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ACQUISITION RESEARCH SPONSORED REPORT SERIES

**An Analysis of Department of Energy Cost Proposal Process
and Effectiveness**

11 October 2011

by

Dr. Timothy Reed, Professor
Graduate School of Business & Public Policy
Naval Postgraduate School

Captain Sean Andrews
Graduate School of Engineering and Management
Air Force Institute of Technology

Captain David Youd
Graduate School of Engineering and Management
Air Force Institute of Technology

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Prepared for: Naval Postgraduate School, Monterey, California 93943



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Abstract

The legacy of World War II and Cold War weapons development and manufacturing is a monumental environmental cleanup program that is being managed primarily by the Department of Energy (DoE). This program has been consistently recognized for the challenges it faces in cost growth. Our research identifies the unique operational characteristics in which the program must be carried out. A model identifying remediation cost drivers is developed. A review of best practices from industry and Department of Defense remediation efforts identifies actionable opportunities from among identified cost drivers.

Keywords: cost type contracts, earned value management, acquisition planning, environmental remediation, cost proposal, contract proposal evaluation, risk, cost analysis



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Finally, I recognize the irreplaceable inspiration and understanding that I receive from my family on a daily basis.

Tim Reed



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About the Authors

Dr. Timothy Reed is a visiting professor at the Naval Postgraduate School, where he teaches master's courses in acquisition management and corporate entrepreneurship. He has also taught at the Air Force Institute of Technology (AFIT), where he created the Air Force Strategic Purchasing Graduate Degree Program and served as the director of the program for two years. In addition, he has taught at the University of Dayton, American University (Washington, DC), the University of Maryland (University College), and he has taught visiting seminars at the American University in Cairo, and Instituto de Empresas in Madrid. Dr. Reed retired after 21 years in the Air Force, where he held various assignments in contracting, including the F-22 (EWI), C-17, and Fighter Engine Systems Program Offices. He deployed as the director of Joint Contracting Command-North, Kirkuk, Iraq. He also served at the Pentagon as deputy chief, Procurement Transformation Division, Headquarters Air Force, where he was responsible for implementing strategic sourcing and commodity councils for the DoD and the Air Force. In his final assignment as commander, 325th Contracting Squadron, Tyndall AFB, FL, he was responsible for \$500 million in annual purchases in support of F-15, F-22 fighter aircraft, and Airborne Warning and Control System (AWACS) flight training. He earned a PhD in Strategic Management and Entrepreneurship from the University of Colorado and is a certified purchasing manager (C.P.M.) with the Institute of Supply Management.

Dr. Timothy Reed
Graduate School of Business and Public Policy
Naval Postgraduate School
Monterey, CA 93943-5000
Tel: 703-599-6696
Fax: (831) 656-3407
E-mail: tsreed@nps.edu



Captain Sean Andrews is a student at the School of Engineering and Management at the Air Force Institute of Technology. The research in this report is a partial requirement for completion of his Master of Science in Cost Analysis. He has served in the Air Force for four years as a financial management and acquisition officer. In his previous assignment he served as the Little Rock Air Force Base (LRAFB) financial services officer in the 19th Comptroller Squadron. As part of his duties, he participated in the LAFB utility privatization effort, acting as price team member; this effort led to successful source selection and potential savings in excess of \$25 million. He was the point of contact for economic analyses, and drafted the LRAFB Economic Impact Statement. Captain Andrews earned his BS in economics and political science at the United States Air Force Academy.

Captain Sean Andrews
School of Engineering & Management
Air Force Institute of Technology
Wright Patterson, AFB, OH 45433-7765
Tel: (937)-255-3636
Fax: (937) 255-2791
E-mail: sean.andrews@afit.edu

Captain David Youd is a student at the School of Engineering and Management at the Air Force Institute of Technology. The research in this report is a partial requirement for completion of his Master of Science in Cost Analysis. He has served in the Air Force for 15 years as a financial management and acquisition officer and as a maintenance technician. In his previous assignment he served as a comptroller for the United States Military Assistance Program at the U.S. Embassy in Amman, Jordan. Serving in this capacity he was responsible for Title 10 and 20 funds totaling \$12 million. Before that, Captain Youd served as deputy budget officer at Seymour Johnson AFB in the 4th Comptroller Squadron, where he was responsible for formulating, analyzing, and monitoring the installation operating budget totaling \$70 million. Captain Youd was the point of contact for all economic analyses and productivity investment funds. He earned his BS in management/accounting at Park University.



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I. Introduction

A. Overview

In the wake of World War II, the United States entered an era of major weapons systems development. Specifically, the U.S. rapidly expanded development and production of nuclear weapons systems. Since the 1970s, the Department of Energy (DoE) has assumed the responsibility of caretaker and remediator of Department of Defense (DoD) legacy weapons manufacturing sites. This responsibility includes removing, neutralizing, and/or monitoring nuclear and other hazardous wastes associated with processing nuclear materials. The DoE relies substantially on contractors to carry out this cleanup effort, making the DoE the largest non-defense contracting agency in the U.S. government. In 2009, the DoE managed nearly 200 remediation-related projects with a total value in excess of \$320 billion (Government Accountability Office [GAO], 2009). The magnitude of these efforts, combined with historically poor management and contractor oversight, landed the DoE's contract management on the General Accountability Office's (GAO) high-risk list for fraud, waste, and abuse in 1990 and continues today (DoE, 2011). For example, inaccurate initial cost estimating contributed to the DoE requesting an additional \$25 to \$42 billion to complete nine of 10 projects reviewed by the GAO in 2008 (GAO, 2009). Costs for many of these remediation projects continue to grow and inadequate record keeping has made an accurate estimate for many projects extremely difficult (Peters, 2010).

B. DoE Actions

The DoE initiated efforts to address GAO concerns. In 2008, the DoE completed a Root Cause Analysis (RCA) to identify problem areas and subsequently better focus its corrective action efforts. The results identified weaknesses in areas such as project planning, manpower and training deficiencies, inadequate contractor oversight, and insufficient acquisition strategies (DoE, 2008b; see Appendix A for a full list of the 10 weaknesses).



Following the RCA, the DoE developed a Corrective Action Plan (CAP) in July 2008. It called for eight corrective measures aimed to address the RCA. The CAP implementation satisfied three of the five GAO criteria for removal from the high-risk list, including demonstration of strong commitment and leadership, progress in implementing corrective measures, and development of a correction action plan that identified causes, solutions, and an implementation plan. Remaining open areas include obtaining adequate capacity, including personnel to resolve its contract management issues, and the monitoring, validating, and sustainability of the corrective measure (DoE, 2011; see Appendix B for the full CAP list).

C. Actions Remaining

The first remaining issue involves adequate staffing and development of skills involving cost estimating, risk management, and technical expertise. Second, the DoE must improve cost estimates for environmental remediation projects (DoE, 2011). The RCA was not specific in identifying which offices had cost estimating issues. The DoE, Office of Environmental Management (EM) took the proactive step by establishing the Cost Estimating Center of Excellence in 2007 (Messner et al., 2007). While establishment of the Center of Excellence resulted in improved cost estimating, challenges remain as EM continues to look for ways to streamline cost evaluations in an effort to accelerate contract award. Our research identifies opportunities to assist the DoE in the latter remaining open item.

D. Preview of Literature Review

We first review relevant literature to define environmental remediation. We then examine the major parties involved in federal remediation. After that, we explore community interests and regulatory framework. This foundation allows us to discuss the major federal laws that impact the remediation contracting environment. Next, we examine literature to gain understanding in how the DoE may differ from other federal agencies and industries. Following this examination, we look for literature on cost proposal requests and evaluation. Finally, we discuss cost proposal effectiveness and review the DoD cost-growth literature.



E. Direction of Future Research

This is an interim report. As our research proceeds, we intend to perform in-depth case studies into the DoE and the DoD remediation project requests for proposals, cost proposals, cost proposal evaluations, and effectiveness. EM recognizes the need to adapt practices to meet its unique requirements such as different regulatory requirements, increased complexity of clean up, and waste characterization because of the radiation and others hazards on sites. The goal is to benchmark DoD best practices and identify ways that the DoE may implement changes to improve its cost proposal processes. The primary objective is to identify procedures and practices that the DoE can implement to facilitate positive change in its cost proposal processes, thereby improving the overall DoE process and meeting one of the open requirements for removal from the GAO's high-risk list. In this report, we offer possible methodological approaches.

F. Purpose of This Study

This study explores the following research questions:

1. What are the government and private industry best practices regarding environmental remediation contracting, cost proposal request, and cost proposal evaluation?
2. What are the key observations regarding the DoE's cost proposal solicitation and cost proposal evaluation processes for environmental remediation contracting?
3. How effective are the DoE's current processes in providing an accurate cost estimate?
4. What policy recommendations can be proposed that may affect positive change to the DoE's cost estimations for environmental remediation projects?

G. Preliminary Findings

After speaking with DoE personnel from Washington DC, Lexington KY, and DoD acquisition professionals at the Air Force Center for Engineering and the Environment (AFCEE) and the Naval Facilities Engineering Command (NAVFAC)



we feel that although the DoD faces some of the same acquisition challenges, the EM challenge is unique. A promising option for DoE remediation is a two phased approach, which is discussed further in the AFCEE and NAVFAC sections later in this report. Two-phased contracting approaches have been highly successful strategies for the Air Force (AF) and Navy, and we recommend this strategy for further investigation and consideration for the DoE. This interim report is meant to lay the groundwork for explaining the reasons as to why two-phased contracting would be more effective, however it does not address the mechanics of that strategy.

H. Chapter Summary

The DoE faces a complex and daunting task in cleaning up America's hazardous nuclear waste legacy. The magnitude of the work, accompanied by the DoE's challenges in contract management and contractor control has landed the DoE on the GAO high-risk list. The DoE has undertaken painstaking analysis to identify and develop corrective actions in order to rectify contract management challenges. The focus of this research is to improve the DoE's cost proposal solicitation and evaluation processes.



II. Literature and Interview Review

A. Overview

The focus of this research is to provide observations and examination of the DoE proposal process. This chapter presents the relevant research, which establishes the foundation for our analysis. In Section B we define environmental remediation. In Section C we identify the major parties responsible for executing environmental remediation contracts. In Section D, we explain the importance of community interests in environmental remediation. Then in Section E we discuss how these interests bring about the current regulatory framework. In Section F, we discuss some of the major laws that govern federal remediation contracting. In Section G, we explain how DoE remediation projects differ from those of other agencies. In Section H, we highlight environmental remediation success stories. Next, we explore cost proposal requests and their evaluation. Then in Section I, we discuss cost proposal request and evaluation. Section J covers cost proposal effectiveness in terms of DoD cost growth. We discuss our initial observations in section K. Finally, in Section L, we provide preliminary research method proposals.

B. What Is Environmental Remediation?

Environmental remediation covers a broad range of activities involving the cleanup of contaminated soil and water, the restoration of ecological environments, the removal and disposal of hazardous materials, and the decommissioning of facilities used to produce, warehouse, or store hazardous and radioactive materials. The Environmental Protection Agency (EPA) provides the federal regulatory framework and enforcement to ensure that responsible parties make the necessary restoration after contamination, degradation, and detriment. The EPA enforces a wide range of regulations, but two main statutes govern federal remediation projects. As Momber (2005) wrote, “The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA) are the two primary environmental laws generally applicable



to federal remediation projects” (p. 11), which we discuss in greater detail in a later section.

As for the actual work that goes on in environmental remediation and restoration, it generally involves several distinct phases. In an Air Force report, Reardon (1992), outlined environmental remediation in the following way: the preliminary assessment/site inspection stage, the remedial investigation/feasibility study stage, the remedial design/action stage, and the site closure stage. For the site assessment phase, project personnel examine sites to determine whether they meet federal requirements for remediation. The remedial investigation phase requires evaluation of appropriate actions to remediate a site. The remedial design phase involves design of the remedial action determined in the remedial investigation stage. Finally, the site closure stage details the actions that project personnel take to close a site, which include documentation and communication (Reardon, 1992, pp. 1–5). Reardon explained, from a non-engineering perspective, two main remediation processes: removal of contaminated soil and groundwater, and monitoring of contaminated locations. The monitoring of sites typically occurs when contaminant risks are unknown (Reardon, 1992, p. 1-5).

Environmental remediation contracts require recognition of more stakeholders than other federal contracts. Typically, federal contracting officers consider contractors and government interests. Contracting officers who are tasked with environmental cleanup must satisfy a greater number of stakeholders. These include, but are not limited to, local population considerations, workforce interests, federal, state, and local regulators, and other political interests. For example, public perception of radiological contamination can entail major issues from a contracting and government perspective (Feldman & Hanahan, 1996). In Section C we identify the federal parties responsible for executing federal environmental remediation.

