suggests that DOE's prime contractors (M&Os and A&Es) are attempting to shift project risk to subcontractors through fixed-price arrangements. This strategy would tend to result in higher cost growth on fixed-price tasks.

DOE CONTRACTING STRATEGY INAPPROPRIATE TO LEVELS OF PROJECT DEFINITION*

*Includes both ER and WM projects.

*Excludes UMTRA projects.

DOECONT6.DRW

PROJECT MANAGEMENT: FIXED-PRICE CONTRACTS HAVE MORE COST GROWTH

EM projects experience greater cost growth than private sector projects. Among the sample of EM environmental projects, fixed price remedial action tasks result in significantly more cost growth than DOE's cost reimbursable arrangements.

From the previous page, fixed-price projects were associated with lower levels of project definition. Hence, it is not surprising that fixed-price projects realized the greatest levels of cost growth. Change orders associated with fixed-price work were substantial. Related to the issue of change orders is the degree of control the M&O or DOE may have over the work performed by an on-site A&E firm (or other contractor).

DOE CONTRACTING STRATEGY FIXED PRICE CONTRACTS HAVE MORE COST GROWTH

PROJECT MANAGEMENT COSTS FOR ER/WM PROJECTS: DOE HAS HIGHER PROJECT MANAGEMENT COSTS

EM's poor cost performance is attributable, in large part, to the extraordinarily high management costs charged by the M&O and on-site A/E contractor. EM project management costs are more than double other government agencies' project management costs, and nearly four times greater than the amount spent by the private sector. In most DOE projects, project management functions such as contract development and administration and construction supervision were divided between the M&O and an on-site A/E firm. This "layering" effect has resulted in redundancies and unnecessary administration costs.¹ It should be noted that DOE project management costs are not being artificially raised by differences in accounting methods. For example, the DOE project management costs shown below exclude many of the costs for installation service and landlord functions such as security and grounds maintenance that are not generally included with the private sector or other government management costs. Project management definitions for different organizations are listed below.

Project Management Definitions

1. Private sector project management refers to owner costs for construction supervision, QA/QC, contract administration, project office operations, regulatory interaction, closure, and certification reports.
2. Other government primarily refers to the U.S. Army Corps of Engineers S&A costs. S&A includes the costs for performing supervision and inspection (S&I) plus applicable district overhead (OH). Over 80% of S&A costs are for salaries and wages, including benefits, e.g., the government portion of health insurance premiums. The remainder is for miscellaneous costs such as travel, Title II, rentals of offices and vehicles, non-construction supplies and materials, utilities, transportation, communication services, contractual services, training and other distributive costs.
3. DOE costs represent management costs charged to the project by M&O and on-site A/E contractor. It excludes any direct DOE personnel costs and unrelated infrastructure cost components.

¹Also, it has been previously noted that higher M&O markups increase DOE project costs by 20 to 25 percent compared to U.S. Army Corps of Engineer managed projects. See *Interagency Review of the Department of Energy, Environmental restoration and Waste Management Program*, April 29, 1992.

Project Management Cost Comparisons:

*EM Costs are More than Double
Other Organizations*

* EM costs represent costs charged to project by M&O and On-site contractor.

PROJECT COSTS FOR WM PROJECTS

On average, the percentage of total cost spent on engineering for WM projects was comparable to the industry average. However, the allocation to project management for WM projects is nearly double that of industry.

The cost of equipment as a percentage of total cost is much less for DOE WM projects than for industry. This difference is partially explained by the high percentage of construction projects in our sample. Construction projects do not require the procurement of major equipment. The average cost of equipment for the non-construction WM projects is 14 percent. The remaining costs (construction, labor, bulks, etc.) are slightly larger than the industry average.

Breakdown of Project Cost By Activity WM Projects

Engineering

Project Management

Equipment

Other (Labor, Bulks,
Lump-sum contracts)

*Percentages calculated in constant \$

BEST PRACTICES

The following charts summarize the extent to which the DOE EM project systems adhere to sound project practices. This information is based on both quantitative analysis as well as qualitative evidence derived from project team interviews.

Best Practice--Project System Inputs

Industry Best Practices

**COORDINATION WITH REGULATORS AND
OTHER INTERESTED PARTIES**

PROJECT MANAGEMENT PRACTICES

Centralized Project Management

Project Manager Accountability

**Performance Incentives for Project
Team or Key Individuals**

Minimize Project Manager Turnover

Dedicated Project Team

Professional Project Manager Career Track

**Effective Allocation of Management
Resources**

Standard Practice by EM

Varies by site. On average, regulatory impacts are occurring late in EM project life cycle. EM is improving over time, like other owners.

Frequent use of multiple prime contractors & dispersed authority. Authority is not always commensurate with responsibilities.

Depends on project. Accountability not always enforced.

Not used.

EM projects have a higher turnover rate.

Team members typically assigned to multiple projects which create priority conflicts.

Yes, but many EM and M&O construction managers lack formal project manager training.

Frequent duplication of efforts and excessive management costs.

Best Practice--Project System Inputs

Industry Best Practices

CONTRACTING STRATEGY ALIGNED WITH LEVEL OF PROJECT DEFINITION

WELL DEFINED PROJECTS AT AUTHORIZATION

Major Functional Groups Included in Project Definition Phase.

Standard Guidelines for Establishing Budget Estimates

Standard Risk Setting Guidelines for Setting Contingencies

Incorporating Lessons Learned from Past or Parallel Projects

Value Improving Practices

Understanding of Site Technical Parameters (geotechnical investigations, fate and transport modeling)

Standard Practice by EM

Fixed-price tasks have worse project definition than cost reimbursable tasks. This result is opposite industry best practice.

Varies by project. On average, less frequent inclusion of all groups (operations).

Yes, but frequently not followed and varies greater by installation.

Depends on project team and estimator. Not always used. Contingencies not set according to project risk.

Depends on project team and project manager. No formal process for sharing lessons learned.

Used less often than Other Government or Private Sector Owners.

Less thorough than Other Government or Private Sector Owners. Assessment activities not well integrated with cleanup/construction phase.

