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D&D OF HANFORD'S RETIRED PRODUCTION REACTORS: AN OPPORTUNITY TO DEMONSTRATE BEST COMMERCIAL PROCUREMENT PRACTICES

Paul Pak
U.S. Department of Energy, Richland Operations Office, Environmental Management

Dennis Houston
Robert F. Potter
Bechtel Hanford, Inc., Environmental Restoration Contractor

ABSTRACT

One of the U.S. Department of Energy's (DOE) strategic objectives of the 1990s was to identify ways to bring best business practices of the private sector (i.e., best commercial practices) to the management and execution of the department's Environmental Management (EM) Program. The decontamination and decommissioning (D&D) of nuclear reactors is an area of common interest in both the commercial electric utility industry and in the DOE complex. The nuclear utility industry has a number of commercial nuclear plants in various stages of decommissioning – pre-shutdown planning, deactivation, decontamination, partial dismantlement, or completed demolition to a brown-field or green-field condition. The DOE EM Program has a number of shutdown reactors ready for D&D, including eight of the nine shutdown plutonium production reactors on the Hanford Site.

In 1998, the DOE Office of Procurement and Assistance Management, in conjunction with the DOE Contractor Purchasing Council (CPC), conducted a benchmarking study to identify best commercial procurement practices that could be applied to DOE D&D projects. The benchmarking study included four commercial nuclear power plants that were in various stages of decommissioning. The study identified several new best commercial practices being used on commercial D&D projects, and confirmed a number of practices that are currently being used by DOE and its contractors. The CPC report, *Benchmarking D&D Procurement Best Practices at Four Commercial Nuclear Power Plants*, as issued in October 1998, describes 10 lessons learned and best commercial practices identified in the study of the four nuclear power plants. (1)

The decommissioning project to place Hanford's C Reactor in interim safe storage (ISS) for up to 75 years began in August 1996, and was successfully completed in September 1998. The C Reactor is the first of eight Hanford Site retired reactors that will be placed in ISS. The B Reactor, which was Hanford's first reactor to produce plutonium, has been placed on the National Historic Register and is scheduled to become a museum. ISS activities for the next two Hanford Site reactors, F and DR, are currently underway, and ISS is planned for five other Hanford Site reactors: D, H, K-East, K-West, and N Reactor.

Many of the lessons learned and best commercial procurement practices identified in the CPC benchmarking study report were utilized on the successful C Reactor ISS Project. The specific lesson learned -- that "project acceleration saves big money" -- can be demonstrated in a multiple reactor ISS project for the next four reactors at the Hanford Site.

INTRODUCTION

The end of the cold war introduced one of the most dramatic changes in the history of America's military-industrial complex. With the arms race over, one could conclude that there would only be a need to maintain the viability of the nation's nuclear arsenal. However, it soon became apparent that another monumental task faced the nation as a result of the cold war victory. It was soon realized that, the nearly 50 years of weapons development, manufacturing, and testing by the DOE, its predecessor agencies and their contractors had created a legacy of radioactive, chemical, and hazardous waste contamination that could pose major risks to the public and the environment. The magnitude of this cleanup effort has created the largest EM Program in the world. DOE's EM Program has a current life-cycle estimate of more than \$150 billion, and a completion schedule of more than 50 years. In the late 1980s, the primary mission of a number of sites in the DOE complex, including DOE's Hanford Site, changed from weapons production to environmental cleanup.

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With the change in mission from weapons production to environmental cleanup came the need for changes in culture, management approach, and contracting strategies. To successfully make these changes DOE faced a number of challenges, including the development of accurate baseline schedules and cost estimates, implementing effective project management techniques, and initiating contract reforms that needed to incorporate experiences and practices of the private industry. In 1994, DOE Richland Operations Office (DOE/RL) executed the Richland Environmental Restoration (ER) Contract. This contract was one of two contracts in the DOE complex executed to demonstrate contract reform and to bring best commercial practices to the DOE EM Program. Bechtel Hanford, Inc. (BHI), a subsidiary of Bechtel Corporation, was selected as the Environmental Restoration Contractor at the Hanford Site. The Bechtel Corporation is a company with over a century of commercial engineering and construction/project management experience.