C. Who Are the Major Parties?

There are several players in the federal government tasked with environmental remediation. The DoE maintains a special mission within the federal



government regarding U.S. environmental challenges. According to the DoE, “The mission of the Energy Department is to ensure America’s security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions” (DoE , 2011). The program office for addressing the specific environmental challenges is the Office of Environmental Management (EM). According to the office’s website, its stated mission is “to complete the safe cleanup of the environmental legacy brought about from five decades of nuclear weapons development and government-sponsored nuclear energy research” (EM, n.d.). The EM’s role is to provide the necessary contract administration, oversight, and program management to ensure that contractors successfully complete contracted environmental cleanup. Over the last 10 years, the DoE has received approximately \$300 billion with one fifth of that going to environmental restoration and remediation. We generated reports in www.usaspending.gov for contracted work in the DoE and found that in FY 2010, the DoE received \$25.1 billion. EM receives an annual budget of approximately \$5 billion (EM, 2011).

While DoE is the only agency responsible for radioactive cleanup, it is not the only federal agency tasked with environmental remediation. The AF, Army, and Navy all have dedicated missions concerning environmental cleanup. In the AF, headquartered on Joint Base Lackland in San Antonio, TX, the AF Center for Engineering and the Environment (AFCEE) is responsible for creating and implementing environmental restoration and remediation services and policy. According to AFCEE, the mission of Environmental Restoration Program Optimization (ERP-O) is to “maximize the effectiveness and minimize the financial liabilities and environmental footprint of the AF restoration program through competent technical leadership and guidance” (Air Force Center for Engineering and the Environment [AFCEE], n.d.).

AFCEE is working under direction issued by the Assistant Secretary of the Air Force for Installations, Environment, and Logistics, Mr. Terry Yonkers to accelerate remediation site completion. Yonkers (2011) directed the accelerated completion of



90% of Base Realignment and Closure (BRAC) sites by 2015, and 75% of non-BRAC sites by 2015. Yonkers directed cleanup efforts to move away from process and study and toward entire installation completion results whenever possible by using Performance Based Remediation.

Interviews with AFCEE personnel indicated that they utilize a two-phase remediation contracting approach. In Phase 1, a remediation site analysis and plan are prepared. Phase 1 is normally completed under a Time and Materials (T&M) type contract. In a T&M arrangement the contractor is paid negotiated labor rates for the number of hours required to accomplish the work (usually capped by a ceiling) plus allowable reimbursable material expenses. Phase 2 of the process involves the execution of the plan prepared in Phase 1. AFCEE refers to Phase 2 as the construction phase and normally y uses a Firm-Fixed Price contract for lasting 24-48 months for Phase 2

In Phase 1, remediation study and project planning are contracted via task orders issued to contractors that have been pre-selected for participation on a Multiple Award Schedule (MAS). These 29 contractors have pre-negotiated labor rates, overhead, and profit with AFCEE for the contract period of performance. Individual tasks are competed amongst the MAS contractors' capacity; technical capacity; past performance; and location in proximity to the work. After selection, the contractor and AFCEE discuss labor and other direct costs and the government compares them to the government estimate for the task order requirement. The plans prepared in Phase 1 are executed in Phase 2, wherein the actual construction or physical remediation work is undertaken. Phase 2 work can be awarded to over 50 different contractors under three separate MAS arrangements. The first is a service based MAS; the second a construction MAS, and the third is a design/build/remediate/restore contract; which enables the accommodation of qualified small business contractors. AFCEE has achieved remarkable success in defining requirements and executing to plan by using the two-phase approach. One indicator of their success is that in three years of using the two-phase approach,



AFCEE has experienced only three requests from contractors for equitable adjustments (additional funds for work that is out of contract scope), which is a key functional metric for contracting organizations.

Similar to AFCEE, the United States Army Corps of Engineers (USACE) provide the Army, as well as state and local populations, comparable services. The USACE operates more independently and is decentralized in order for greater state and local integration. The USACE's mission is much larger than the AF because its tasks go beyond its Service agency. The USACE staffs 52 different centers of expertise, many with environment missions. The Environmental and Munitions Center of Expertise (EM CX) Directorate, located in Huntsville, AL, provides support for field offices executing environmental remediation:

The USACE environmental mission encompasses the restoration, management, and enhancement of local and regional ecosystems. This broad mission includes the restoration of sites contaminated with hazardous waste, radioactive materials and munitions and their constituents. The EM CX has played a vital supporting role in the identification and cleanup of contaminated defense and commercial sites throughout the Nation for the Department of Defense, the US Environmental Protections and various other federal agencies. The CX has used its knowledge to assist operating facilities in complying with environmental regulations, thereby reducing the legacy of contamination requiring future cleanup. The CX has also developed an integral role providing programmatic support to various customers. The overall success that the CX has had with these various activities can be built upon as the Nation's environmental programs continue to mature. (EM CX, n.d.)

Administration for the superfund sites vary by district and region. Different regions staff environmental offices that are responsible for environmental remediation. For example,

Our [Buffalo] district's primary missions include: Environmental Restoration and Protection, Regulatory Program, and Hazardous, Toxic, and Radiological Waste Site Management [to include the Formally Utilized Sites Remedial Action Program (FUSRAP), The Defense Environmental Restoration Program (DERP), Formally Used Defense Sites (FUDS)]. (Army Corps of Engineers [ACE] Buffalo, n.d.)



Created in 1974, the FUSRAP is tasked to

identify, investigate and clean up or control sites that were part of the Nation's early atomic energy and weapons program. Activities at the sites that are eligible for FUSRAP were conducted by the Manhattan Engineer District (MED) or the Atomic Energy Commission (AEC), both predecessors of the Department of Energy (DOE). (ACE Buffalo, n.d.)

The USACE maintains a close relationship with the DoE and the EM. DoE field sites, responsible for cleanup operations, sometimes solicit USACE support. Like the FUSRAP initiative, the DERP's role is to cleanup all DoD contaminated locations to include FUDS. The USACE's insights, with its history of DoD legacy site management and clean up along with its experience with federal contraction projects, are substantive.

In addition to the Army and AF, the Navy maintains a capability to conduct environmental remediation and restoration, the Naval Facilities Engineering Command (NAVFAC), headquartered in Washington, DC. Its mission is to “[deliver] and [maintain] quality, sustainable facilities, [acquire] and [manage] capabilities for the Navy's expeditionary combat forces, [provide] contingency engineering response, and [enable] energy security and environmental stewardship” (NAVFAC, n.d.). More specifically, NAVFAC defined its environmental mission as follows:

NAVFAC's Environmental Program provides high quality, timely, cost effective and efficient environmental support to the Navy, the Marine Corps, and other clients. Environmental management is the means of conserving, protecting and restoring the environment and natural and cultural resources for future generations. We offer sound environmental management and technical support necessary for Navy and Marine Corps compliance with federal, state, local and host nation regulations. (NAVFAC, n.d.)

NAVFAC uses a two-phase remediation contract strategy for projects in U.S. territories. The two-phase strategy is similar to that used by AFCEE. Phase 1 is known as “study side”. In Phase 1 NAVFAC issues stand-alone contracts using an evaluation process that allows them to first select the best technically qualified contractor and then negotiate labor rates and overhead with that contractor. Contractors are selected based on experience, key personnel, past performance,



and labor rates. A notable NAVFAC initiative in the proposal process is to significantly limit the number of pages of data that contractors may submit with their proposals. This initiative standardizes and reduces contractor proposal effort and cost, as well as the cost of government evaluation and audit.

Phase 2 or “clean-up side” remedial action contracts are issued through a mixture of MAS or single-contract actions. NAVFAC policy is to issue phase 1 and phase 2 contracts to different contractors so that there is no organizational conflict between the two contract phases.

NAVFAC is seeking to incentivize contractor performance by substantially limiting base fee (or profit), in some cases fee is limited to zero. Contractor profit is instead earned via award fee assessments that are limited to ten percent of target cost. Initial analysis of remediation contracting initiatives being undertaken in DoD organizations indicates that further investigation and identification of best practices is warranted and will be presented in a future report.

As the DoD restores environments it damaged from past and current operations, the AF, Army, and Navy face similar challenges as the DoE. Some challenges include complex laws and increased community interest (Momber, 2005). In addition, we have identified challenges with DoE proposal evaluation, acquisition schedule, and contract and requirements risk.

D. What Are the Community Interests?

The responsible parties in both government and industry who participate in environmental remediation projects must acknowledge the local community as a major stakeholder in the cleanup effort. The DoE recognizes the seriousness of environmental contamination. Issues arise regarding potential health risks to local communities, but there are also perceptions that affect the local community economically and socio-politically. Furthermore, the DoE has recognized the need for local community participation for educational purposes as well as policy and contracting decisions. After surveying the local population surrounding the St. Louis



FUSRAP, researchers Feldman and Hanahan (1996) found that the local population had a desire to participate in remediation decisions. The local community was most concerned about health risks, treatment, and excavation (specifically offsite disposal methods). As for soil cleanup, the respondents viewed onsite remediation as the least preferable method. They concluded by recommending to the DoE community relations program that the public needs to be informed and educated of the process and that the DoE must ensure open communication with the public (Feldman & Hanahan, 1996). Community interest with stakeholder status is not the only perspective. In fact, for environmental restoration and remediation, community interest becomes the driving force for such action. As we discuss in the following section, local community interest is not alone in making the remediation contracting environment more challenging.

E. What Is the Regulatory Framework?

Understanding remediation requires an understanding of U.S. regulation and environmental law. As Findley and Whitridge (1996) described it, “regulations largely created the remediation industry” (p. 83). Public interest, pushing for an effective bureaucracy to carry out environmental protection through federal and state regulatory authorities, harbors new challenges.

Environmental regulations are an ever-increasing part of business, legal, and governing aspects of the U.S. Optimistically, regulators come from unbiased, disinterested, technocratic perspectives and seek to rectify decades of environmental damage. Pessimistically, regulators come from biased constituencies, or are themselves biased, regarding enforcement, communication, and efficiency. The truth lies somewhere in-between. In a study looking to understand regulators’ bias, Viscusi and Hamilton (1999) concluded that

one cannot distinguish with the current information whether risk perception matters primarily because they reflect biases of regulators as individuals or regulators as representatives of constituents with biased perception, a topic with significant implications about the efficiency of regulator perceptions. (p. 1025)



Whether regulators are biased, or come from biased groups, is a question of interest to students of psychological aspects of regulatory expansion and enforcement. Socio-political theory might consider broader casual relationships for such phenomena. For our analysis, Adler's (2007) observation that wealthier nations seek greater environmental protection is sufficient. This study does not question the political underpinnings; instead, we highlight the rapidly expanding regulatory framework and examine its effect on environmental remediation contracts.

The DoE, like the DoD and industry, faces an exponentially growing regulatory framework. Before the 1970s, from a federal perspective, the DoE self regulated while state and local agencies enforced their own environmental regulation and protections, usually without a high degree of standardization or efficacy (Adler, 2007, p. 67). Adler (2007) highlighted the nature of wealthy nations and their relationship with the environment when he wrote, "wealthier and more knowledgeable societies demand greater levels of environmental protection" (p. 72). Indeed, as the U.S. solidified its role as the major world superpower and enabled globalization, the luxury of environmental protections ensued. One can look to title 40 of the *Code of Federal Regulations* (C.F.R.), which is a repository of federal environmental regulations. Cahill (2011) echoed Alder's assertion with a graphical description on the increase of environmental laws, shown in Figure 1.



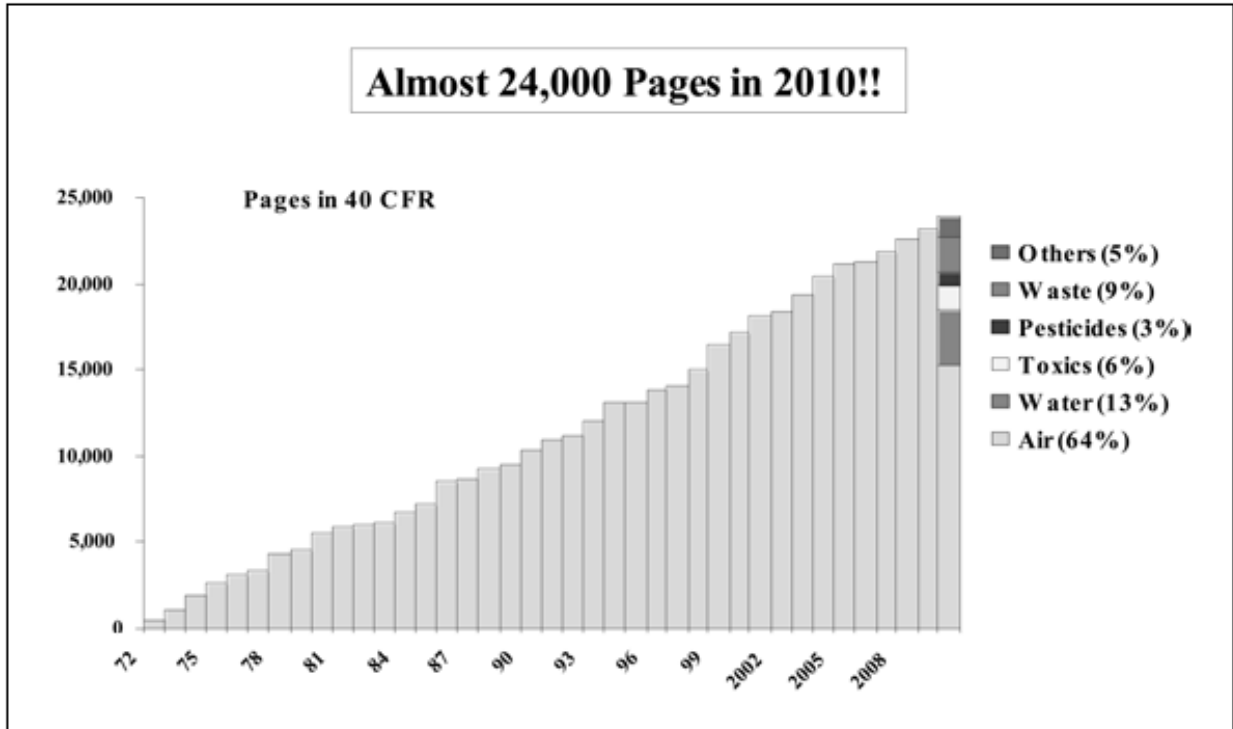


Figure 1. Growth of U.S. Environmental Regulations
(Cahill, 2011, p. 44)

Environmental remediation usually requires the end state of site closure. As the number of environmental requirements increase, the government and contractor encounter a “sliding bar” if state and local regulators are not involved in the decision-making process. Consequently, the performance measurement for programs becomes problematic if the regulators remain unsatisfied. To avoid this kind of scenario, clear metrics and end states should be agreed to, as we discuss in Section H. In addition to title 40, Allen and Shonnard (2002, p. 2) tracked federal environmental statutes. Figure 2 shows an exponential increase in federal laws.