Best Practice--Project System Inputs

Industry Best Practices

Standard Practice by EM

WELL DEFINED PROJECTS AT AUTHORIZATION continued

Well defined project planning
(schedules, critical path analysis, etc.)

Less comprehensive relative to Other
Government or Private Sector Owners.

DEFERRAL OF AUTHORIZATION UNTIL ALL
NECESSARY REVIEWS ARE RECEIVED.

No.

OUTLINE

- APPROACH
- DATA
- DRIVERS OF SYSTEM PERFORMANCE
- **PROJECT SYSTEM OUTCOMES**
 - Remedial Action Costs for ER Projects**
 - Remedial Design Costs for ER Projects**
 - Project Schedule Duration**
 - Project Schedule Slip**
 - Importance of Predictability**
 - Cost Growth Comparisons for ERWM**
 - Project Definition and Contingency Requirements**
 - Project System Performance Summary**
 - Project Performance Trends Over Time**
- CONCLUSIONS AND RECOMMENDATIONS

REMEDIAL ACTION COSTS FOR ER PROJECTS

CONTROLS FOR PROJECT COSTS

EM ER project costs are compared to ER projects executed by others on a consistent basis. For example, the analysis controls for differences in the following project factors:¹

- Estimated volume of waste
- Remedial Technology
- Contaminated media
- Classes of contaminants
- Tasks included in the project

The influence of these factors on costs is straightforward. Greater quantities of waste increase remediation costs. In addition, costs are also highly dependent on the remedial technology employed. For example, the model calibrates for the cost differential between incineration, stabilization, soil washing, bioremediation, capping, excavation and disposal, and various groundwater treatment technologies. The model also takes into account the cost impacts of different types of media present and contaminants that have to be treated.

The industry average for a given project is derived from the database after controlling for all these factors. The industry average is used in creating the performance index described in the following charts.

¹The soundness of this approach for comparing remedial action costs was confirmed by a DOE Peer Review panel in 1991. See *Report of the HAZRISK® Peer Review Panel*, American Association of Cost Engineers, Morgantown, WV, December, 1991.

Controls for Project Costs

REMEDIAL ACTION COSTS FOR ER PROJECTS

ER COST PERFORMANCE IS POOR

On a comparable basis, ER project costs are significantly higher than either other government organizations or the private sector. By dividing the actual remedial action cost by the industry average for a given project, the **Cost Performance Index** is obtained. Overall, ER projects cost 32 percent more than the private sector for comparable projects. Compared to other government organizations, DOE spends 15 percent more. If UMTRA projects are excluded, ER cost performance looks even worse. For non-UMTRA projects, ER spends 44 more than the private sector and 25 percent more than other government agencies on remediation projects.

It should be noted that these cost comparisons are being made on a project level basis to ensure "apples-to-apples" comparisons. The project cost data used for this analysis include both the direct and indirect costs charged to the project. The indirect costs are defined as the M&O and/or on-site A/E project management and contract administration costs. Both the private sector projects and the other government projects in the database include these type of management costs.

In addition, the results are not being skewed by differences in cost collection or reporting methods. For example, the ER project costs do not include any federal employee costs and support or unrelated infrastructure costs. Also, the projects exclude the costs of any federal DOE personnel. In essence, the cost analysis treats the M&O and/or onsite A/E as the "owner" for comparison purposes. Analogous costs for Superfund projects would be the U.S. Army Corps of Engineers SIOH (Site Inspection and Overhead) costs. If DOE costs were included, their comparative cost performance would be poorer.

ER Cost Performance: DOE Projects Cost More

REMEDIAL ACTION COSTS FOR ER PROJECTS

ER COST PERFORMANCE IS UNRELATED TO WASTE TYPE

The ER projects can be categorized into three waste categories:

1. Hazardous Chemical Waste;
2. Low-Level Radioactive Waste¹;
3. Mixed Waste².

It should be noted that none of the ER projects were characterized by high-level radioactive waste and that none of the Mixed Waste or LLW projects employed treatment technologies. In most cases, the waste is being removed and stored at a Temporary/Storage/Disposal facility at the installation. There is essentially no difference in the cost performance between the three types of projects. These results demonstrate that ER's poor cost performance is attributable to factors other than the presence of mixed or low-level waste.

It should also be noted that the cost differential between ER projects and other projects in the database is not a function of differences in clean-up levels. Additional cleanup levels primarily result in disposing of or treating more waste. While many ER projects may, in fact, adhere to stricter cleanup levels, any added cost is being controlled for by the direct estimating model. In any case, the overwhelming majority of ER projects in the study sample use excavation and containment technologies. For these projects, waste is being either removed, stored, or capped. As a result, there is little opportunity to incur added costs due to tougher treatment standards.

¹Radioactive waste not classified as high-level waste, transuranic waste, spent nuclear fuel, or by-product material.

²Waste containing both radioactive and hazardous components, as defined by Atomic Energy Act and RCRA.

ER Project Cost Comparisons:

No Significant Differences by Waste Type

REMEDIAL DESIGN COSTS FOR ER PROJECTS

The chart below shows the amount spent on remedial design as a percentage of the remedial action cost. On average, DOE spends about the same (13%) as the Private Sector (14%) and slightly more than Other Government agencies (11%). The results must be examined with caution. "High" engineering costs are generally associated with two types of projects: a) poor projects characterized by extensive recycling of engineering work due to changes, and b) projects where engineering costs were investments, resulting in significantly lower overall project costs. The ER project systems are somewhat unique in that the relatively high engineering costs are primarily a function of redundancy in design efforts by the M&O and on-site A/E.

Remedial Design Cost Comparisons

PROJECT SCHEDULE DURATION

It can be difficult to compare the amount of time required to bring projects from start to finish. Projects are of differing size, complexity, difficulty, etc. In this section, EM project schedules are compared to other government and industry after controlling for differences in key project characteristics. For ER projects, the analysis controls for the following factors:

- *Project cost*
- *Remedial technologies*
- *Classes of contaminants*
- *Contaminated media*

The analysis of WM project schedules controls for the following factors:

- *Project cost*
- *The level of project definition at authorization*
- *The percent of cost associated with unproven technology*
- *Whether the process employs a raw solid feedstock*
- *The number of impurity problems*

The industry average for a given project is derived from the database after controlling for the above mentioned factors. The industry average is used in creating the performance index described in the following charts.