Also in 1994, DOE's Procurement Executive joined with senior executives from DOE contractor organizations to create the DOE CPC. The purpose of the CPC was to develop a cooperative government/industry relationship, and to determine how the "best commercial practices" of private industry could be applied to DOE's new cleanup mission. Since its formation in 1994, the CPC has sponsored a number of benchmarking and best practices studies, including a commercial D&D procurement benchmarking study that was conducted in 1998. This study, in partnership with the DOE Office of Procurement and Assistance Management and five DOE contractors, benchmarked four commercial nuclear plants that had completed or were in the process of D&D. The primary purpose of the study was to learn from the experience and practices of others in order to address the pending D&D procurement challenges throughout the DOE complex.

FOUR COMMERCIAL NUCLEAR PLANTS CHOSEN FOR D&D BENCHMARKING

The four nuclear power plants used in the CPC study were Oyster Creek, Trojan, Fort Saint Vrain, and Maine Yankee. The following is a historical summary of each plant.

Oyster Creek Nuclear Generating Station

The Oyster Creek Nuclear Generating Station, owned by GPU, Inc., and operated by GPU Nuclear, Inc. (GPUN), is located in Forked River, New Jersey. Oyster Creek is a 640 Mwe boiling water reactor. The plant has operated since 1969 and has a U.S. Nuclear Regulatory Commission (NRC) license to operate to the year 2009. In 1998, with the expected deregulation of the electric utility industry, GPU, Inc. evaluated the competitiveness of the Oyster Creek Plant in a deregulated marketplace. At the time of the benchmarking study, one option being studied included early plant shutdown with decommissioning planned to begin in 2000. The plan was for GPUN to serve as its own Decommissioning Operations Contractor (DOC), and to establish an integrated project team with specialty contractors. GPUN planned to perform as much of the work in-house as possible, to minimize job loss, and to enter into specialty contracts for additional support, as needed. Since the study report was issued, GPU, Inc. has decided to sell the Oyster Creek Plant, and the pending purchase is based on the plant operating for a number of years.

Trojan Nuclear Power Plant

The 1100 Mwe pressurized water reactor Trojan Nuclear Power Plant is located in Rainier, Oregon. Portland General Electric (PGE) operated the plant from 1976 until its shutdown in 1993. In the early 1990s, the plant was in need of major repairs and/or replacement of the plant's steam generators. At the same time the region was experiencing an abundance of inexpensive hydroelectric power from Canada. A 1992 cost-benefit analysis determined that it was in the best interest of ratepayers and stockholders that the plant be shut down, rather than making the necessary major repairs or replacing the steam generators. The plant was shut down and decommissioning began in 1993, more than 20 years before the expiration of its NRC operating license. PGE is performing the D&D as an integrator with specialty contracts, using detailed up-front, multi-year planning and in-house personnel. As of August 1999, the steam generators and the reactor vessel have been removed, barged up the Columbia River, and disposed in a commercial burial ground on the Hanford Site.

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Fort Saint Vrain Nuclear Generating Station

The Fort Saint Vrain Nuclear Generating Station, located outside of Denver, Colorado, was operated by the Public Service Company of Colorado (PSC). The plant received a 60-year operating license in 1973. The 330 Mwe high-temperature, gas-cooled reactor plant went on line in December 1976. In 1989 the plant was shut down because of its history of high operating costs and frequent shutdowns. Decommissioning began in 1992, and was completed in 1996. Following the NRC's review of PSC's final radiation survey report and follow-on inspections and confirmatory surveys, the NRC released the site and facility for unrestricted use and terminated the operating license in 1997. The site has since been re-powered with a 130 Mwe gas-fired turbine generator.

Maine Yankee Nuclear Power Plant

The Maine Nuclear Power Plant, in Wiscasset, Maine, was operated by the Maine Yankee Atomic Power Company. The 820 Mwe pressurized water reactor went into commercial operation in 1972. As a result of economic and deregulation issues, the Board of Directors voted to shut the plant down in 1997. Maine Yankee, the plant owner, and Entergy, Inc., a management contractor, are managing the D&D as an integrated management team. The management team awarded a firm fixed-price contract for the site characterization, and has executed a multi-year firm fixed-price contract for a DOC.

A summary of the lessons learned and best practices that were identified and discussed in the CPC benchmarking study of these four plants are shown in Table I. (1)

Table I. Lessons Learned and Best Commercial Practices Identified and Discussed in CPC D&D Benchmarking Report.