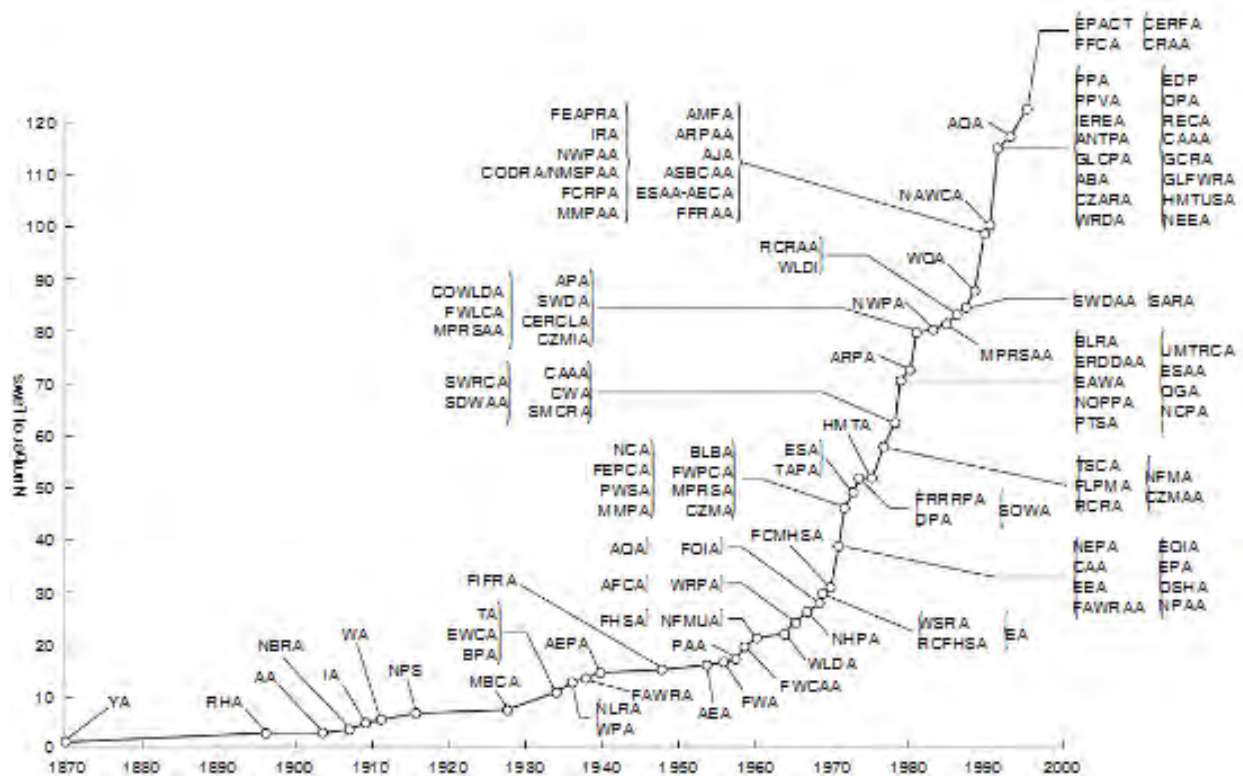


Figure 2. Cumulative Growth in Federal Environmental Laws and Amendments

(Allen & Shonnard, 2002, p. 2)

With the rapidly increasing number of laws, remediation professionals can expect increased difficulty meeting regulatory compliance goals. More optimistically, citizens should rejoice in the dramatic correction in lack of any environmental protections beginning in the late 19th and improving throughout the 20th century. The increased environmental protection due to laws enacted before 1988 account for 53–69% of the overall cost to business (excluding the superfund program; Crain, 2005, p. 25). In any event, new protections are a challenge to government, contractors, and the U.S. taxpayer. State and local regulators before the 1970s operated, for the most part, independently of the federal government. Typically, they enforced highly disparate rules and regulations; the increase in federal involvement has brought greater standardization and consolidated enforcement. As Adler (2007, p. 114) contended, optimal environmental regulation comes when federal regulators effectively communicate and synthesize efforts with state and local regulators.



Oppositely, the uncoordinated effort, lack of communication, and conflicting interests between federal and state regulators becomes an additional challenge to remediation efforts.

From the regulators' perspective, Adler (2007) pointed to some interesting findings: federal regulation does not always provide a floor for state environmental protection and there is no evidence for "the race to the bottom" among states. In other words, poorer states will not weaken environmental protection in order to attract investment. Although Alder (2007) found no evidence of a race to the bottom among states, differing state mandates create a diverse set of obstacles. The impact wealth has on communities is more interesting than one would assume. For example, when looking at water standards among states, Adler (2007) found "that increases in median income will affect the state environmental regime differently in relatively poor or rich state" (p. 156), where if a state with a medium income greater than the national average becomes wealthier, water standards rise. But in the case of a state with a medium income less than the national average, increases in wealth will actually lower water standards (Davis, 2007, p. 156). More specifically, Davis (2007) highlighted the differences in state standards; "states often do not take a uniform approach to setting all metal standards either stricter or weaker than the [National Toxics Rule]" (p.145). States have an extremely broad authority to regulate hazardous (and non-hazardous) products and waste. As an example, Jennings and Hanna (2010, p.11) demonstrated in a survey of state soil standards that Texas defines 1,888 different contaminant levels for individual pollutants, whereas North Dakota identifies one. The solutions for federal remediation projects involving nuclear material exacerbate the differing state environmental standards and enforcement. Constituencies are often hypersensitive to nuclear waste disposal, forcing state and federal elected officials to act on their behalf. Political actors can interject themselves into the remediation decision-making process, or galvanize legislatures to prevent or alter outcomes. Although different state laws impact remediation decisions, a more in depth discussion of the major federal laws is important to understanding the federal remediation contracting environment.



F. What Are the Some Influential Federal Statutes?

As previously mentioned, federal, state, and local laws and ordinances make remediation projects exceedingly challenging to execute. For purposes of brevity, we examine the major federal laws that complicate the acquisition process. For environmental cleanup, the DoE and the DoD operate in similar, albeit difficult and complex, regulatory environments. In 1980, in order to address hazardous waste sites, Congress passed CERCLA, which established the statutory framework for post-hoc environmental damage. In the same year, Congress passed RCRA, which established a framework to limit the impact of current and future degradation. What Momber (2005, pp. 14–15) called the “Environmental Law Conundrum” is the paradox between the signals these laws call for. Although environmental laws help determine liability of parties who have or will have caused environmental damage (including the U.S. federal government), federal acquisition law requires contracting professionals to maintain fiscal discipline in an effort to protect the taxpayer (Momber, 2005, p. 15). As a result, contracting officials face a paradox: they must seek to fully indemnify the public through comprehensive environmental restoration or shield the taxpayer from excessive cleanup costs.

The Brooks Act (1972) is another law that impacts the acquisition process. The law creates a federal policy “concerning the selection of firms and individuals to perform architectural engineering and related services for the Federal Government” (preamble). When contracting for architectural and engineering services, it specifically requires work as described by the law:

1. professional services of an architectural or engineering nature, as defined by State law, if applicable, which are required to be performed or approved by a person licensed, registered, or certified to provide such services as described in this paragraph;
2. professional services of an architectural or engineering nature performed by contract that are associated with research, planning, development, design, construction, alteration, or repair of real property; and



3. such other professional services of an architectural or engineering nature, or incidental services, which members of the architectural and engineering professions (and individuals in their employ) may logically or justifiably perform, including studies, investigations, surveying and mapping, tests, evaluations, consultations, comprehensive planning, program management, conceptual designs, plans and specifications, value engineering, construction phase services, soils engineering, drawing reviews, preparation of operation and maintenance manuals, and other related services. (Brooks Act, 1972, § 901)

It is a “qualification-based assessment” selection process that enables the government to request qualifications from firms, then select the best-qualified contractor, and finally begin negotiation on a specific contract (American Council of Engineering Companies [ACEC], n.d.). An added challenge is determining whether the Brooks Act is applicable to specific projects. For instance, the American Consulting and Engineers Council (ACEC) protested a DoE contract in which the contractor was a non-engineering firm. This protest required the DoE to request a decision from the Comptroller General to determine Brooks Act applicability, which determined that the Brooks Act was not applicable (Comptroller General of the United States, 1982). Brooks Act inapplicability extends to Maintenance and Operations contracts, which will be discussed further in Section H.

The Brooks Act is not the only law that brings increased challenges; the Davis-Bacon Act (2002) also complicates things. According to the Department of Labor (DoL), “contractors and subcontractors must pay their laborers and mechanics employed under the contract no less than the locally prevailing wages and fringe benefits for corresponding work on similar projects in the area” (DoL, n.d.). Interestingly enough, the DoL determines those labor rates. Conceivably, union interests at sites where the DoE is the only major employer essentially bind the department to ever-increasing labor rates. Although the DoE is not immune to this reality, the Davis-Bacon Act’s impact on projects does not give contracting officers as much flexibility as they otherwise would have. Furthermore, compliance with the McNamara-O’Hara Contract Act (Service Contract Act, SCA) applies to all service employees. The SCA and the Davis-Bacon Act affect a contractor in a similar way,



but the SCA seeks to protect services workers—not mechanical and wage workers—from competitive (lower) wages (McNamara-O'Hara Service Contract Act, 1965).

Finally, the Price-Anderson Act is another major law affecting the DoE and the nuclear remediation acquisition process. As Berkovitz (1989) explained, “the Price-Anderson Act, as amended, governs liability and compensation in the event of a ‘nuclear incident’ arising from activity of Nuclear Regulatory Commission licensees and [DoE] contractors” (p. 1). He continued by explaining how the law provides coverage for contractors in projects that “involve ‘risk of public liability for a substantial nuclear incident’” (Berkovitz, 1989, p. 1). In other words, the DoE practices self-insurance when it comes to its major environmental cleanup. Although environmental liability is not the primary focus of this study, in a later section we describe insurance options that can offer possible solutions. Although the DoD and DoE face the same legal obstacles concerning environmental law, there are other DoE challenges.

G. Why Is Remediation Different for the DoE?

Unlike the DoD, the DoE executes some projects with Management and Operations (M&O) contracts governed under the Federal Acquisition Regulation (FAR) subpart 17.6. These contracts limit available options for contracting officers due to specific clauses, such as the following:

- (d) The work is closely related to the agency’s mission and is of a long-term or continuing nature, and there is a need—
 - (1) To ensure its continuity; and
 - (2) For special protection covering the orderly transition of personnel and work in the event of a change in contractors. (FAR, 2005, subpart 17.604)

One can immediately see two issues. First, the general vagueness regarding the clause that identifies the regulation’s applicability, begging the question: what is the meaning of “closely?” Second, why is there special protection for personnel



transition? In any event, this section of the FAR makes the contracting environment more difficult for EM contracting officers.

Researchers and DoE contracting managers understand the need to move away from M&O contracts. Design-build contracts are a single vehicle for which "the total cost of the construction plus the cost of design are gathered into the design-build contract" (Beard, Loulakis, & Wundram, 2001, p. 37). Person (2003) analyzed the use of design-build contracts and explained that the design-build contracting approach, at least within the DoE Weapons Complex, "had mixed results at best" (p. 6). The primary reason the Weapons Complex was not a total success is that the design-build approach did not allow for phasing of construction (Person, 2003). The second problem involved major disagreement and numerous commenting over design preference (Person, 2003). And finally, the design-build contract is not appropriate when the existing conditions are not fully known or characterized (Person 2003). Person (2003) explained that "for those environmental remediation projects that present significant challenges in characterization and the like, cost reimbursable contracting may be the only viable option" (p. 6). He concluded that

for a variety of reasons, most subcontracts placed by M&O contractors should employ the firm, fixed-price contract delivery method. The use of the design/build contracting model should be limited only to those situations where multiple processes can satisfy the desired result and where the M&O contractor can demonstrate that it will employ a 'hands-off' interfacing strategy. (Person, 2003, p. 9)

The size and scale of projects are another way that the DoE is different. For example, the DoE has over 100 remediation construction projects, and 97 cleanup projects with a total value of over \$320 billion (GAO, 2009). The DoD, on the other hand, has approximately 2,300 sites, with an estimated cost of only \$35 billion (GAO, 2004).