PROJECT SCHEDULE DURATION DOE PROJECTS ARE LONGER THAN INDUSTRY AVERAGES

By dividing the actual elapsed time by the predicted time and multiplying by a hundred, we get the **Schedule Duration Index**. The comparison of the index is shown below. DOE's EM and WM projects require 22 percent more time than would be typically expected for projects of their characteristics; that is their index value is 122. The average private sector project is the baseline measurement and has an index value of 100 compared to 101 for other government ER projects. The Best projects require only 75 percent of the time needed by the private sector or other government agencies. The performance of EM WM projects has been quite poor. They required over 50 percent more time than comparable capital projects executed by the private sector.

Schedule Performance: DOE Projects Are Longer

PROJECT SCHEDULE DURATION

EM WM PROJECTS ARE MUCH LONGER THAN INDUSTRY

In the graph below is a comparison of the cycle time for EM WM projects with the industry and the "Best" projects. All groups are controlled for size and technical difficulty to allow for valid comparisons. As shown, EM Waste Management projects require more than seventy percent more time on average than similar industry projects to complete the detailed engineering and construction phase of the project (through mechanical completion). The WM average time for engineering exceeds the industry average by more than fifty percent. Twice as much time is required for construction alone.

The overlap between detailed engineering and construction is also twice that of industry. Overlap between engineering and construction often means that the construction schedule will be driven by the availability of drawings. Typically, the greater the overlap, the greater the delays and inefficiencies in construction.

Project Execution Times

WM Project Execution Times Are Much Longer Than Industry

PROJECT SCHEDULE SLIP

The performance measure Schedule Slip is an indication of the accuracy of the estimated schedule. It is measured in terms of actual slip and relative slip.

Actual schedule slip is measured in months and is calculated as follows:

$$\text{Actual Slip} = \text{Actual Months} - \text{Planned Months.}$$

Relative schedule slip is a percentage and is calculated as follows:

$$\text{Relative Slip} = \text{Actual Months/Planned Months.}$$

Schedule slip was analyzed for ER and WM projects separately. The chart on the following page shows schedule slip from project design through construction completion. EM ER projects experienced an average slip of 42%, or 4.5 months. Non-UMTRA ER projects experienced an average slip of 50% while UMTRA projects experienced an average 31% slip. This is fairly low compared to the WM projects which experienced significantly more schedule slip. On average, the six WM projects analyzed experienced a slip of approximately 10.5 months, or almost 100%. It must be noted however, that these results are somewhat skewed due to two WM projects which had schedule slips of 250% and 300% each. The median slip for the WM sample was 18%, which is comparable to the industry's average of 16%. In terms of months, WM's average slip of 10.5 months is much higher than the industry (2.5 months). Note, industry averages are not available for ER schedule slip comparisons.

In summary, EM's ER and WM projects are taking 40-100% longer than estimated. Combined non-UMTRA ER and WM projects slipped on average by 69 percent.

EM Project Schedule Slip

EM Projects Slip Considerably

Relative Schedule Slip, %

Relative Slip = Actual Schedule/Planned Schedule

Actual Schedule Slip, Months

Actual Slip = Actual Months - Planned Months

Notes: Industry averages not available for ER projects.

ER results include UMTRA projects.

PROJECT SCHEDULE SLIP BY PROJECT PHASE

Relative schedule slip is shown below by project phase. Both ER and WM projects consist of a design phase and a construction, or action phase. The total represents the schedule slip from start of design work through construction completion.

The remedial design phase for ER projects slipped approximately 75%, while the remedial action phase slipped 38%. Total schedule slip for ER projects is approximately 42%. For WM projects, the engineering phase slipped approximately 48%, while the construction phase experienced a much larger schedule slip, 153%. Total schedule slip for WM projects is almost 100%.

Unanticipated events, such as changes in environmental regulations or scope changes, can have a tremendous impact on project schedule. However, this was not the case for the EM projects in our sample. None of the projects included in the analysis were impacted by unanticipated events, as defined above. For the EM ER and WM projects, reasons for schedule slip include:

- 1) Inexperienced project teams unfamiliar with environmental regulations, such as permitting requirements,
- 2) Design errors and resulting changes,
- 3) Poor project definition, for example little knowledge of essential geotechnical information,
- 4) Project team turnover, and
- 5) Contracting issues.

Although it is not possible to determine how much of the total schedule slip is attributable to each of these factors, improving performance in these areas will result in improved schedule performance.

EM SCHEDULE SLIP BY PROJECT PHASE

WM Projects Slip More than ER Projects

WM statistics are based on 6 WM projects.

IMPORTANCE OF PREDICTABILITY

Predictability in a project system is important. A predictable project system aids in determining the economic viability of projects by estimating accurate project costs. It provides management with a solid basis for determining project feasibility. Failure to predict project cost and schedule accuracy erodes the rationality of the planning process and, in some cases, leads to the selection of projects that are infeasible.

This section examines the predictability of the EM project systems. The basis for estimating cost contingencies and the predictability of the ER and WM cost contingencies are discussed.

IMPORTANCE OF PREDICTABILITY

- Predictability is essential to the success of the planning function: if estimates are correct, then resource and funding allocations will be in line with expectations

Effects of low initial estimates:

- Resources "taken" from other projects due to unplanned cost increases
- Schedules stretched because of inefficiencies in the project planning process
- Implication of out-of-control project systems

Effects of initial over-estimates:

- Expanding scope and costs to meet available budget
- Other projects not initiated because of perceived lack of available funds
- Tying up unrequired resources

COST GROWTH COMPARISONS FOR ER/WM

The chart below shows the variation in cost growth for EM compared to other environmental restoration project systems and industry capital project systems.¹ Simply examining the average cost performance can mask wide variations in actual to estimate project costs. A great deal of variation in cost performance shows a project system that is not in control. This is problematic because the impact of changes to the project system cannot be predicted with any degree of confidence.