• Innovative Contracting Models Solve Old Problems, Save Money/Time
• Performance Based Incentives (PBIs) Work
• Competitive Use of Pre-Qualified Vendors
• Unproven Technologies are Risky and Time Consuming – Keep it Simple
• Finish Line/Closure Culture
• Property Disposition
• Planning/Project Controls
• Safety/Environmental Compliance/Quality Expectations
• Manage or Eliminate Risks
• Project Acceleration Saves Big Money

HANFORD'S C REACTOR IS THE FIRST OF DOE'S SURPLUS PLUTONIUM PRODUCTION REACTOR PLACED IN 75 YEAR SAFE STORAGE STATUS

In 1942, the United States government commissioned the Hanford Site to produce weapons-grade plutonium. Between 1942 and 1955, nine water-cooled, graphite-moderated production reactors were constructed in the 100 Areas on the Hanford Site, along the Columbia River, as shown in Fig. 1. The C Reactor facility is located in the 100-B/C Area of the Hanford Site. Construction of C Reactor began in June 1952 with startup in November 1953, 17 months after groundbreaking. The design of the facility was based on the earlier Hanford Site reactors. Drawings of the older facilities were modified for C Reactor design drawings.

The C Reactor facility houses a single-pass, graphite-moderated production reactor. The building is 106 m by 93 m by 30 m (346 ft by 305 ft by 98 ft) in height. The lower levels of the building (and the central portions surrounding the reactor) are made out of reinforced concrete. The massive reinforced-concrete walls surrounding the reactor are 0.9 m to 1.5 m (3 ft to 5 ft) thick. The upper portion of the building, and many of the at-grade ancillary rooms, are steel-framed and enclosed with corrugated asbestos cement (transite). The roof is constructed of badly deteriorated

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poured-in-place gypsum, with felt paper and gravel roofing serving as a waterproof membrane. Fig. 2 shows a pre-1996 aerial photo of the C Reactor, and a floor plan of the facility. The C Reactor was the principal Hanford Site facility for testing the effects of power level increases, graphite burn-out, and fuel design for contemporary, new and future reactors. Reactor operations terminated in April 1969, and deactivation activities were initiated. These activities involved defueling the reactor, and deactivating the operating system. Deactivation of the C Reactor was completed in early 1971.

In 1993 a Record of Decision was issued by DOE stating that the preferred decommissioning alternative for the Hanford production reactors was to place the reactors in safe storage followed by deferred one-piece removal of the reactor block and transporting the block to a specially prepared burial facility in the Central Plateau of the Hanford Site.