Additionally, the DoE garners a considerable amount of scrutiny from the GAO, Congress, and the Defense Nuclear Facilities Safety Board. For example, in 2007, the House and Senate Energy and Water Development Appropriations



Subcommittee commissioned the National Academy of Public Administration (NAPA) to perform an overall review of the EM. The report included myriad recommendations to improve Project Management, Organization and Management, Acquisition, and Human Capital (Messner et al., 2007). In addition, the GAO's high risk list evaluation and review contain similar recommendations. The DoE is not a reactionary organization, it conducts internal reviews and initiatives in order to meet GAO recommendations and findings. For example, the DoE leaned forward by establishing the Environmental Management Consolidated Business Center, it also addressed HR concerns in the field at regional contracting locations and continues to streamline acquisition processes (DoE, 2011). In response to the GAO high risk list, the DoE performed the 2008 RCA and CAP which are instrumental to the EM's transformation. Although the EM has made institutional transformational change, there is still room to improve contract and project performance. In the following section we identify examples in the DoE and industry that can shed light on successful contracting approaches.

H. What Are Some Success Stories?

Despite the challenges facing the DoE, and remediation contracts in general, there are examples of successful projects. We review a few positive examples, highlighting successful contracting strategies.

In August 2006, the DoE released a report titled *Rocky Flats Closure Legacy: Accelerated Closure Concept* that highlighted the factors which led to the successful acquisition. Located near Denver, CO, Rocky Flats housed legacy nuclear weapon production facilities. The Rocky Flats cleanup project was so successful it was awarded the Project Management Institute's (PMI) project of the year award in 2006. Policy-makers saw the need to accelerate the Rocky Flats closure due to suburban growth in the greater Denver area. First, the notion of contract reform was emphasized; contracting personnel saw an opportunity to move away from the M&O contract model to a performance-based contract (DoE, 2006, p. 1-7). The Performance-Based Integrating Management Contract (PBIMC) was also a



departure from the cost plus award fee; instead, the contracting team employed a cost plus incentive fee. Contract type was not the only aspect in the Rocky Flats success; there were other contributing factors. First, defining a clear end-state vision, and ensuring that the DoE and the contractor maintained this vision as their primary focus. Moreover, secondary and other objectives were “systematically eliminated” (DoE, 2006, p. 1-16). Another key factor of success was teaming between government and regulators to properly identify a “fixed or bounding set of objectives for the cleanup end state” (DoE, 2006, p. 1-18). The DoE should communicate these objectives with the contractor to reduce regulatory uncertainty. Another key factor, discussed in more detail in the following section, includes adequate site characterization (DoE, 2006, p. 1-18). Additionally, the program enjoyed sufficient congressional support to a stabilized funding level, which greatly diminished program (budget) risk. Another finding is that contracting personnel should use firm-fixed price contracts to the maximum extent for all known work, and cost plus incentive contracts where requirements are more uncertain. In addition, by embracing performance-based contracting, the DoE fulfilled its role by managing the contract rather than managing contractor processes (DoE, 2006, p. 1-18).

Another DoE success story is the Fernald Waste Pits located northwest of Cincinnati, OH. The Waste Pits were a sub-project within the larger Fernald site. In 2007, Fernald as a whole, project won the PMI's project of the year. Under the privatization model, with a fixed-priced contract, a contractor would “design, engineer, procure, construct, own and operate a facility that would undertake the remediation” (Cherry, Lojeck, & Murphy, 2003, p. 1). Project management used industry best practices, on-site labor, and support of the local community to bring about site closure. This is not the first time researchers have looked at Fernald as a success, as Cherry et al. (2003) observed:

The key components for success of the privatization contracting for the [Waste Pits Remedial Action Project] at the [Fernald Environmental Management Project] were Fluor Fernald Inc's development of a strong procurement package, setting a reasonable capital outlay, along with a reasonable recovery timeframe, utilizing demonstrated commercialized



technology, and the dedication to success displayed by Shaw as the parent corporation of the privatization contract for the WPRAP. (p. 17)

A “strong procurement package” refers to sufficient requirements definition, boundaries and limitations of the project, and contingency plans for both known elements that may vary and unknown variables that may emerge. The use of readily available technology facilitated competition, and as a result, minimized up-front costs and expedited capital recovery. In environmental remediation contracts, complexity drives constantly changing conditions and results in contractor malaise or stagnation. However, in the WPRAP experience, Shaw’s dedication prevented typical diversions, which was a key factor in site closure (Cherry et al., 2003, p. 7). Needless to say, this may have been an isolated case in which privatization was possible under the right circumstances. Investigation of the variables involved provides an opportunity for future research.

In a private-industry success, one company created an innovative technology in which it was able to, “perform, for a fixed price, all remediation activities necessary to achieve regulatory closure for known, and in some cases unknown contamination. [The] contract provides regulatory, performance and schedule completion guarantees” (Maierle, Cote, & Suthersan, 2004, p. 36). This resulted in the contractor securing market-rate project financing, with site closure within 30 months of initiating remediation activities, and as a result, area property values increased by a factor of seven in just four years (Maierle et al., 2004, p. 37). In this case, a patented remediation technology enabled the contractor to offer its services with a greater degree of cost certainty, allowing it to use firm-fixed price contracts. Such a technology solution, like most, is for a specific type of cleanup activity. Environmental remediation activities are exceedingly broad and varied, differing chemical contamination, water and soil composition, and obsolete or aging storage facilities all include different technology challenges that require a multitude of technology solutions.



As explained in the WPRAP and Fernald Waste Pits, the importance of site characterization cannot be underestimated.. Rigorous requirements definition will not only optimize contract type but also will reduce regulatory uncertainty, streamline remediation alternatives, and potentially improve cost construction and estimation. Another common element in the successful project examples was funding regularity. Achieved in two different ways, one through increased congressional support and the other through the use of standard technology, success is a function reducing program risk. On the other hand, these examples also provide interesting contrasts. Contract types differ between the two projects; WPRAP used a fixed-price model, whereas the Rocky Mountain Waste Pits used a cost plus incentive fee. Furthermore, readily available commercial technology in the WPRAP contributed to risk mitigation, whereas new technology in the industry example drove the purchasing strategy to a firm-fixed price. It is important to note in both examples that technology played a key role in enabling the firm-fixed model. Contract type is not the only mechanism to manage risk between contractor and government; insurance schemes enable parties to manage risk as well.

Remediating contaminated, radioactive waste sites is a complex undertaking with a great deal of uncertainty and risk. Although the acquisition strategies discussed have proven successful in past projects, insuring remediation projects is a promising strategy that has gained popularity since the mid-1990s. Insurance provides four basic benefits for remediation projects: it improves land marketability, quantifies site risks, provides financial security, and spreads the risk of unanticipated remediation costs (GSA n.d., p. 1). If and when the government can externalize risk, insurance companies can provide necessary support in quantifying environmental (and cost) risk, which brings about clearer statements of work and requirements definition. Richardson (2002) explained this relationship, stating “insurance also promises reduced transaction costs for all involved” (p. 295). Moreover, if site closure and eventual private development is the end state, improving marketability of the land via insurance is an appropriate course for the government, contractor, and regulators. Insurance comes in a variety of forms and costs, and for differing



purposes. The government can garner successful remediation contracting outcomes through the following policies: pollution liability (PL) policies, finite risk (FR), secured lender (SL), and cost cap (CC; “Environmental Insurance,” 2011, p. 2).

PL policies protect the insured against liability arising from cleanup costs, injury, and property damage. These policies generally provide coverage periods of one to 10 years in amounts between \$1 and \$100 million (Yount & Meyer, 2005, pp. 17–20). FR policies require the insured to transfer the entire expected cost and net present value of the remediation project to the insurance company, which pays the contractor as it achieves remediation milestones. Generally, these policies work best on projects estimated to cost between \$5 and \$60 million and lasting between five and 20 years (Yount & Meyer, 2005, pp. 40). SL policies, on the other hand, aid the insured party’s capital loan acquisition. An SL policy “typically pays the lesser of (i) the anticipated cleanup costs or (ii) the loan balance in the event that a borrower defaults on loan payments” (“Environmental Insurance,” 2011, p. 2). Smaller projects costing between \$3 and \$10 million benefit from SL policies. And finally, CC policies define the insured party’s cost ceiling. This ceiling is the estimated cost of the remediation plan. The insurance company covers costs above the ceiling. CC policies cover projects costing more than \$2 million because cost proves “ineffective for small projects” (Yount & Meyer, 2005, pp. 30). Similarly, remediating contractors can purchase insurance when providing remediation at a guaranteed, fixed price. On the surface, insurance is a simple solution to combat remediation uncertainties and risks; however, that is not necessarily the case.

Insuring environmental remediation projects is often difficult. First, significant cost accompanies insuring environmental remediation projects:

the price of insurance is driven by the level of site characterization, the nature of the constituents of concern, the nature of the reuse (e.g., whether residential or industrial), the terms of the policy and limits of liability, the amount of the deductibles, and the expected costs of remediation. (“Environmental Insurance,” 2011, p. 3)



Additionally, structuring an environmental remediation insurance policy entails great complexity. Insurance program development is a "result of negotiations among the purchaser, carrier, broker, attorneys, and other parties" (Yount & Meyer, 2002, p. 37). Negotiation requires experienced negotiators and brokers, which becomes difficult when insuring multiple projects scattered throughout the country. Although it is difficult to implement, insurance can successfully mitigate project risk. Considering the large resources allocated for remediation, insurances would account for a small fraction of total outlays. Although insurance costs require an increase in upfront funds, its use decreases project risk, thereby limiting long-term costs.

States throughout the U.S. have implemented brownfield remediation insurance programs. The EPA defined brownfield sites as, "real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant" (Environmental Protection Agency [EPA], n.d.). Massachusetts established the first state brownfield insurance program, MassBRAC, in 1999. The Massachusetts Business Development Corporation (MBDC), a "for-profit, non-governmental economic development organization" (Yount & Meyer, 2006, p. 12), administers the state's program. In practice, the program pre-qualifies insurance firms to provide environmental remediation insurance. Since its establishment, MassBRAC has yielded numerous successful remediation projects.

In 1994, MassBRAC insurance programs enabled a local community to obtain \$15 million in financing to remediate a former manufacturing facility. Today, the site is home to a 40,000 square foot commercial facility, employing 140 people. Additionally, property values and economic activity in the area were enhanced (Yount & Meyer, 2006, p. 14). In another case, a developer looked to turn a former landfill into a retail facility, but was concerned about the cost of remediating the area. The developer used MassBRAC to obtain CC and PL policies. With policies in place private industry developed the land, which now employs "500 new retail, warehousing and office jobs" (Yount & Meyer, 2002, p. 14). They explained that



when the government utilizes insurance strategies to carry out environmental remediation, it enables private capital the opportunity to enter the market for future restoration, reclamation, and development (Yount & Meyer, 2002, p. 6). The DoE has attempted insurance strategies, but unfortunately they could not find willing underwriters.

Extracting these success stories from the literature is no doubt useful, however, our initial observations of most current solicitation and evaluation practices will be illustrative as well. The East Tennessee Technology Park (ETTP) contract employs the DoE's newest methods for cost proposal solicitation and evaluation. As an initial comparison, we observe specific differences with Request for Proposal, Section L, between with the Savannah River Liquid Waste, more specifically, the Salt Waste Possessing Facility (SWPF) design/build contract and the ETTP. One challenge to proposal evaluation is lack of standardization among proposals. The ETTP resolves this by requesting clear reporting requirements for offerors. For the cost worksheets, the ETTP requires cost summary and details through exhibits in an alpha-naming convention, A through G, with additional exhibits labeled H through Q as the contractor sees fit. The SWPF requires the cost summary, and detail reports, through a less than clear narrative, with an alphanumeric naming convention F.1-F.4. Another way the ETTP ensures greater standardization among proposals is to describe clear, detailed assumptions contractors should use when building cost proposals. The ETTP provides the typical assumptions of labor, overhead, escalation, rates, and fringe benefits, similar to the SWPF contract. But the ETTP goes further, and provides contractors with specific assumptions about contract award schedules, funding profiles, and technical aspects relevant to the site. As our research continues, the following chapter will use the ETTP methods as the proper benchmark for the EM's current solicitations.

Success is not isolated to a few DoE and industry cases; our study also seeks to identify successful DoD approaches to remediation contracts. Before we look at



the DoD we examine the general aspects of cost proposal request, evaluation, and effectiveness.