As the figure below shows, the DOE project systems are characterized by high average cost growth and a wide degree of variance indicating project systems that are not predictable. On average, ER and WM projects experienced cost overruns of 48 percent. More important, the variance in cost growth is wider for EM than for any other organization.

This poor performance is a function of the following factors:

- EM projects have a poorer level of project definition than projects executed by other government agencies or the private sector;
- Weak cost control;
- Unrealistic estimates; and
- Contingencies are not set according to project risks.

¹ For EM projects cost growth was measured as the ratio of the actual cost to the Title I or pre-detailed design estimate. Cost growth for other government and private sector projects was measured as the actual cost to the ROD (Record of Decision), or pre-design estimate.

Project Cost Growth Comparisons:

EM ER and WM Project Systems Have Higher Cost Growth

Cost Growth=Actual Cost/Estimated Cost 1992\$

PROJECT DEFINITION AND CONTINGENCY REQUIREMENTS

Cost contingencies cannot be accurately established for ER projects by a constant value or looking only at the project stage. Instead, the project characteristics with respect to their impact on the cost risk must be examined for each individual project. Industry experience has demonstrated that the most important of these characteristics is the level of project definition at the time of the estimate.

The chart below shows the effect of project definition in determining the level of needed contingency to prevent a cost overrun for remediation projects in the database. The figure shows that as the quality and level of definition improves the historically-required contingency decreases.

Effect of Project Definition on Average Contingency Requirements

EM CONTINGENCIES UNRELATED TO PROJECT DEFINITION

For this analysis, contingency is defined as any allowance that is intended to cover costs that remain unknown or unforeseen at the time the estimate is prepared within a defined project scope. Contingency is not intended to cover changes in project objectives outside a defined project scope.

The charts below shows that EM project contingencies (at the completion of remedial design) are not set on the basis of project definition. There is no relationship between the contingency included in the estimate and the level of project definition at the time of the estimate. Of the projects with good or best practical levels of project definition, contingency estimates range from 0 to 40 percent with no consistent pattern.

For the most part, EM contingencies have been and are currently being set by M&O policies, norms, or politics and not by project fundamentals. Underlying this phenomenon is the pervasive belief that project costs can be reduced by reducing contingencies. Forcing contingencies that are low relative to the inherent risks creates behavior on the part of project teams that is deleterious to the project system. Hidden contingency does indeed lead to higher costs. Realistic contingencies lead to lower costs. Realistic low contingencies lead to the lowest cost.

ER Estimated Contingencies Are Unrelated to the Level of Project Definition

EM ESTIMATED CONTINGENCY AND NEEDED CONTINGENCY

The chart below compares the level of contingency included in the cost estimate with the level of contingency required to prevent a cost overrun. In an ideal system, one where contingencies were perfectly commensurate with project risks, all of the contingencies included in the estimate would equal the amount needed to prevent an overrun. This chart includes both ER and WM projects (for which contingencies were identifiable) and shows that there is no relationship between the estimated and needed contingency. It is also important to notice that the estimated contingency ranges from 0% to 40%, while the level of needed contingency ranges from -35% to 130%. This demonstrates that the magnitude of cost growth varies greatly from what is expected.

EM Estimated Contingencies Are Unrelated to Needed Contingencies

CONTINGENCIES CAN BE RELATED TO CHARACTERISTICS

In order to determine whether EM contingencies are predictable by project characteristics, IPA correlated the predictions from historically-based contingency allocation models with the actual needed contingency to prevent a cost overrun. The contingency models were applied for both ER and WM projects. The 45° line represents a perfect relationship: if the models exactly predicted the needed contingency, then all points would lie on this line. While there are large variations in several cases, the contingency models provide a good understanding of project risks and the potential for cost overruns and underruns.

The purpose of this analysis is to demonstrate that the needed contingencies are related to basic project characteristics. Proper analysis of project characteristics, even early on in the project cycle, would be able to achieve a much greater level of accuracy in setting project contingencies.

Why is this important? Setting the cost contingencies incorrectly costs money. Setting a high contingency relative to its likely need can waste money. Setting a contingency too low can also lead to wasted money by eroding cost discipline. Undesirable scope reductions and failures to adopt desirable design improvements can also result.

EM Cost Contingencies Can Be Determined by Project Characteristics

DOE EM PROJECT SYSTEMS PERFORMANCE SUMMARY

The DOE EM project systems have produced poor results in terms of cost and schedule. EM projects costs significantly more than either other government agencies or the private sector. EM projects require 22 percent more time than comparable private sector or other government projects.¹

EM also has poor cost and schedule control. EM projects have experienced an average cost overrun of 48 percent. This compares to an average cost overrun of 28 percent for other government and for private sector ER projects. EM ER and WM projects also slip their schedule by 52 percent compared to 16 percent for private sector capital projects.

The EM project systems have some unique characteristics when compared to the private sector and other government project systems represented in the IPA industry databases. In essence, the EM project systems are a collection of independent project systems run by the various M&O contractors. For the most part, actual DOE input and supervision on the projects evaluated was minimal. The project teams, consisting of M&O and/or on-site A/E employees, executed the projects according to the procedures and practices of their respective firms, which vary across the DOE complex. It is important to note that the analysis of the EM ER and WM systems is not being skewed due to poorly executed projects at a few installations.

¹ Differences in performance measures between DOE EM and the private sector are all statistically significant at least at the 0.01 level. Differences in performance measures between DOE EM and other government agencies are all statistically significant at least at the 0.05 level.

Summarizing Project Outcome Measures

ER COST PERFORMANCE

Private Sector
Average
= 100

COST OVERRUN

Average cost
overrun
(in percent)

SCHEDULE PERFORMANCE

Private Sector
Average
= 100

SCHEDULE SLIP

Average schedule
slip
(in percent)

1. THE BEST includes those projects with superior performance in all categories.

PROJECT PERFORMANCE TRENDS OVER TIME

EM's cost performance has remained constant over time. As shown in the next figure there is no relationship between cost performance and start year of project. This result suggests that the EM ER and WM project systems will have to make some fundamental changes in practices and procedures to reduce the cost differential between itself and other organizations.