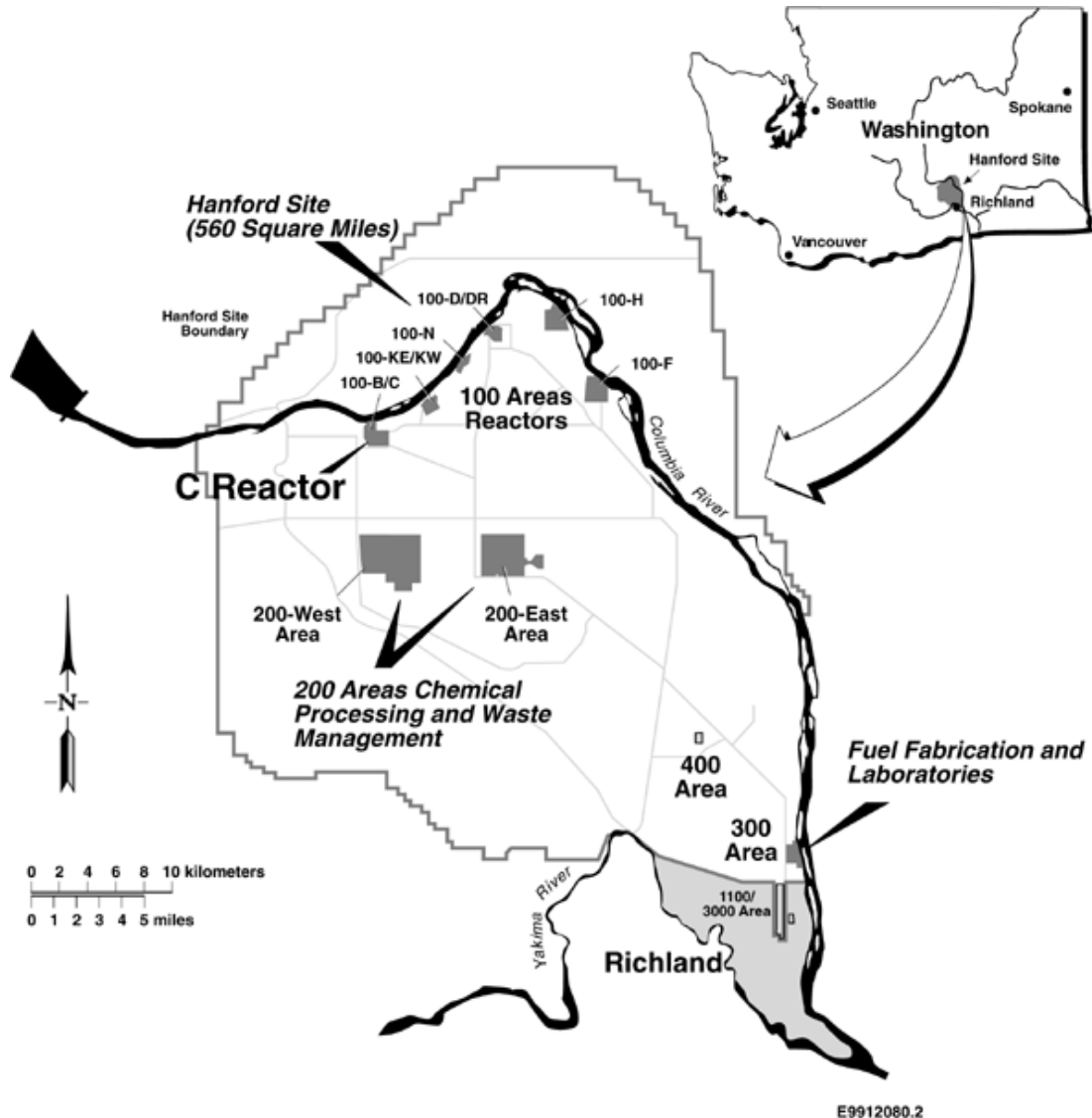


Fig. 1. The U.S. Department of Energy's Hanford Site.

The C Reactor was selected as the first Hanford reactor to be placed into ISS due to the advanced deterioration of roof sections of the reactor building. These sections would have required extensive repair. The design effort for the

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project had to incorporate long-term facility surveillance and maintenance (S&M) needs into the plan for storage of the reactor. The protective structure that would remain was required to be durable, while providing for safe access and practical follow-on maintenance operations. The following are some of the main features of the ISS design:

- Safe storage for up to 75 years
- No credible releases of radionuclides to the environment under normal design conditions
- Required interim inspections on a five-year frequency basis
- Completion of a safe storage enclosure (SSE) configuration that would NOT preclude or significantly increase the cost of any final decommissioning alternative.

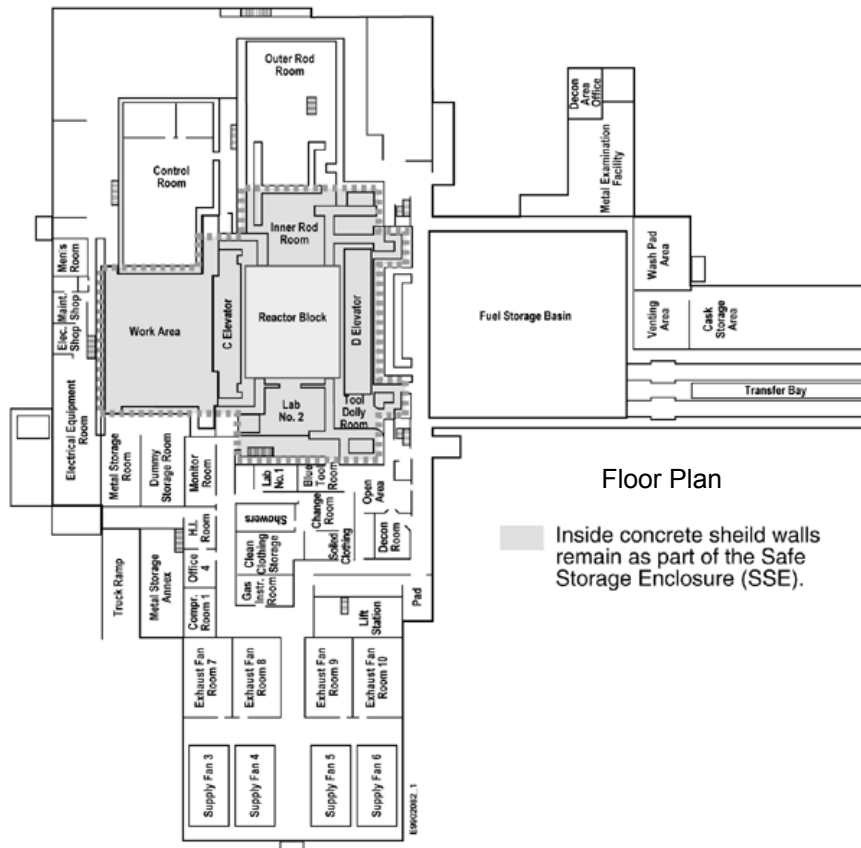


Fig. 2. C Reactor.