I. Cost Proposal Request and Evaluation

The acquisition strategy and contracting approach is very complicated and nuanced, not only for the DoE but also for the DoD. We focus our attention on contract solicitation and proposal evaluation issues. Due to the complexity and size of DoE projects, proposal request and evaluation has become onerous for both government and contractors. The challenge contracting personnel face is developing clear statements of work, with complete requirements definition necessary for successful remediation.

Unfortunately there is not a robust academic framework for proposal requests. The varying nature of projects and differing contract approaches influence proposal request development. However, as indicated in numerous acquisition guides and project management texts, requirements definition is fundamental in generating a definitive proposal. As Lock (2007) wrote, "before any person or organization considers investment in a new project ... the project requirements must be clearly established, documented and understood" (p. 29). For environmental remediation, requirements definition includes site characterization.

Complex engineering projects incorporate teams of highly specialized professionals from diverse fields. Typically, engineering professionals define environmental remediation project requirements. Contracting personnel use these requirements to generate the statement of work and ultimately the government's Request for Proposal (RFP). In environmental remediation projects, site characterization is fundamental to requirements definition. As Murphy and Herberling (1994) asserted, "perhaps the most critical element in writing a successful restoration contract is accurate, clearly written specifications or statement-of-work" (p. 48). They explained that remediation project requirements are difficult to define, which "increases risk of failure" (Murphy & Herberling, 1994, p. 48). The authors underscored the importance of definitive requirements definition by explaining the



negative effects of their absence. They highlighted the additional workload encumbered on purchasing and engineering personnel such as readdressing the government's negotiation position, communicating new requirements to offerors, and updating information for cost realism. Problems are exacerbated when requirement changes occur post-award, leading to cost and schedule growth and potential legal action (Murphy & Herberling, 1994, p. 50).

Regrettably, when the RFP contains vague or uncertain work requirements, the evaluation of contractor proposals becomes ever more difficult. In addition, contracting officers face numerous challenges, not only from the technical complexity and issues with requirements definition but also from the different stakeholders and goals. There are numerous strategies when determining the “best” proposal. Our observations include one DoE contract with 11 “winners.” That specific case is discussed in the next chapter. What we can extract from the literature are ways to approach the alternative selection process. The DoE and the DoD have guidance for government officials. As Kiker, Bridges, Varghese, Seagar, and Linkov (2005) explained, the DoE has an eight-step process:

defining the problem, determining the requirements, establishing goals of the project, identifying alternative methods and project, defining the criteria of concern, selecting an appropriate decision making tool for the particular situation, evaluating the alternative against the criteria, and finally, validating solutions against the problem statement....5 recommended evaluation methods include pros-and-cons analysis, Kepner-Tregoe (K-T) decision analysis, [Analytical Hierarchy Process], [Multi-Attribute Utility Theory], and cost benefit analysis. (p. 101)

What Kiker et al. (2005) added to the discussion is an interesting approach using multi-criteria decision analysis (MCDA). They advocated a decision support model, which generates alternatives for decision-makers that comes with ranking alternatives using success criteria and weights on “value judgments” (Kiker et al., 2005, p. 103). Their approach included a synthesis of different methods for proposal evaluation; they concluded with the notion that no one approach is best (Kiker et al., 2005, p. 106). As a previous version of the DoD *Risk Management Guide* explained,



when the government makes a proposal selection determination the Source Selection Authority (SSA) should select the proposal that represents the best value in terms of performance, schedule, and cost (DoD, 1998, p. 40). The DoD Risk Management Guide echoes the FAR (2005) , “The objective of source selection is to select the proposal that represents best value” (subpart 15.302). More important to evaluation processes, it explains proposal risk as “the risk associated with the offeror’s proposed approach to meet the Government performance, cost, and schedule requirements” (DoD 1998, p. 40). In contrast, in its most recent edition the DoD treated risk in a more malleable, less deterministic way. It emphasized the importance of risk mitigation, in which proposals should include contractor risk analyses, which help formulate initial Risk Management Plans (RMP; DoD, 2006, p. 5). Similarly, the DoE *Risk Management Guide* discusses processes to mitigate and manage risk, rather than derive upfront assessment and quantification of proposal risk (DoE, 2008a).

The proposal evaluation requirements in the FAR are necessarily flexible; however, this leads to a lack of standard execution among agencies, offices, and individual contracting officers. Appendix C shows the transcription of FAR 15.305, Proposal Evaluation. This is the primary tool contracting officers and Source Selection Boards (SSB) use to evaluate proposals. As we discuss in a later section, ranking usually entails decision matrices, with accompanying weights. The SSB reports include qualitative assessments to distinguish alternatives. There is a robust decision science literature that demonstrates numerous quantitative methods to prioritize alternatives. Moreover, researchers apply decision science to environmental remediation decisions; however, in our preliminary findings, we have yet to see this in practice among DoE personnel. The following discussion briefly outlines a few common decision methods we observed in the literature.

1. Decision-Making Methodologies

Decision-makers both in industry and in the public sector have often preferred data-driven, analytically described alternative sets to ensure that the optimal (most



rational) alternative remains an option to their policy or business goal. This becomes exceedingly difficult in large, complex projects, such as environmental remediation. Multiple stakeholders, the number of risk scenarios, and multiple objectives make the problems complex and the solutions to those problems all the more prescient. Saaty (1982) created one of the first decision-making models to facilitate optimal decisions of this kind of complexity. The Analytical Hierarchy Process (AHP) attempts to disaggregate decisions by breaking down alternatives, outcomes, and stakeholders into hierarchies. Saaty (1982) described several key concepts as follows:

1. Hierarchic representation and decomposition, which we call hierarchic structuring—that is, breaking down the problem into separate elements.
2. Priority discrimination and synthesis, which we call priority setting—that is, ranking the elements by relative importance.
3. Logical consistency—that is, ensuring that elements are grouped logically and ranked consistently according to logical criterion. (pp. 25–26)

Decision-makers and analysts can define hierarchies in many ways. AHP is meant to be flexible; risks, stakeholders, and alternatives are all possible branches with their own hierarchies. The depth of hierarchy should be a function of the knowledge available in the problem:

Once the decision maker defines the problem hierarchies, the evaluation includes a pair-wise matrix operation. This involves a priority setting where each aspect is measured against another, and the decision maker provides a scalar value to determine those values. If there were seven elements the following table would show the construction:

C	A ₁	A ₂	...	A ₇
A ₁	1			
A ₂		1		
.				
.				
.				
A ₇				1



(Saaty, 1982, p. 77)

Saaty (1982) described the comparison method: “To compare elements, ask ‘How much more strongly does this element (or activity) possess—or contribute to, dominate, influence, satisfy, or benefit—the property than does the element with which it is being compared’” (p. 77). AHP is a useful tool when prioritizing *within* program projects. In addition, when the number of the evaluation criteria is relatively low, such as in EM SSBs, the comparisons and computations are manageable. AHP is not the only method to analytically evaluate problems with multiple criteria and objectives.

The importance of satisfying multiple stakeholders is mentioned throughout the MCDA literature. For example, Linkov et al. (2006) conducted a case study and found several conclusions relating to the value of MCDA applications in environmental remediation:

The principal purpose of the MCDA approach is not necessarily to find the “best” decision but to improve the understanding of different stakeholder values. The approach of eliciting these values in parallel to development and assessment of the alternatives at hand is unusual but it may allow for smoother introduction of new technological alternatives (such as beneficial reuse of contaminated sediments) at a more fully developed point in the decision process. (pp. 75–76)

Linkov et al. (2006) rightly explained how MCDA can offer more information to decision-makers, not necessarily a more correct solution. The non-inferior frontier will include multiple “correct” solutions; only with decision-maker indifference curves can the analyst rank the approaches. One method that can avoid the additional task of building indifference curves is Multi-Attribute Utility Theory (MAUT). In MAUT, analysts rank alternatives between 0 and 1 for purposes of prioritization using a linear transformation (or depending on the model, nonlinear transformations would be more appropriate). In more complex decision-making modeling, the MAUT approach includes parametric sensitivity analysis due to uncertain value preferences.



Other researchers, in contrast, make the effort to define a more succinct evaluation process for decision-makers. Lahlou and Cantor (1993) advocated a three-step approach: “preliminary screening, intermediary screening, and final evaluation and selection” (pp. 57–58). The preliminary phase includes inclusionary and exclusionary criteria to make initial judgments more manageable for contracting officers. The second phase includes two screening methods. Lahlou and Cantor (1993) applied weights to impact magnitude or outcome estimation, and a partial ordering into “trichotomic classification” (pp. 57–58). The first approach includes a classical unranked paired comparison, and the second method an Eigen value on a 1–9 scale. The authors described their final phase, final evaluation, and selection in the following way:

This phase provides a unique evaluation procedure, which develops two rankings of the alternatives: an optimized and a compromised ranking. The procedure provides for multi-level hierarchical representation of the decision problem and uses the Eigen-value method to derive the importance weight coefficients of the decision criteria based on a ratio scale (Saaty, 1980). The two aggregation models incorporated in this procedure consist of a weighting-summation model and a compromise programming model. The rating of the alternatives with respect to lower level criteria uses a normalized interval scale. This absolute scaling system provides a stability of the rankings, however, the overall scores obtained are interally scaled. (Lahlou & Cantor, 1993, p. 58)

The authors described a two-part process that utilizes the AHP (Eigen-value) method for the alternative prioritization ranking. According to this approach, the optimal decision would not get screened, and by applying both a weighting summation model and compromise program, the analyst can provide an internal check of the rankings. In regards to AHP application, when the decision-maker’s value function is ill-defined or non-existent, the value of AHP decreases dramatically. AHP can properly address the relative prioritization; however, without a value function, it will fail to filter categorically suboptimal alternatives. This is especially the case when analysts screen initial alternatives. Despite AHP’s analytical approach to knowledge-based decision-making, as problem complexity increases analysis becomes more cumbersome. As Kirkwood (1997) wrote, "even ignoring the



theoretical objections that have been raised to the AHP, the approach seems overly complex, with the need for sometimes extensive pairwise comparisons of alternatives and extensive mathematical calculations to determine rankings" (p. 260). In a strategic setting AHP is insightful, yet considering the challenges contracting officers face, it is often impractical for operational decision-making. There are plenty of methods to employ when determining the most appropriate proposal; MCDA, MUAT, AHP, and other strategic decision-making processes have their place. Although, in the current DoE contracting environment, a goal to minimize upfront work should be sought especially if cost proposals, no matter how detailed, and evaluations, no matter how analytically based, do not surmount actual life cycle costs.

Before one examines the numerous aspects involved in environmental remediation cost proposals, in either the DoE or the DoD, a careful and thoughtful discussion of cost growth is necessary. Specifically addressing historical cost-growth experiences, how to identify cost drivers, and categorization in project cost accounting.

J. Cost Proposal Effectiveness

A cost proposal attempts to estimate the total cost of a contract. Cost proposal effectiveness refers to the accuracy of the estimated cost. Typically, decision-makers, program managers, and analysts are less concerned about those programs with actual costs less than the original estimates. Good management practices will ensure that these instances are not overlooked for the purposes of lessons learned, but programs completed under cost are not a source of controversy. Conversely, the programs that experience total costs above the original estimates often lead to greater scrutiny, credibility loss, program cancellation, and political fallout. The programs whose costs exceed the initial (and even ongoing) estimates experience what is called cost growth.



1. Cost Growth

Cost growth is not a phenomenon unique to the DoE. In fact, the DoD has a long and infamous history of cost growth. Since its early history, the U.S. has experienced challenges in military contract cost growth, such as in the 1794 construction of six frigates. The project had an innovative design, with competing requirements, state of the art materials, and political bickering over project necessity and expenditures. The contractor ensured several geographic constituencies to maintain political support (Cancian, 2010, pp. 391–392). And like programs today, the frigate program experienced “cost growth and schedule slippage,” which prompted congressional inquiries (Cancian, 2010, p. 392).

Business and government planners observe two forms of cost growth: unexpected and expected. From a strategic perspective, replacing legacy systems with more capital intensive, cutting-edge technology, requiring greater support systems, and systems integration inevitably leads to greater expected costs. A special panel on the Defense Procurement Procedures of the Committee on Armed Services explained cost growth in two categories: controllable and uncontrollable. Uncontrollable cost growth includes factors such as inflation, natural disasters, and other episodes beyond management control, which no one can rectify. For this reason, our study does not address it. Calcutt (1993, p. 15) cited a 1982 House Appropriation Subcommittee’s definition of controllable cost growth as the growth due to decision-making within an acquisition program . Our research seeks to address the unexpected-controllable disparity between cost estimation and cost reality; as some DoD authors plainly put it, “one way to reduce the amount of unexpected cost growth is to develop better cost estimates” (Sipple, White, & Greiner, 2004, p. 79). Unexpected cost growth comes about when cost forecasts do not properly predict the future; and as Yelle (1974) reminded readers, “a forecasting methodology that does not require a degree of crystal-ball gazing has yet to be developed” (p. 8). There are different ways to attribute or categorize cost growth. For those in the government and academic research industry, cost growth, while a



bane to the U.S. taxpayer, provides a wonderfully secure means of employment. Our study looks at DoD cost-growth experience to extract insight for the DoE.