Cost Performance:

EM ER Cost Performance Has Remained Constant Over Time

PROJECT DEFINITION NOT IMPROVING OVER TIME

As project systems mature, it is expected that project definition improves over time. As has been shown by previous charts, good project definition is fundamental for project systems to meet their goals. However, as the chart below indicates, there has not been any such relationship for the EM ER project system. While this project system is fairly new (as are almost all remediation project systems), it was hypothesized that there would be a significant increase in project definition in the past several years. This hypothesis was based on the 1990 creation of the EM organization and the recent increased attention that is being placed on remediation projects. The analysis indicates that this conjecture was incorrect--over the past ten years, there has been no improvement in the level of project definition for ER projects. In fact, there is a statistically-significant trend (at the 0.03 probability level) of declining project definition.

Quality of ER Project Definition May Be Declining

OUTLINE

- APPROACH
- DATA
- DRIVERS OF SYSTEM PERFORMANCE
- PROJECT SYSTEM OUTCOMES
- **CONCLUSIONS AND RECOMMENDATIONS**

CONCLUSIONS -- PROJECT OUTCOMES

The EM project systems are failing to produce adequate results. EM project outcomes rank below other organizations in both the environmental restoration (ER) and waste management (WM) sectors. The project systems show no improvement over time (1984 to present).

COMPARABLE ER PROJECTS

Comparative System	On a Percentage Basis ER Projects Cost More	On a Percentage Basis ER Projects Take Longer
Private Sector	32%	18%
Other Government	15%	17%

COMPARABLE WM PROJECTS¹

Comparative System	On a Percentage Basis WM Projects Have More Cost Growth by:	On a Percentage Basis WM Projects Take Longer by:
Private Industry	44%	52%
Industry "Best"	61%	103%

¹ A sample of seven projects was used to characterize EM WM projects.

CONCLUSIONS -- CAUSAL FACTORS

WEAKNESSES OF THE EM PROJECT SYSTEMS

Project Definition

- Few, if any, standard practices are used for establishing well defined projects.
- Not using the pre-design phase to develop well defined projects.
- Major design changes and regulatory impacts occur more frequently in the later stages of a project's life-cycle, relative to industry or other government.
- Cost contingencies are not related to the degree of project risk.

CONCLUSIONS -- CAUSAL FACTORS

WEAKNESSES OF THE EM PROJECT SYSTEMS

Project Management

- The system appears to have reactive, not proactive, project management.
- No complex-wide project management system controlling and tracking projects on a comparable basis.
- No formal process of sharing "lessons learned" across projects and installations.
- Few dedicated project teams. Team members support multiple projects at the same time which creates priority conflicts.
- EM project teams experiences more M&O project manager turnover.
- Project management costs are excessive due, in part, to duplication of efforts.

CONCLUSIONS -- CAUSAL FACTORS

WEAKNESSES OF THE DOE PROJECT SYSTEMS

Contracting Strategy

- Contracting strategy is not aligned with project risks and/or degree of project definition. Fixed price contracts are used for poorly defined tasks and cost-reimbursable terms are used for better defined tasks.
- Cost growth is greatest on fixed-price tasks and the management of change orders is difficult due to decentralized management practices.
- The use of M&O contractors along with on-site A&E firms has further diluted project controls and accountability.
- Project teams have few incentives to ensure well defined projects due to cost-reimbursable contract support.

CONCLUSIONS

WHERE TO GO FROM HERE?

- The EM system is fundamentally sound as proven by its predictability. Project outcomes are directly related to known causal factors.
- Cost, schedule, and needed contingency are all predictable based on key technical and management characteristics.

FOCUS ON THE CAUSAL FACTORS AND IMPLEMENT STEPS FOR IMPROVEMENT:

- Improve project definition prior to the commitment, or authorization, of funds. **Is the project ready to go forward?**
- Improve project management by matching project responsibility with authority. Improve accountability by centralizing management functions and avoiding duplication of effort. **Who's decision is it?**
- Improve contracting strategy by aligning incentives with degree of project definition. **In case of mistakes, who's paying the bill?**

KEY RECOMMENDATIONS

- **OVERHAUL PROJECT DEFINITION PROCESS**
- **REFORM PROJECT MANAGEMENT APPROACH**
- **CHANGE CONTRACTING STRATEGY FOR EM PROJECTS**

OVERHAUL PROJECT DEFINITION PROCESS

- Establish a complex-wide process for defining EM projects in a uniform manner that accords with best practice and train project teams in these practices.
- Establish a project measurement program for tracking the quality of project definition for all projects.
- Hold project teams accountable for achieving well-defined projects prior to start of execution by means of the measurement program.

REFORM PROJECT MANAGEMENT CONTROL APPROACH

- Discontinue use of Activity Data Sheets as a project management tool. . Specific measures to make the project basis comparable, traceable, and measurable across the complex must be developed.
- Set quantitative goals for project systems improvement.
- Work with field offices to measure and monitor project system performance.

CHANGE CONTRACTING STRATEGY FOR EM PROJECTS

- Determine target number of Federal & contractor personnel necessary to perform essential owner functions for EM.
- Regain control of essential owner functions from the contractors.
- Set up contracting strategy according to project objectives and risks. Fixed-price contracts for well-defined projects, reimbursable for poorly defined projects.
- Enhance project controls and eliminate redundancy by avoiding the use of multiple prime contractors.
- Place accountability of Federal and contractor personnel for project performance at the project level.