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The ISS Project for C Reactor included removing all portions of the reactor facility outside of the reactor block shield walls. The areas removed included the fuel storage basin, the metal examination facility, outer rod room, control room, electrical room, switchgear room, lunch room, office space, fan supply and exhaust rooms, sample rooms, ready rooms, lift station, upper reactor framing and roofing, and other miscellaneous rooms and tunnels. The demolition reduced the original footprint of the reactor facility by more than 80%, while the remaining portion of the reactor facility (the areas inside the concrete shield walls, as shown in Fig. 2) became part of the SSE. After the upper reactor demolition was completed, new anchor bolts were grouted into the top of the concrete shield walls and new structural framing was installed. Galvalum-coated steel roofing and siding was then attached to the framework. Galvalum is a coating that contains 55% aluminum and 45% zinc. The resulting “cocoon” placed the reactor core in safe condition for at least 75 years, while accommodating surveillance inspections that are scheduled for every five years. The completed ISS of the C Reactor is shown in Fig. 3.



Fig. 3. C Reactor in Interim Safe Storage. (The reactor footprint was reduced by more than 80%.)

The C Reactor ISS Project was completed on schedule in September 1998 -- 24 months after the decommissioning of the reactor began. The project was completed with more than 260,000 hours of work without a lost-time injury, and with zero radiological skin contaminations. The C Reactor ISS Project successfully demonstrated 20 innovative technologies that have since been deployed on other DOE projects in both the United States and in the former Soviet Union. In recognition of these achievements, the project was also selected as one of three international finalists in the Project Management Institute 1998 “Project of the Year” competition. (2)

HANFORD’S REACTOR ISS PROJECTS DEMONSTRATE BEST COMMERCIAL PROCUREMENT PRACTICES IDENTIFIED IN BENCHMARKING STUDY RESULTS

The C Reactor ISS Project demonstrated the lessons learned and the application of the best commercial procurement practices identified and discussed in the October 1998 report on the CPC benchmarking study of D&D projects. The following is a summary of the lessons learned and best practices discussed in the study report, and how the

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completed C Reactor ISS Project demonstrated those practices. Also discussed below is how one specific lesson -- “project acceleration saves big money” -- can be demonstrated in a multiple reactor ISS project for the next four Hanford reactors.

Innovative Contracting Models Solve Old Problems, Saves Money/Time

The primary objectives of the contract reform initiative for the DOE EM Program were as follows:

- Focus on accomplishments and outcomes, rather than on process; i.e., organize the work as a project, and manage the work with a focus on completion.
- Implement performance-based accountability for management contractors; i.e., pay contractors for measurable performance and deliverables, not for effort.
- Use lump sum, fixed-price subcontracting, where appropriate; i.e., control costs by using fixed-price contracts for defined scopes of work.

The Hanford ERC and the C Reactor ISS Project have demonstrated these key objectives and the effectiveness of the contract reform.

The Richland ER Contract is a project management contract, using specialty subcontractors to execute the work. The site-wide environmental restoration scope of work is organized and managed as a project: the Richland ER Project. Major elements of the work scope, such as the C Reactor ISS, are also managed as projects and executed under strict, directly applicable project management cost and schedule controls. Detailed work plans are developed for each project, with a clear definition of cost, schedule, and deliverables; a defined end-state; and a focus on completing the project on schedule.

A major regulatory driver for the cleanup of the Hanford Site is the *Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement)*. The DOE, the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology executed the *Tri-Party Agreement* in May 1989. (3) The milestones of the *Tri-Party Agreement* are used to develop the life-cycle long-range plan for Hanford Site cleanup. The long-range plan integrates the technical scope, cost estimates, and detailed schedules with a prioritization logic to identify the funding levels necessary to complete the cleanup milestones in the *Tri-Party Agreement*. By applying a project management approach to the ER Project Long-Range Plan, the baseline cost estimate for the Richland ER Project was reduced by \$8 billion (from \$20.4 to \$12.3 billion), and the completion schedule was accelerated by 12 years (from 2047 to 2035). (4)