Despite the above-mentioned parceling between controllable, uncontrollable, expected, and unexpected cost growth, we need to identify, for our analysis, what cost growth describes. Cost growth is an *a posteriori* construct, as the measurement between actual cost and estimated cost. The cost estimate, is an *a priori* construct, therefore, it will never “expect” or anticipate cost growth. As a decision support tool, the estimate can deliver a probabilistic range and accompanying risk profile to increase information for decision-makers. To arrive at an estimate, cost drivers include the major cost categories that account for total cost, yet dynamic costs are not determinants of cost-estimate changes. This distinction will become more important in our model discussion.

Modern policy and academic research with the aim to address defense industry cost growth dates back to the early 1960s. An outcome due to the intense Cold War build up, when costs initially took a backseat, decision-makers realized the need to at least identify this phenomenon. Researchers have long identified acquisition challenges; yet policy-makers fail to curtail incidences of cost growth. Peck and Scherer (1962) are two of the first academics to identify cost-growth phenomena, or at least the differences the defense industry faces as opposed to more classically oriented markets. They successfully provided practitioners and policy-makers with the proper background and information to better understand the acquisition environment. In their description of cost and schedule growth, Peck and Scherer (1962) stated, “development time estimates frequently turn out to be erroneous by as much as 100%, and early development cost projections by even greater margins” (p. 300). They found that the contractors typically use overly optimistic projections, and the government attempts to correct these but fail because it operates under incomplete information (Peck & Scherer, 1962, p. 301). Peck and Scherer attributed acquisition shortcomings to the defense industry’s distinctiveness when they explained, “a high proportion of the effort involves research and



development activities, whose outcomes are generally considered to be highly unpredictable” (Peck & Scherer, 1962, p. 25). Another aspect they concluded was a root cause in weapon acquisition is that defense programs entail greater internal risk, due to the use of cutting edge technology, more so than other in industries (Peck & Scherer, 1962, p. 45). Although technology risk remains a factor for today’s cost growth, it is no longer a central theme, just part of a larger story.

Today, the DoD continues to struggle with cost growth. The DoD, despite having a career field dedicated to cost estimating and forecasting, cannot seem to prevent unexpected cost growth. O’Neil (2011), a researcher and practitioner in the cost-estimating field, provided worthy insights by addressing the incentive issues imbedded in the acquisition process:

If they [contractors] promise too much, then they may come to regret it in a few years. Yet, if they promise too little, they will lose out at once to a competitor. In such circumstances, the incentives weigh heavily on the side of accepting future risks rather than immediate ones. (O’Neil, 2011, p. 284)

This signaling problem is the very same issue we find in all major government acquisitions, especially as the number of firms decreases and the likelihood for future opportunities remains—as in environmental remediation. Another important insight O’Neil (2011) offered includes the issues surrounding cost realism and source selection:

In principle the government can reject offers deemed unrealistic, as it does when offerors omit some significant element or make a demonstrable error. But a source selection authority cannot simply substitute his or her own judgment for the contractor’s regarding prospective improvement or advances in development or production. Even at best, attempting to distinguish degrees of realism among competing proposals, in many cases, is fraught with unforeseen difficulties. (p. 284)

Some in the source-selection business might take exception to O’Neil’s observation; however, his point is very important, especially for our study. The amount of work and analysis that goes into source selection at best ensures contractors meet basic criteria. The DoE’s current acquisition process entails large



and complex remediation projects. Thus, acquisition personnel, in an increasingly litigious contracting environment, require large and complex proposals. These proposals come with equally large and complex cost estimates. The SSB must conduct drawn-out and costly reviews, exceedingly difficult analysis of alternatives, and lengthy internal and external audits. This is not to say that upfront resource allocation is inappropriate for site characterization and clear statements of work, but the onerous cost proposal construction and evaluation are probably not as important as they afford themselves. Because of a long history of cost growth, the DoD continues to implement corrective measures to stymie cost growth. Abate (2004, p. 3) studied the effects of acquisition reform initiatives on missile system cost growth and build timeline for recent acquisition reforms. Figure 3 shows the timeline.

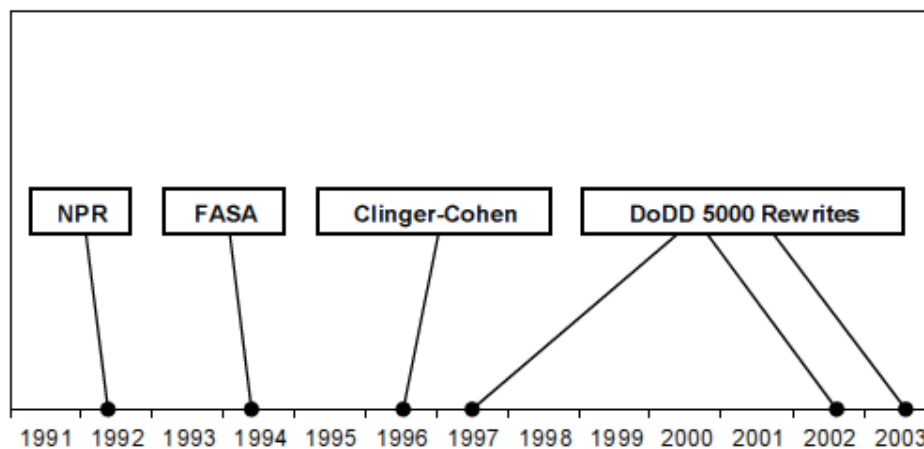


Figure 3. Current Acquisition Reform Initiatives (1991–2003)
(Abate, 2004, p. 3)

All the initiatives have goals in reducing work that is considered not valuable to the objectives. Beginning with Nation Performance Review (NPR), in 1992, the DoD made efforts to move away from a bureaucracy focused to a customer oriented acquisition strategy (Abate, 2004, p. 26). The Federal Acquisition Streamlining Act of 1994 (FASA), overhauled the DoD acquisition system by reducing the number of statutes, transitioned hardcopy items into electronic media, process re-engineering, and introduced past performance as a attribute for source selection. (Abate, 2004, p.28-29). The Clinger-Cohen Act of 1996 (Clinger Cohen) was a management-



focused initiative that was meant to “link information technology (IT) investments to agency accomplishments and establish a process to select, manage, and control IT expenditures” (Abate, 2004, p.29). The DoDD 5000 rewrite in 1997 was the first major overhaul of the regulation (Abate, 2004, p. 30-31). It dramatically simplified regulatory guidance for acquisition professionals; it separated mandatory and discretionary use of funds, as well as separating major information systems from other acquisition programs (Abate, 2004, p. 31). In 2002, in accordance with guidance directed by Undersecretary of Defense Paul Wolfowitz, the DoD suspended the DoDD 5000 until 2003, where policy makers sought greater acquisition flexibility, more streamlining with a favorable implementation environment (Abate, 2004, p. 31)

More changes to the DoDD 5000 have occurred since Abate’s analysis. In 2009, several DOD initiatives attempted to curb the prevalence of weapon system cost growth. The DoD unveiled more revisions to the DoDD 5000 series, according to Schwartz, the changes “[include] a mandatory requirement for competitive prototyping, more of an emphasis on systems engineering and technical reviews, and a requirement that all programs go through a Material Development Decision process prior to entering the acquisition system” (2010, p. 16). Schwartz also summarizes the changes as a result of recently enacted laws, to include the Duncan Hunter National Defense Authorization Act and the Weapon Systems Acquisition Reform (WSAR) Act of 2009. They create a new cost review system, more acquisition billets for senior military personnel, and an expedited review process for combatant commanders to enhance requirements generation. In addition, the WSAR creates a position of Director of Cost Assessment and Program Evaluation, Director of Developmental Test and Evaluation, and Director of Systems Engineering, who directly reports to Secretary of Defense (SECDEF) (Schwartz, 2010).

Every few years, the DoD agencies re-attack the cost-growth problem. This should bring one to conclude that the nature of cost growth is always changing or



that the solutions and their implementation have never been correct. According to O'Neil's (2011) analysis of the situation,

(a) [cost growth] is a limited but persistent phenomenon, which has not improved in any material respect over at least the last four decades; (b) it is not unique to defense; (c) cost growth may flow from a variety of causes—including errors in the management or contracting process—but defects in the original concept are a very common cause; (d) a limited group of similar remedies have repeatedly been tried but achieved very little success due to lack of clear analysis of underlying causes; and (e) research by social management sciences points to a corrective technique, “taking the outside view” or “reference class forecasting.” (p. 279)

He acknowledged the DoD's inability to implement remedies because of poor or unclear analysis of root causes. For example, the AF's latest attempt to address cost growth employs the “Will Cost/Should Cost” approach in which the Will Cost is the government independent cost estimate (ICE), and the Should Cost establishes an internal goal for the government to seek. As if something is better than nothing, Martin (2011) explained that the Will Cost/Should Cost numbers will help program management. In other words, this is a way to help program managers and analysts maintain greater focus on getting programs under cost. The Will Cost/Should Cost approach seems to avoid the question of whether the Should Cost *should be* the Will Cost, where the proverbial “just try harder” mentality prevails and certainly avoids the incentive problems. O'Neil's (2011) aforementioned analysis called for the academic and strategic focus to prevent these kinds of overly optimistic, arbitrarily implemented, and ultimately flawed initiatives. Therefore, we attempt to synthesize literature, looking at the nature of cost-growth trends and, if possible, addressing root causes.

The extant literature is replete with cost-growth studies. We discuss the major works that help describe program characteristics, which identify those programs subject to higher cost growth. Sipple, White, and Greiner (2004) conducted a survey of studies of cost growth in DoD acquisitions. They analyzed seven major studies: The Ballistic Missile Defense Organization (BMDO), RAND



1993, NAVAIR, Christensen and Templin, Eskew, Institute for Defense Analyses (IDA), and RAND 2001.

The BMDO study identified significant cost growth in Research Development Test and Evaluation (RDT&E) with less than 16% of programs completing at target or lower cost. The BMDO study also revealed that programs with lower dollar values typically maintained greater probability of cost growth (Coleman, Summerville, & Dameron, 2000).

The RAND study from 1993, to reiterate Sipple et al.'s (2004) synopsis, found that smaller programs experience more cost growth and the RDT&E stage encounters more cost growth than production. In addition, they found that those programs with longer life cycles have a greater probability of cost growth. The RAND study showed that cost growth is more likely in a "new start program" than a "modification" program (Drezner, Jarvaise, Hess, Hough, & Norton, 1993).

Sipple et al.'s (2004) analysis of the NAVAIR study found that there is no difference in likelihoods of cost growth among program sizes. Cost growth "var[ies] by commodity" and by programs with different characteristics (Sipple et al., 2004, p. 80). Most interestingly, there has been a reduction in cost growth in the post-Cold War era.

The Christensen and Templin (2000) study covered the use of management reserve; they found that fixed-price contracts use more management reserve than cost-reimbursement contracts. They also found that there is no difference in the use of management reserve between production and RTD&E stages (Christensen & Templin, 2000).

The Eskew (2000) study focused on the difference among fighter programs. The study found 90% of the variation between programs is accounted for by weight, production rate, speed, and time.



The IDA study discovered the relationship in production and RTD&E between schedule growth and cost growth. In addition, the intensity of the testing phase, the exigency of the program, and the complexity of the technology all are cost-growth factors (Tyson, Harmon, & Utech, 1994).

Finally, the RAND 2001 study focused on the Joint Strike Fighter. RAND researchers found that there is no statistical difference between competitive and non-competitive solicitations in both procurement and development cost factors (Birkler et al., 2001). Sipple et al. (2004) made the observation that “it should also be clear to the estimator that more often than not, estimates will be low” (p. 89). They then explained a two-part solution such that “the two sides of the solution coin are: more realistic baseline estimates (with accompanying risk dollars) and better cost control” (p. 89). As any practitioner would know and understand, although Sipple et al. provided a clear and simple solution, it came with opaque and complex challenges. Cost growth has an elusive nature, intuitively and empirically, front-end acquisition stages have greater cost risk. Despite the lack of academic consensus, those studies that find no differences in cost growth by states of acquisition are in the minority. The DoD, in an effort to at least begin to categorize cost growth, is our baseline approach for analyzing DoE cost growth.

In a different IDA report, Tyson, Balut, Om, and Welman (1990) described how the Strategic Acquisition Reports (SARs) categorize cost growth, stating, “as the program progresses, variances from planned costs are reported in the following categories: Economic, Quantity, Schedule, Engineering, Estimating, Support, Other” (p. 3). The Office of the Secretary of Defense (OSD) mandates the use of these categories when reporting cost variance. Fast (2007) offered definitions for each variance category, shown in Table 1.