APPENDIX

- GLOSSARY
- CORRESPONDENCE

GLOSSARY

Assessment	The quantitative and qualitative evaluation of site conditions, including contamination levels and volume of contaminated material. Also includes review of alternative treatment technologies.
Authorization	For ER projects it corresponds to the point in time, after completion of the Record of Decision (ROD), when funds are approved for remedial design and remedial action. For WM projects, it corresponds to the point in time when a company approves full-funding of a project for development.
The Best	A subset of projects from IPA's Environmental and Capital Project databases that experienced superior performance in all four major project outcome criteria; absolute cost, meeting the cost estimate, absolute schedule, and meeting the planned schedule.
Best Practices	Those practices found to produce superior performance in projects.
Cleanup	Actions taken to correct a release or threat of release of a hazardous substance that could adversely affect humans and/or the environment. The term is sometimes used interchangeably with the terms remedial action, removal action, response action, or corrective action.
Construction	For waste management projects, the phase following detailed engineering when the selected treatment is implemented and the required structure/facility is erected.
Contingency	A cost allowance within a defined project scope that is included in an estimate to provide a determined level of confidence that the estimate will not overrun due to unpredictable events.
Cost Growth	The ratio of actual cost to estimated cost and multiplied by 100. A ratio greater than 100 indicates a cost overrun, and a ratio less than 100 represents a cost underrun (or negative cost growth). A value equal to 100 indicates the project came in exactly on budget.
Cost Index Value	The absolute project cost relative to the comparable private sector project (private sector index = 100). For ER projects, the average private sector cost is determined from the database direct cost estimating model. The index value is calculated by dividing the actual cost by the private sector average cost. A value of 100 indicates the project's actual cost is equal to the model predicted cost for a comparable private sector project (greater than 100 indicates the project cost more, and less than 100 indicates the project cost less).

Environmental Restoration (ER)	Refers to those projects managed by the Office of Environmental Restoration (EM-40). The goal of these projects is to reduce and/or eliminate contamination that currently poses a risk to human health and safety.
Environmental Restoration and Waste Management, Assistant Secretary of - (EM)	DOE organization responsible for ensuring that potential risks to human health and the environment, posed by DOE's past, present, and future operations, will be eliminated or reduced to prescribed, safe levels. Areas of concentration include waste management, environmental restoration and technological development.
Project Definition	Front-End Loading: The process of defining a project prior to beginning detailed design. Project definition includes defining what will be done, how it will be done, who will do it, when it will be done, and what resources will be required to complete the project.
Hazardous Waste	As defined in RCRA, solid waste which because of its quantity, concentration, or physical, chemical, or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness, or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.
Industry Average	The average of projects included in IPA's Environmental Restoration and Capital Project databases. All references to Industry and the Environmental Restoration and Capital Project databases exclude the EM projects. The industry includes private sector companies, as well as government agencies other than EM.
Innovative Technologies	Treatment technologies considered innovative by EPA and discussed in <u>Innovative Treatment Technologies</u> , Semi-Annual Status Report (Fourth Edition), dated October 1992. Technologies include: ex situ and in situ bioremediation, chemical treatment, dechlorination, in situ flushing, in situ vitrification, soil vapor extraction, soil washing, thermal desorption, in situ air sparging, and contained recovery of oily wastes.
Mixed Waste	Contains both radioactive and hazardous components.
Performance Measurement	The comparison of an organization's performance with others executing similar projects to identify best practices that drive superior performance.
Performance Metrics	Specific measures which indicate the level of performance of the EM ER and WM project system. Examples of performance metrics include: cost growth, schedule slip, project definition, cost estimate basis, and project team quality.

PES	Project Evaluation System: IPA's capital projects database and associated set of calibrated statistical models. The database consists of over 900 projects from the oil, chemical, and mineral industries. From this database, analytical models have been developed to estimate contingency allowance, engineering and construction schedule, startup time and performance for capital projects.
Project	An action that eliminates or mitigates a release, a threat of a release, or an exposure pathway. Examples include: excavation and treatment of soils from a disposal area; installation of an air stripping tower and extraction wells to treat contaminated groundwater; and construction of a waste management facility.
Radioactive Waste	A solid, liquid, or gaseous material of negligible economic value that contains radionuclides in excess of threshold quantities.
Remedial Action (RA)	For environmental restoration projects, the actual construction or implementation phase that follows the remedial design of the selected cleanup alternative.
Remedial Design (RD)	For environmental restoration projects, the technical analysis and procedures which follow the selection of remedy for a site and result in a detailed set of plans and specifications for implementation of the remedial action.
Schedule Performance Index	Calculated by dividing the actual elapsed time required for the project by the predicted time and multiplying by 100. A value greater than 100 indicates the project took more time than private sector projects with similar characteristics, and a value less than 100 indicates the project took less time. A value of 100 means the project took the same amount of time as similar private sector projects.
Schedule Slip	This metric, measured in terms of actual slip as well as relative slip, is used to determine the accuracy of the estimated schedule. The actual slip is measure in months and is calculated as follows: Actual Months - Planned Months. Relative slip is calculated as follows: Actual Months/Planned Months and multiplied by 100. A relative schedule slip greater than 100 indicates a schedule overrun, and a relative slip less than 100 indicates a schedule underrun. A relative schedule slip of 100 indicates the project was completed on schedule.
Waste Management (WM)	Refers to those projects managed by the Office of Waste Management (EM-30). These projects focus primarily on the treatment, storage and disposal of radioactive, hazardous, mixed and sanitary waste generated at DOE sites.

United States Government

Department of Energy

memorandum

DATE: JUL 30 1993

REPLY TO
ATTN OF: EM-24

SUBJECT: Project Performance Metrics Study Data Collection

TO: Distribution

Mr. Thomas P. Grumbly, Assistant Secretary for Environmental Restoration and Waste Management, requests your assistance in collecting data to support the Project Performance Metrics Study. The attached memorandum describes the EM Functional Cost Reduction Initiative which includes establishment of a performance measurement system for environmental restoration and waste management activities. Your support is needed to facilitate the data collection and to have the cognizant project manager(s) available to answer questions about the projects. Please identify your points-of-contact to Vincent Fayne at (202) 586-0126 by August 3, 1993. Your full support is urgently needed to meet Mr. Grumbly's due date for completing the study by November 1, 1993. Attached is a list of projects for which we need your help in acquiring the relevant data.