Performance-Based Incentives (PBIs)

Performance-based contracting, using performance incentives, has been used successfully in the commercial construction industry for many years. Commercial construction contracts often use target labor hours with incentives, but D&D projects are currently inclined toward firm fixed-price contracts, using clearly defined scopes of work. Detailed scopes of work, along with accurate site characterization and well-defined end-states, are critical if firm fixed-price contracting is to be effective for decommissioning projects. (1)

The ER Contract is a 100% performance-based contract, with performance incentives established for each fiscal year. Fee is paid to BHI for accomplishing pre-negotiated measurable milestones and deliverables. *Tri-Party Agreement* compliance milestones are included as part of the annual performance incentives for the ER Contract. During FY 1997 and 1998, interim milestones for the C Reactor ISS Project were included in the ER Contract Performance Fee Plan. The *Tri-Party Agreement* milestone to complete the ISS by September 30, 1998, was an incentive in the FY 1998 ER Contract Performance Fee Plan.

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Competitive Use of Pre-Qualified Vendors

Key elements of DOE's EM Program contract reform initiative were as follows:

- Subcontract as much site cleanup work as possible
- Increase the amount of lump sum/fixed-price subcontracts
- Focus more activities on accomplishing cleanup work in the field.

BHI subcontracts more than \$50 million per year, which is approximately 40% of the ER Project's annual budget. This amount of subcontracting is significantly more subcontracting for construction/remedial action type work than is normal for a conventional DOE site Management and Operation contract. Since 1995, the percentage of lump sum/fixed-price subcontracting for the ER Project has increased from 40% to more than 70%, and the percentage of work directly related to in-the-field remedial action work has increased from 33% to more than 80%.

Standard BHI subcontracting practice is to pre-qualify vendors for all construction and/or remedial action subcontracts prior to issuing requests for proposals. Each pre-qualified vendor must demonstrate an ability to meet minimum financial requirements for a bid bond, performance bond, and payment bond. Each potential subcontractor must also have a minimum number of years' experience and project references in the following areas of expertise: general construction, hazardous waste, remedial action, and radiological work. In addition, each contractor must be able to commit the availability of a full-time site superintendent and radiological/safety engineer with minimum qualifications in those same areas of expertise. However, even with the above conditions met, there is one criterion that is an immediate qualifier (or disqualifier). This is a contractor's safety record. To be selected as a pre-qualified vendor, a company must have a documented Experience Modification Rate (EMR) of 1.0 or less for fieldwork over the immediate past three years. The EMR is a factor that ranks a company's industrial safety record against companies of similar size and industry. The EMR also is a factor assigned by the insurance industry to measure a company's rate of insurance claims for personnel injuries, when compared to companies of similar size in the same industrial category. An EMR of less than 1.0 indicates that company's rate of injury claims is less than the average for companies of similar size in their industry. The use of these type of criteria for pre-qualifying vendors is standard procurement practice on commercial Bechtel project/construction management contracts.

For the C Reactor Project, a total of 22 major procurements were placed, including subcontracts for the conceptual design of the SSE, the demonstration and deployment of 20 innovative technologies, and the final design, fabrication, and installation of the SSE.

Unproven Technologies are Risky and Time Consuming

There is always the need for new technologies and new applications for existing technologies in emerging markets. However, in the decommissioning of commercial nuclear plants, the plant owners and the decommissioning managers expect the decommissioning contractors they hire to have the expertise to choose the "right" technologies to meet the schedule and requirements in the NRC-approved decommissioning plan for their plant. While the potential rewards for using innovative technologies may be great, the potential risk to cost and schedule if the unproven technology or application were to fail are thought to be greater. The nuclear utilities do not want their plants to be test beds for demonstrating unproven technologies or applications. By using the well-defined scopes of work and performance-based, firm, fixed-price contracts that pass the risk for financial and schedule performance to the D&D experts, the owners believe that the contractors will select the best practices and technologies available to complete the project on schedule. (1)

In the case of the C Reactor ISS Project, however, the reactor did provide a test bed to demonstrate new and innovative D&D technologies that had the potential benefit of lower life-cycle costs, accelerated schedules, and reduced worker exposure, among others. The project benefited from a funding partnership between the DOE Environmental Restoration Program and the DOE Office of Science and Technology (OST). The C Reactor ISS Project was selected by the OST as one of three large-scale demonstration and deployment projects. These projects were to identify and demonstrate new and innovative D&D technologies that could benefit cost, schedule, and safety, and which could have potential applications on other DOE projects as well as in the private sector.