Table 1. DoD Categories of Cost Changes
(Fast, 2007, p. 25)

DOD Cost Variance Categories	Definition



Quantity	Cost Variance resulting from a change in the number of end items being procured
Other	Changes in program cost due to natural disasters, work stoppage, and similarly unforeseeable events not covered in other variance categories.
Support	Changes in program cost associated with training and training equipment, peculiar support equipment, data, operational site activation, and initial spares and repair parts.
Schedule	Cost variance resulting from a change in procurement or delivery schedule, completion date, or intermediate mile stone for development or production
Engineering	Cost variance resulting from an alteration in the physical or functional characteristics of a system or item delivered, to be delivered, or under development after establishment of such characteristics
Economic	Cost variance resulting from price-level changes in the economy, including changes resulting from actual escalation that differs from the previously assumed and from revisions to prior assumptions of future escalation
Estimating	Cost variance due to correction of an error in preparing the baseline cost estimate, refinement of a prior current estimate, or a change in program or cost estimating assumptions and techniques

The DoD categorization is no doubt useful for reporting purposes; however, from an analysis perspective it does not encapsulate root causes or cost-change interconnectedness. Figure 4 conceptualizes the DoD cost growth categories. Note that these are not relationships between variables per se, but they help begin to paint the picture for cost growth accounting. For the DoE experience, these cost-change categories are both relevant and relatable (applicable).



DOD Categories
of Cost Change

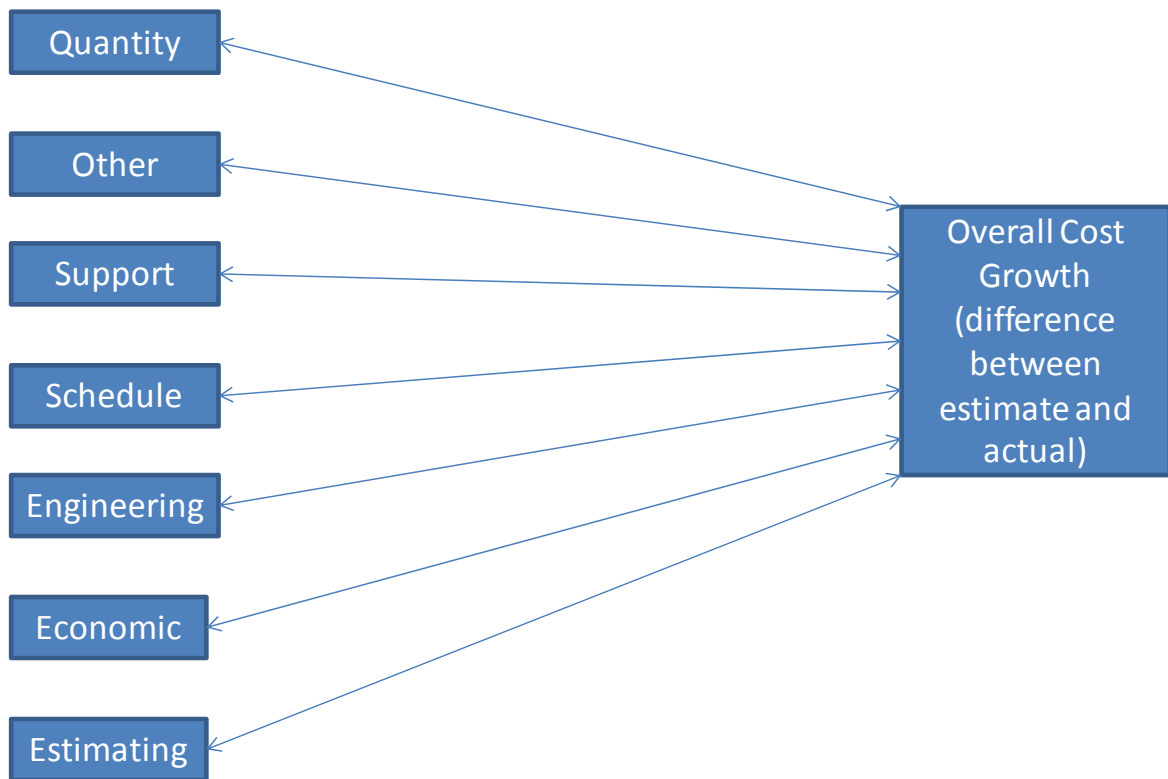


Figure 4. Cost Accounting Model

The model lends itself to attribute cost change, and several studies show ways researchers integrate them into more in-depth analyses. For example, Bolten, Leonard, Arena, Younossi, and Slinger (2008, p. 21) analyzed the cost-change categories and related them to their cost-growth category. Table 2 shows their integration.



Table 2. RAND Matrix
(Bolten et al., 2008, p. 21)

RAND Cost-Growth Category	SAR Variance Category						
	Quantity	Schedule	Support	Economic	Engineering	Estimating	Other
Estimation and planning errors							
Cost estimation			X		X	X	
Schedule estimation		X	X		X		
Technical issues		X			X	X	
Decisions							
Requirements			X		X	X	
Affordability			X	X		X	
Quantity	X	X	X	X	X	X	
Schedule		X	X		X	X	
Program transfers			X			X	
Financial							
Exchange rate				X		X	X
Inflation			X	X		X	X
Miscellaneous							
Error corrections	X	X	X	X	X	X	X
Unidentified variances	X	X	X	X	X	X	X
External events	X	X	X		X	X	X

Bolton et al. (2008) found that contractor performance is the primary result of cost growth. But the specific reasons are more interesting. They concluded that

most decision-related cost growth involves quantity changes (22%), requirements growth (13%), and schedule changes (9%). Cost estimation (10%) is the only large contributor in the errors category. Growth due to financial and miscellaneous causes is less than 4% of the overall growth. (Bolten et al., 2008, p. xvi)

More illuminating, they argued that the root causes of cost growth act as “trigger events” in which one unforeseen event starts a chain of probabilistic events, and they identified four major triggers: “program restructuring, change in schedules, increased requirements (either alone, or as continuing product-improvement programs), and errors in initial cost estimates” (Bolten et al., 2008, p. 81). In order to prevent these kinds of trigger events, the acquisition process must ensure appropriate requirements definition in order to arrive at sound cost estimates and schedules. From a technical standpoint, analysts need to incorporate these risk estimates, arguably, at the expense of a lower baseline.



K. What Are Our Initial DoE/EM and DoD Agency Observations?

The DoE sought our services to address cost proposal solicitation, evaluation, and effectiveness. We utilized the DoD cost-variance categories to focus our study on the cost-estimating change category. We met and held discussions with DoE EM personnel. After meeting with personnel at EM HQ in Washington, DC; at the Environmental Management Consolidated Business Center (EMCBC) in Cincinnati, OH; and at the Lexington, KY, field office, we identified current trends and challenges in the DoE environmental remediation contracting management and procurement process. In addition, we met with personnel at AFCEE and NAVFAC.

The EM acquisition process is complex. Not only do EM contracting officers operate in a challenging environment for reasons mentioned previously, but they also have dramatically fewer resources than their DoD counterparts. According to the latest GAO reports, greater funding has improved much of the DoE's contract management and oversight; however, more time is necessary to verify improvement quantitatively. When discussing the proposal process, we found many personnel reiterating the issues found in the literature. .

Our first actionable point of inquiry going forward will be the proposal evaluation process. For example, SSBs have difficulty evaluating proposals because contractors team together through Limited Liability Corporation (LLC) entities for proposal formulation and submission. The large contractors that form the LLC allow it to claim large resources and expertise, and soon after contract award, , individuals responsible for proposal writing and development are not available, either as key personnel, or as consultants. This can be more detrimental than typical acquisitions due to the scale, complexity, and uncertainty in remediation work. Considering past performance is a factor for source selection; the new LLC gets the credit for past performance it never, as a legal entity, carried out itself. This is not technically a cause of proposal evaluation error, yet this external reality shows that whatever score the proposal receives has little impact on how the contractor executes the contract. In addition, DoE personnel see contractors "bidding to win,"



where, as previously mentioned, contractors take on upfront risk at the expense of the customer. Additionally, requirements definition remains the greatest challenge. The current process, in our view, lacks the flexibility that could employ contracting approaches that would more appropriately address requirements risk. The magnitude of projects, difficult evaluations, limited personnel, linear acquisition strategy, and the LLC shortcomings either compound or obfuscate the problem of requirements definition. Currently, the DoE EM expends substantial resources to solicit and evaluate cost proposals that have become extremely complex. For example, one cost proposal for the Nationwide-indefinite delivery indefinite quantity (IDIQ) solicitation contained over 2,500 pages. The DoE's attempt to simplify the cost proposal construction included the use of what are called "plug numbers." Plug numbers are DoE-directed costs for elements of a contract not readily available or explicitly defined. . In our on-going research we seek to explore the relationship between the proposal evaluation and likelihood and/or magnitude of the estimate changes in further research.

Another frustrating challenge that DoE personnel face includes a difficult scheduling environment. This is not to be confused with program schedule as outlined in the DoD cost-variance categories, but the acquisition schedule. Program schedule outlays the time to complete a project, acquisition schedule refers to the events required for contracting personnel to solicit, award, and begin work on projects. The current requirements force the DoE to ensure external audits through the Defense Contract Audit Agency (DCAA) and KPMG. ,DCAA has not been helpful to the DoE. The DCAA operates on a different schedule, typically six months from SSB submission, and then after review, if the audit finds items needing remedy, the contracting officer must correct and resubmit. This resets the six month DCAA schedule. Not only are there workforce morale issues with this schedule defect but also there are practical implications. The long lead-time between solicitation and work start requires what practitioners call "true-up." After the contract award, estimates are immediately re-baselined, which in our view, invalidates the time and work spent on the cost proposal construction and evaluation. Azhar, Farooqui, and



Ahmed (2008, p. 503) conducted a survey among construction firms and industry experts to determine the factors that increase the likelihood of cost overruns (cost risk). They warn of the dangers of lengthy acquisition schedules, where the estimates become more risky as the time between the solicitation and design increases. The underlying issue that causes the re-baselining is the tremendous requirements risk. As the solicitation process begins, the extent of the environmental damage is very unclear. When the EM solicits new work, it often is to replace a previous contract. Work from previous contracts is continuous during the new contract solicitation and award. By the time contractor and acquisition personnel award the contract, new knowledge of damage requires an immediate estimate change. In response, the DoE is now using a private firm, KPMG, for many of its audit requirements.

Re-baselining due to requirements change in the DoD arena stems from two major sources: intelligence on enemy capabilities and what the technology challenges are (Peck & Scherer, 1962, pp. 46–49). The DoE, on the other hand, has to overcome the requirements risk due to poor site characterization. Our discussions with DoE personnel explain their dilemma: the more robust the site characterization, the longer it takes to start work, the longer it takes to start work, the larger the cost adjustment. Our review showed no possibility of a positive relationship between poor requirements definition and high levels of project performance. The question then becomes how much requirements definition yields an effective, or realistic estimate. DoE personnel voiced this as the most difficult question, and they have yet to find the right balance. Some did cite the IDIQ process as a success, where the larger umbrella contract effectively screened contractors through an RFP, and actual work was piecemeal through Request for Task Proposals (RTPs). An abundance of project management literature emphasizes the importance of requirements definition and management. As Meli (1999) argued, “poor definition of objectives and inadequate allocation of resources are two of the most significant factors capable of negatively impacting the projects’ result” (p. 1). Goldstein and Ritterling (2001) echoed a similar point: “the accuracy of



cost estimates improves as project becomes more defined” (p. 103). They conclude that

cost estimates developed during the early stages of the cleanup process are based on limited information, but are typically given significant weight in making remedy selection and other types of clean up decisions. For this reason, it is important at this state to develop clean up cost estimates that are as complete and accurate as possible. (Goldstein & Ritterling, 2001, p. 121)

Although current cost proposals seem exceedingly robust, they obviously have achieved greater completeness and accuracy. On the other hand, if they are complete, their cost controls, or performance measurements, are insufficient. Our observations point to the former; however, our solution should not be to make the problem worse by requesting cost proposals with greater detail and justification. Instead, the EM should consider broader solutions. In other words, the cost growth phenomenon extends beyond contract management and administration. If variables in the pre-award sphere have little impact on overall contract or program cost performance, then policy makers can reduce current workloads that are not adding value. This can open the door to two phased acquisition approach, and can focus research on program management, performance measurement, and risk management. Before we explore more broadly, we must first understand how DoE requirements definition quantitatively relates to estimate changes. According to DoE personnel, proposal evaluation, acquisition schedule, and requirements definition are not the only sources of potential estimate changes. Contract type can lead to estimate adjustments as well.

Contract type refers to different contract vehicles: the fixed-price model pushes risk to the contractor, and the government assumes risk under the cost reimbursement model. We observed that for smaller projects, contracting personnel seek to employ fixed-price vehicles, and for larger projects they use cost plus incentives. Our observations show that for smaller stand-alone projects, firm-fixed price has worked well. Current contracts, such as the West Valley Demonstration Project (WVDP), include various non-remediation work such as landscaping and



snow removal. Ideally, services like this would be done under fixed-price vehicles, however, due to the DoE's limited acquisition personnel, contracting solicitation, evaluation, and management for smaller services are aggregated into the larger remediation contract. Furthermore, there are incumbent workers that the replacing contractor must hire, due to collective bargaining agreements with trade unions, inhibit cost savings. The literature sees contract type as a factor for estimate changes. A European Commission found that "the form of procurement and contract used by the project sponsor can alter an estimated cost of a project" (*Understanding and Monitoring*, n.d., p. 9). Oberlender and Trost (2001, p. 181), in a factor analysis study, sought to identify which factor groups associate with cost growth. They found that building and labor climate, where contract type is a determinant, account for 14.5% of explainable cost growth. In a forthcoming analysis we explore the relationship between contract type and estimate changes as well.