This study will be conducted in the following phases:

1. **Orientation and Preparation - Four weeks (August 2nd - August 27th):** During this phase the Operations offices are contacted and points-of-contact are designated. The sample of projects for the study is finalized and data collection trips and project team interviews are arranged. To conduct this study, our support contractor, Independent Project Analysis (IPA), will utilize standardized data collection worksheets that will be provided to all points-of-contacts for the project selected. These worksheets facilitate data collection and ensure consistency. We ask that, when available, supporting documentation describing the project also be provided. Typically, a worksheet takes about one day to complete provided that the information is available. We will collect and complete the worksheets from the relevant points-of-contact during the project team interviews.
2. **Data Collection and Normalization - Four weeks (August 30th - September 24th):** Data collection worksheets are filled out and project team interviews are conducted at DOE facilities. The participants during the project interviews will vary depending on their availability. Ideally, IPA would like to meet with the project manager (DOE and Contractor), the estimator or project engineer, and operating representative. If the project manager is unavailable, other key participants such as key supervisors are feasible alternatives. In past studies, the number of participants ranged from as few as two to as many as five people. The interviews should take no more than four hours.

Project team members should be prepared to discuss the following types of questions as they relate to their projects:

- A. General information regarding project locations, cost and schedule, changes in project scope, government regulations, and other external factors that might have affected project performance.
- B. Information about the technologies used in the projects and the level of technical innovation.
- C. Project management activities including contracting strategy, the amount of experience and turnover in the project team, and the participants in front-end loading and contingency analysis.

It is recommended that interviewees bring with them to the meeting any information or documentation that might help address these questions and provide insight into a project's performance. These include project progress reports, baselines, memorandums, original and supplemental estimates, and project completion reports.

- 3. **Analysis - Four weeks (September 27th - October 22nd):** Using IPA existing database and the updated DOE database, we will measure DOE's performance on a series of key project metrics.
- 4. **Product Preparation and Delivery (Week of October 25th - October 29th):** Prepare a written draft report and a briefing on the results of the study.

Thank you for your cooperation and assistance. If you have questions, please contact Kay Wohl at (202) 586-0381 or Vincent Fayne at (202) 586-0126.

Randal S. Scott
Deputy Assistant Secretary
for Oversight and Self-Assessment

Attachments

cc:
K. Klein, EM-3
J. Werner, EM-4
K. Wohl, EM-24
D. York, IPA

Distribution of Memorandum dated JUL 9 0 1993 :

C. Lewis, EM-10
J. Lytle, EM-30
R. Whitfield, EM-40
C. Frank, EM-50
W. Bixby, EM-60
J. Bickel, AL
D. Dashevsky, CH
R. Hansen, FN
T. Burns, ID
J. Fiore, NV
W. Adams, OR
J. Wagoner, RL
J. Hartman, RF
J. Davis, SF
L. Sjoström, SR

United States Government

Department of Energy

memorandum

ATTACHMENT I

DATE: JUL 28 1993

REPLY TO
ATTN OF: EM-20 (Fayne:6-0126)

SUBJECT: Implementation of EM Functional Cost Reduction Initiative

TO: Distribution

I am committed to an initiative which will achieve substantial cost reductions and productivity improvements within the Office of Environmental Restoration and Waste Management (EM). I have repeatedly stated this objective in hearings before congressional committees and in other public statements. This will only be successful if we work as a team. To assure our success, I have asked Randal S. Scott, EM-20, to form a task force. He has designated Vincent Fayne to be the task force leader.

Please name a senior representative from your organization to participate in this activity. For each of the cost reduction candidates on the attached list (or others as identified by the task force) targeted cost savings and plans for achieving these goals must be developed by September 7, 1993.

The second item on the attached list is especially important to me; it will establish a performance measurement system for environmental restoration activities. This system will be built on data collected from 15-20 projects at DOE field sites over the next 8-10 weeks. Performance measurement systems for other activities will be developed after this initial project. I am directing that the staff and field counterparts support and assist this effort which is critical to the success of this activity.

We have an opportunity to strengthen EM's management and cost control capability. We must work together across program lines to find more efficient ways of doing business.

Please contact Vincent Fayne with the name of your representative by July 29, 1993, and be prepared to meet the week of August 2, 1993.

Thomas P. Grumbly
Assistant Secretary for Environmental
Restoration and Waste Management

Attachment

Distribution of Memorandum dated: 7/28/93

L. Lewis, EM-10
R. Scott, EM-20
J. Lytle, EM-30
R. Whitfield, EM-40
C. Frank, EM-50
W. Bixby, EM-60

cc:

J. Werner, EM-4
D. Waldrop, EM-4
E. Livingston, EM-5
R. Gibson, EM-12
E. Bronstein, EM-13
R. Aiken, EM-14
C. Guidice, EM-20
L. Vaughan, EM-20
M. Kleinrock, EM-22
O. Thompson, EM-23
H. Dalton, EM-25
L. Harmon, EM-32
J. Turi, EM-33
M. Frei, EM-34
J. Coleman, EM-35
J. Tseng, EM-36
J. Jicha, Jr., EM-37
J. Fiore, EM-42
W. Wisenbaker, EM-43
S. Mann, EM-44
R. Lightner, EM-45
G. Voelker, EM-50
T. Evans, EM-50
S. Prestwich, EM-52
G. Boyd, EM-53
S. Lien, EM-54
K. Hain, EM-55
G. Boyd, EM-56
D. Smith, EM-62
L. Claytor, EM-63
L. Smith, EM-64
J. Bickel, AL
O. Dashevsky, CH
R. Hansen, FN
T. Burns, ID
J. Fiore, NV
W. Adams, OR
J. Wagoner, RL
J. Hartman, RFO
J. Davis, SF
L. Sjostrom, SR

COST REDUCTION CANDIDATES

1. WELL INSTALLATION PROJECTS

The Hanford and Nevada Sites estimate that they will spend approximately \$1.2 Billion for various well projects over a ten year period. A survey is being conducted to analyze factors that could reduce overall costs. **SAVINGS: TBD**