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Innovative technologies were identified and evaluated in the areas of characterization, decontamination, dismantlement, demolition, waste minimization and disposal, facility stabilization, and worker health and safety. The technologies were competitively selected using a “market search” approach where the project presented problems to industry and industry responded with ideas for innovative technologies and/or new application of existing technology. A team of international D&D experts reviewed more than 200 identified technologies and selected 20 technologies to be demonstrated at the C Reactor and compared to existing baseline technologies. The 20 technologies demonstrated in the C Reactor ISS Project are shown in Table II. Of those demonstrated technologies, 13 were successful for deployment. These have been added to the Hanford D&D toolbox, and have been deployed on other DOE projects both in the United States and in the former Soviet Union. (2)

Table II. 20 Technologies Demonstrated During the C Reactor ISS Project.

Laser-Assisted Ranging and Data (LARADS)	Concrete Shaving
Gamma-Ray Imaging	Concrete Diamond Grinder
Position-Sensitive Radiation Detector	Concrete Spaller
Self-Contained Pipe Cutting Shears	Reactor Stabilization
Heat Stress Monitoring System	Automatic Dust Suppression System
Mobil Integrated Temporary Utility System (MITUS)	System for Tracking Remediation, Exposure, Activities, and Materials (STREAM)
Seam-Seal Sack Suit	Residual Radioactivity Dose Model (RESRAD and RESRAD-BUILD)
Wireless Remote Monitoring	Nitrogen-Cooled Diamond Wire Cutting
2-D Linear Motion System	Compact Subsurface Discreet Sampler
High-Speed Clam Shell Pipe Cutter	Lead Decontamination (Chemical)

Finish Line/Closure Culture

A commercial electric utility, faced with the decommissioning of a commercial nuclear power plant, and the DOE (in pursuing the cleanup of the nation’s weapons complex) share a common management challenge. That challenge is managing a transition in culture from “operation and maintenance” to “cleanup and closure.” When the decision is made to decommission a nuclear power plant that has been operating for 20 to 30 years, utility management is faced with critical personnel issues. These issues include retaining the operating personnel with hands-on knowledge of plant operation and maintenance who will be invaluable in decommissioning, while separating personnel who are surplus to the decommissioning effort. For personnel who are retained, the most difficult management issue is to replace the employees’ “operational mind-set,” which has been directed at ensuring on-going plant operations for decades, with a “cleanup and closure” mentality. Over the many years of plant operations there has developed a strong sense of loyalty to the company and pride in keeping the plant operating efficiently. Over those years, the company and the plant have also become the cornerstone of these employees’ financial security and well being. Because of these emotional ties and a desire for job security, human nature has the tendency to prolong jobs as long as possible.

DOE has these same personnel issues in shutting down and cleaning up many of the sites and plants in its weapons complex. The majority of the employees on DOE sites do not establish deep-seated loyalties to contractor companies (on the site), because the majority of DOE site contractors change every five to ten years due to contract re-competition. But, since most of the DOE locations have been in operation for more than 40 years, many site employees have come to look to the site for career-long employment, and have a long established operation and maintenance mentality rather than the needed “cleanup and closure” mentality.

The need to develop a closure culture is being addressed by both the utility industry and the DOE. The utilities are hiring DOCs, and DOE is contracting with EM contractors who have project/construction management expertise

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that focuses on project completion. These companies address the challenge of overall plant decommissioning and all major tasks with project management discipline. The total scope and all major decommissioning tasks are managed as projects. The overall project and each major task has a defined beginning, intermediate milestones and accomplishments, and an agreed-upon definition of the completion state and dates for each milestone. Strict project management cost and schedule controls are used throughout the project duration. The emphasis on task and project completion is also increased by the use of performance-based contracts that pay the decommissioning contractors for meeting milestones and completing cleanup work.

One of the key factors in successfully focussing on project completion for the C Reactor ISS Project was instilling a sense of ownership and teamwork in both craft workers and the management team. By having the project work plans and schedules jointly developed by the workers and managers of each involved organization, all members of the project team took ownership of their respective work elements. All parties were held accountable for performing their portion of the plan, and the entire project team jointly celebrated the accomplishment of schedule objectives and the completion of milestones. This fostered a genuine atmosphere of teamwork, with the entire team focused on project completion and meeting the *Tri-Party Agreement* milestone to complete the C Reactor ISS Project by September 30, 1998.