1. Federal and State Environmental Regulation

The previous factors that go into estimate changes all have one thing in common, they are all subject to the decision-making process; a "controllable" part of program and contract management. The last aspect of our discussions included the nature of federal environmental remediation, where the projects are very different and regulations are different from state to state. Acquisition personnel explained that contractors have difficulty writing Performance Work Statements (PWSs), because of unknowns, local regulation changes, and acquisition schedule. Gaston and Bell (1985) painted this picture:

Regulations are imposed by state legislatures, by regulatory commissions, and by city and county governments and their subordinates. Each entity acts at times without regard for actions taken at other levels of government. The potential tangle is staggering when one considers there are 22,250 governmental jurisdictions with some power to regulate. (p. 709)

Their research addressed the difficult regulatory burden facing private enterprise, but the same difficult standards apply to DoE acquisition personnel trying to meet regulatory compliance.



Our study is not the first time researchers have looked into the causes of environmental remediation cost overruns. In Warfel's (2007) examination of insurance solutions for environmental liability issues in the brownfield sites, he explained the general causes of cost growth:

Factors that can result in a cost overrun include, for example (1) discovery during the cleanup process that the contamination has spread further than what originally was thought; (2) discovery during the cleanup process of additional constituents that were not originally anticipated (e.g., discovery of oil constituents when removing contaminated soil); (3) the issuance by the board of a more stringent regulatory environmental remediation standard than what was originally negotiated with and approved by the board—this more stringent regulatory environmental remediation standard must be met because it was issued before the cleanup project was completed by the redeveloper; (4) a failure of the proposed technology (e.g., an engineering measure such as a liner system) to contain or control the migration of a regulated substance; and (5) schedule delays attributed to additional remediation work that was not anticipated. (p. 3)

Warfel (2007) extracted findings similar to our observations. Requirements definition, changing goals due regulatory uncertainty, overly optimistic technology solutions, and schedule delays all relate to cost growth. However, we focus on attempting to correct those estimates so that the cost overruns do not occur, which brings us back to the definition: A cost overrun, by its very nature will never be predicted with a cost estimate. The estimate, therefore, must incorporate the inherent risks in a project. We examine the potential causes, or associative properties of factors, that affect early cost-estimate changes. As a result of our observations and meetings with DoE personnel, we developed the model in Figure 5 to describe early cost estimates.



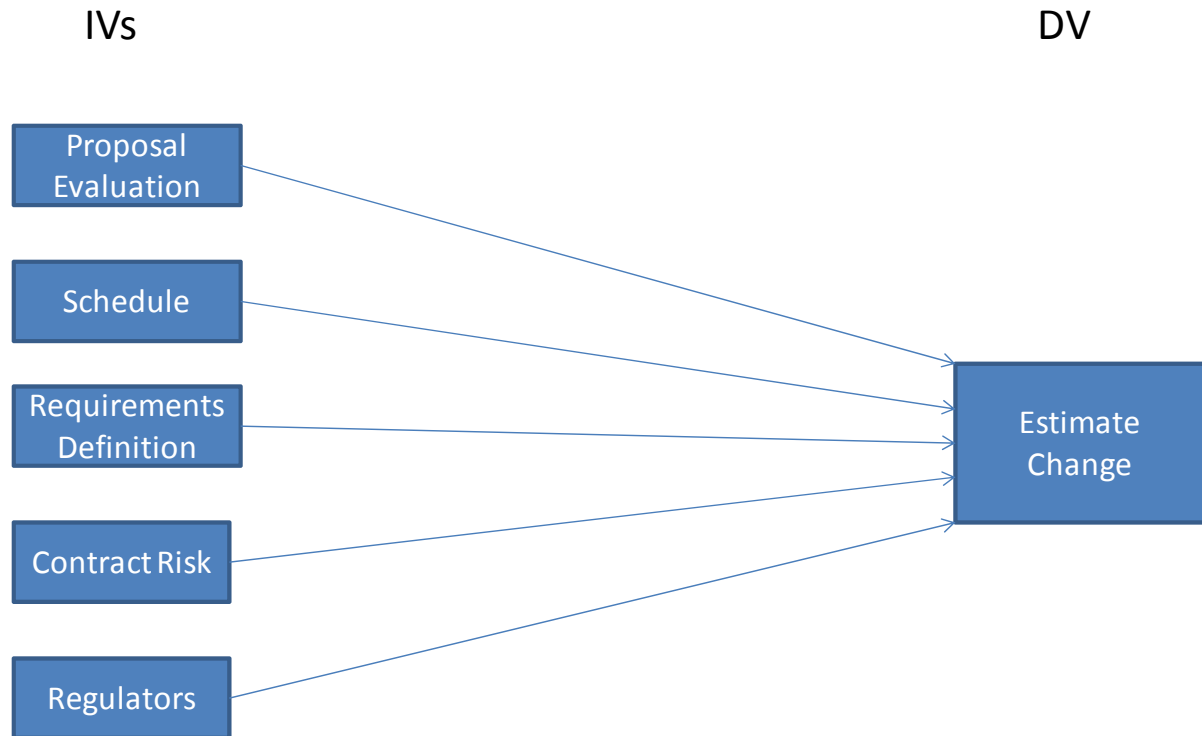


Figure 5. Early Estimate Change Model

L. Proposed Methodologies

Inside and outside of academia benchmarking is a natural process of identifying the most effective processes that meet individual and/or organizational goals. The methodology itself is not necessarily groundbreaking; however, with its careful use and implementation, benchmarking can identify those best practices that can bring about necessary transformational change. Before we utilize this method, we first provide relevant literature to identify strengths and weaknesses.

As McCabe (2001) wrote in *Benchmarking in Construction*, “if any individual or group wishes to consider how it should attempt to improve the way in carries out any task(s), the best method is to look at how others do so” (p. 26). Some of the positive benefits of benchmarking include low costs, speed, and relatively simple data collection (McCabe, 2001). Conversely, there are some challenges in benchmarking. A study on the effectiveness of public-sector benchmarking cited one major shortcoming: implementation challenges and skepticism of applicability



(Kouzmin, Loffler, Klages, & Korac-Kakabadse, 1999, p. 121). Despite the potential shortcoming, benchmarking is our initial methodology.

As we continue with our research, we plan to utilize data from several sources. We will use the Project Assessment and Reporting System (PARS) II, and Integrated Planning, Accountability, and Budgeting System (IPABS) databases to gather Earned Value Management (EVM) data and www.fbo.gov for contractor demographics and contract attributes. Once built, we will use appropriate statistical methods to analyze the data. We intend to use both case study analysis and regression analysis. We plan to compare the most current practices in the East Tennessee Technology Park (ETTP) with historical examples, and illustrate more generalizable findings with a quantitative analysis of population data.

M. Summary

In this literature review we aimed to shed light on the many aspects of the DoE EM's cost proposal process. First, we defined environmental remediation. Then, we discussed who, at the federal level, executes environmental remediation contracts. After that, we discussed the importance of integrating community interests in remediation decisions and how those interests bring about the increasing regulatory framework. In addition, we explored how regulations can impact remediation decisions and how they can then create obstacles for site closure. We highlighted six major federal laws that make environmental remediation contracting more difficult. We explained how the DoE contracting environment is more difficult than industry or the DoD experience. Following that, we pointed out some successful experiences in government and private industry. Then, we discussed the aspect of cost proposal solicitation and evaluation. Next, we investigated cost growth as a measure of cost proposal effectiveness. Finally, we discussed our observations from DoE site visits and formulated a research model with potential methodologies.



Appendix A. DoE Root Cause Analysis Findings

1. DOE often does not complete front-end planning (project requirements definition) to an appropriate level before establishing project baselines.
2. DOE does not have an adequate number of federal contracting and project personnel with the appropriate skills (e.g., cost estimating, scheduling, risk management, and technical expertise) to plan, direct, and oversee project execution.
3. Risks associated with projects are not objectively identified, assessed, communicated, and managed through all phases of planning and execution.
4. Failure to request and obtain full funding or planned incremental funding results in increased risk of project failure.
5. Contracts for projects are too often awarded prior to the development of an adequate independent government estimate.
6. DOE acquisition strategies and plans are often ineffective and are not developed and driven by federal personnel. DOE does not begin acquisition planning early enough in the process or devote the time and resources to do it well.
7. The DOE organizational structure is not optimized for managing projects.
8. DOE has not ensured that its project management requirements are consistently followed. In some instances projects are initiated or carried out without fully complying with the processes and controls contained in DOE policy and guidance.
9. Ineffective DOE project oversight has sometimes resulted in failure to identify project performance issues in a timely manner.
10. DOE is not effectively executing its ownership role on some large projects with respect to the oversight and management of contracts and contractors.



Appendix B. DoE Corrective Action Status

Significant Contract and Project Management Issues and Associated Corrective Measures	Status
1. CM 1 – Improve Project Front-End Planning	Complete
2. CM 2 – Enhance the Federal Contract and Project Management Workforce	Substantially Complete
3. CM 3 – Improve Project Risk Assessment, Communication, and Management	Complete
4. CM 4 – Align and Integrate Budget Profiles and Project Cost Baselines	Substantially Complete
5. CM 5 – Improve Independent Government Cost Estimates	Partially Complete: FY11
6. CM 6 – Improve Acquisition Strategies and Plans	Complete
7. CM 7 – Improve Project Oversight and Management ¹	Partially Complete: FY12
8. CM 8 – Improve Adherence to Project Management Requirements	Complete



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Appendix C. Federal Acquisition Regulation

15.305 Proposal Evaluation

(a) Proposal evaluation is an assessment of the proposal and the offeror's ability to perform the prospective contract successfully. An agency shall evaluate competitive proposals and then assess their relative qualities solely on the factors and subfactors specified in the solicitation. Evaluations may be conducted using any rating method or combination of methods, including color or adjectival ratings, numerical weights, and ordinal rankings. The relative strengths, deficiencies, significant weaknesses, and risks supporting proposal evaluation shall be documented in the contract file.

(1) *Cost or price evaluation.* Normally, competition establishes price reasonableness. Therefore, when contracting on a firm-fixed-price or fixed-price with economic price adjustment basis, comparison of the proposed prices will usually satisfy the requirement to perform a price analysis, and a cost analysis need not be performed. In limited situations, a cost analysis (see [15.403-1\(c\)\(1\)\(i\)\(B\)](#)) may be appropriate to establish reasonableness of the otherwise successful offeror's price. When contracting on a cost-reimbursement basis, evaluations shall include a cost realism analysis to determine what the Government should realistically expect to pay for the proposed effort, the offeror's understanding of the work, and the offeror's ability to perform the contract. (See [37.115](#) for uncompensated overtime evaluation.) The contracting officer shall document the cost or price evaluation.

(2) Past performance evaluation.

(i) Past performance information is one indicator of an offeror's ability to perform the contract successfully. The currency and relevance of the information, source of the information, context of the data, and general trends in contractor's performance shall be considered. This comparative



assessment of past performance information is separate from the responsibility determination required under [Subpart 9.1](#).

(ii) The solicitation shall describe the approach for evaluating past performance, including evaluating offerors with no relevant performance history, and shall provide offerors an opportunity to identify past or current contracts (including Federal, State, and local government and private) for efforts similar to the Government requirement. The solicitation shall also authorize offerors to provide information on problems encountered on the identified contracts and the offeror's corrective actions. The Government shall consider this information, as well as information obtained from any other sources, when evaluating the offeror's past performance. The source selection authority shall determine the relevance of similar past performance information.

(iii) The evaluation should take into account past performance information regarding predecessor companies, key personnel who have relevant experience, or subcontractors that will perform major or critical aspects of the requirement when such information is relevant to the instant acquisition.

(iv) In the case of an offeror without a record of relevant past performance or for whom information on past performance is not available, the offeror may not be evaluated favorably or unfavorably on past performance.

(v) The evaluation should include the past performance of offerors in complying with subcontracting plan goals for small disadvantaged business (SDB) concerns (see [Subpart 19.7](#)), monetary targets for SDB participation (see [19.1202](#)), and notifications submitted under [19.1202-4\(b\)](#).

(3) *Technical evaluation.* When tradeoffs are performed (see [15.101-1](#)), the source selection records shall include—

(i) An assessment of each offeror's ability to accomplish the technical requirements; and



(ii) A summary, matrix, or quantitative ranking, along with appropriate supporting narrative, of each technical proposal using the evaluation factors.

(4) *Cost information* Cost information may be provided to members of the technical evaluation team in accordance with agency procedures.

(5) *Small business subcontracting evaluation.* Solicitations must be structured to give offers from small business concerns the highest rating for the evaluation factors in [15.304\(c\)\(3\)\(ii\)](#) and (c)(5).

(b) The source selection authority may reject all proposals received in response to a solicitation, if doing so is in the best interest of the Government.

(c) For restrictions on the use of support contractor personnel in proposal evaluation, see [37.203\(d\)](#).



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