2. ESTABLISH A PERFORMANCE METRIC SYSTEM

A performance measurement system (i.e., report card) should be employed to measure select categories for Environmental Restoration activities and to target areas for cost reduction. **SAVINGS: TBD**

3. REVAMP THE PUREX/UO3 PLANT DEACTIVATION PROJECT

The annual maintenance and surveillance cost for these facilities is about \$50M/yr. A revised Safety Analysis Report with reduced operational safety requirements would reduce cost and be more cost-effective. **SAVINGS: TBD**

4. EXPENDITURES FOR MOBILE LABORATORIES

EM should consider using existing analytical or sampling equipment in other agency's surplus instead of purchasing new analytical or sampling equipment. **SAVINGS: \$3-4M**

5. HANFORD TANK FARM SAMPLING

Eliminate unnecessary analysis of "minor" constituents. At least half of the sample constituents analyzed for are either of negligible concern or their presence in the sample would not be reasonably expected. Data quality objectives have not been completed to address this issue. **SAVINGS: \$5-8M/yr**

6. REDUCE THE COST OF CONSTRUCTION PROJECTS

DOE appears to be paying a disproportionately higher cost for construction projects than other agencies or the private sector. The Idaho Operations Office has taken the lead in coordination with other Operations Offices to look at ways to reduce the cost of construction projects. Several sites have their own initiatives to reduce the cost of construction projects. EM should benefit from these cost reduction opportunities. EM-20 can help monitor cost savings. **SAVINGS: TBD**

7. CONSOLIDATE, CENTRALIZE, AND SIMPLIFY THE FOLLOWING AREAS

ADP: Eliminate duplicate tracking and database systems. Require all ADP type activities to be approved through central focal point.

BUDGET AND REPORTING: Avoid duplicative and conflicting guidance to field.

CONTRACTS: Consolidate support contracts and avoid duplicate developmental tasks. Maintain database of deliverables to allow visibility of work already performed.

TRAINING: Eliminate duplicate training activities.

ES&H: Avoid duplication and centralize the use of federal resources.

SAVINGS: TBD

8. CONDUCT VALUE ENGINEERING STUDIES ON ALL MAJOR SYSTEM ACQUISITIONS AND MAJOR PROJECTS

Assist field sites to acquire the capability within their prime contractors or independently to have value engineering studies performed. **SAVINGS:** TBD

9. CONDUCT INDEPENDENT COST ESTIMATES OF FIELD ACTIVITIES

Require DOE field sites to independently check a reasonable portion of all cost estimates prepared by their prime contractors.

SAVINGS: TBD

10. DEVELOP AND IMPLEMENT SYSTEMATIC REVIEW OF THE COST-EFFECTIVENESS OF EM ACTIVITIES

Help to assess whether products and services received by EM are comparable in value to the monies spent. Target high cost activities. **SAVINGS:** TBD

11. ANALYZE UNCLOSED OBLIGATIONS AND RESCIND UNOBLIGATED CARRYOVER

The Chief Financial Officer has initiated a system to have M&O contractors, field offices, and HQ program managers to certify that reviews of unclosed balances were performed and the results integrated into the budget formulation decision process. EM should develop criteria for defining what is considered acceptable "carryover" and perform a detailed analysis of contracts to identify potential savings. EM-10 has asked the field to reduce their unclosed obligations by \$88M. The independent assessment by the Contract Reform Team may generate greater savings. **SAVINGS:** TBD

12. CONDUCT COST BENEFIT ANALYSIS ON CODES, STANDARDS & REGULATIONS THAT EM MUST COMPLY WITH

EM should perform analysis of the public and worker safety benefits and environmental protection achieved by following the various regulations that we are required to comply with. SAVINGS: TBD

13. INDIRECT COST ANALYSIS

An analysis of the management and size of indirect costs being charged to the EM program needs be made. Management systems will require revisions to improve efficiencies and to reduce the size of the production related support activities. An EM-wide approach could be patterned after to the Indirect Cost Sub-team review. SAVINGS: TBD

ATTACHMENT 11

Candidates for Project Performance Metrics Study

#	Name	Description Status
1	AL: Sandia Livermore-Trudell	Complete
2	AL: Mound West Powerhouse PCB Removal Action	Complete
3	AL: Mound Miami-Erie Canal Remediation IRM	Complete
4	AL: Pinellas-Neutralization Facility Upgrade Construction	Complete
5	CH: Brookhaven-Detector Station Construction	Complete
6	Fernald: Amended Consent Removal Actions	Complete
7	INEL: Radioactive Soil Contamination at Test Reactor Area	Complete
8	INEL: Liquid Effluent Treatment and Disposal Facility	Complete
9	OR: Bear Creek RCRA Closures	Complete
10	OR: K-25 Site-Refurbishment of seven vaults in K-25 building	Complete
11	OR: ORNL White Oak Creek Embayment & Tank 7860A	Complete
12	OR: ORNL 3001 Storage Canal	Complete
13	OR: Portsmouth X-749 Closure	Complete
14	OR: Portsmouth X-235 Landfill Closure	Complete
15	OR: Weldon Springs Quarry Bulk Removal	Design/Construction
16	RF: OU 1 (881 Hillside)	Interim Measure/Interim Remedial Construction Complete
17	RL: Hanford-Construction of Effluent Retention Basins	Complete
18	RL: 300 Area Process Trenches	Complete
19	RL: 618-9 Burial Ground ERAs	Complete

20	RL: 183-H Solar Evaporation Basins	Complete
21	SF: LLNL Eastern GSA groundwater treatment unit	Complete
22	SF: LLNL Gasoline Spill Area	Complete
23	SR: Construction ITP Facility	Complete
24	SR: Construction of K-Reactor Cooling Tower	Complete
25	SR: Construction of Replacement High-Level Waste Evaporator	Complete
26	SR: M-Area Settling Basin	Complete
27	SR: Mixed Waste Management Fac. - 305-C	Dynamic compaction (waste stab). Construction completed 1990
28	SR: F&H Seepage Basin Closure 316 A	Complete
29	SR: A/M - Area Groundwater Remediation	Construction completed O&M ongoing

END

**DATE
FILMED**

31/2/94