Property Disposition

Decommissioning of nuclear power plants produces excess equipment, which represents a significant investment by the utility. It would be desirable to recover some of this investment to help offset the cost of plant decommissioning. Unfortunately, contrary to conventional wisdom, the net revenue recovered from the resale of surplus equipment does not approach paying a substantial part of plant decommissioning costs. In most cases, the cost and effort spent in selling the spare parts and unused equipment is more than the recovered revenue. In the case of major components, problems associated with interchangeability and certification of components makes the nuclear aftermarket less than lucrative. (1)

However, recycling of equipment and uncontaminated materials can represent substantial cost avoidance by reducing the cost of the waste disposal, which is a major cost element in plant decommissioning. One of the main objectives of the C Reactor ISS Project was recycling and waste minimization. The materials recycled during the C Reactor project are shown in Table III. (2)

Table III. Materials Recycled from the ISS of the C Reactor.

362 metric tons (400 tons) of steel
2,268 kg (2.5 tons) of copper and aluminum
36 metric tons (40 tons) of lead
3.8 L (1 gal) of mercury

Planning and Project Control

An important element in the successful management of a decommissioning project is the early involvement by all entities in the planning phase of the work. Participation and input from each organization and function involved in the project are required in order to establish a valid baseline cost and schedule for the project. Also, decommissioning of a power plant requires a set of management skills and tools that are totally different than the skills and tools used for day-to-day plant operations. The project management cost and schedule controls required for decommissioning are different than those used for managing power production. The cost and schedule controls used for decommissioning need to be similar to those used for the construction of large facilities, like the power plants being “de-constructed” in the decommissioning process.

For the C Reactor ISS Project the planning was conducted jointly between DOE/RL, the EPA, and the Washington State Department of Ecology. Major objectives and milestones for the 24-month project were documented in the

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Tri-Party Agreement, and interim objectives and milestones were negotiated between DOE/RL and BHI. BHI's performance fee was based on achieving both the *Tri-Party Agreement* milestones and the interim objectives and milestones. The project work plans and schedules were jointly developed by the workers and managers from all organizations involved in the project. The workers and managers from each organization then jointly took ownership of their respective work elements.

In the February 1999 Contract Performance Report for the ER Project, DOE stated that, "BHI designed, implemented, and manages the finest cost control system in the DOE complex. It has been used as a model for other DOE sites. From a detailed work baseline, through strict budget control, to a disciplined change control process, BHI knows and plans every dollar." The baseline and funds management systems used by BHI for the ER Project, and for the C Reactor ISS Project, use the same fundamental principles and practices used by the Bechtel Corporation for all major commercial project/construction management projects.

Safety/Environmental Compliance/Quality Expectations

For all the companies benchmarked, an excellent record of safety, environmental compliance, and quality in past performance was emphasized as a prerequisite for all subcontractors working on their projects. And, it was expected that high standards in these areas would be maintained throughout the duration of the decommissioning project. (1)

The ER Project maintains *SAFETY*, both industrial and radiological, as a principal core value. The objectives of the BHI safety program are no lost work days, an injury-free work place, zero skin contaminations, and reduced numbers of recordable injuries. Since the beginning of the ER Contract, the ER Project team has reached the one-million work-hour milestone without a lost work day three times, and the Occupational Safety and Health Administration (OSHA) Recordable Case Rate has been reduced from 6.46 cases per 200,000 hours worked in calendar year 1995 to 1.56 in 1999.

The C Reactor ISS Project demonstrated BHI's dedication to safety. Throughout the project, safety remained the paramount core value that guided the project. The importance of safety was emphasized in the design, procedure development, and day-to-day operations. The success of this emphasis on safety is reflected in the safety record for the project. A total of 276,300 manual and non-manual hours were spent on the entire project. During the duration of the project there were no (zero) lost workdays, and only 14 OSHA recordable injury cases. The project work was planned and executed using the as low as reasonably achievable radiological safety principle. The project was completed with no personnel skin contaminations and a total personnel radiation exposure of 3.4 person-rem. (2)

Key factors in maintaining a successful safety program include the teamwork and involvement of both craft labor and management. In July 1998, BHI and the Hanford Atomic Metal Trades Council (HAMTC) entered into a Joint Ownership Brings Success (JOBS) Alliance Agreement for the ER Project. The vision for the JOBS Alliance is to "create a cooperative long-term commitment that ensures a high quality, safe, productive work environment which is founded on mutual trust, open communication and sharing for success." The sharing for success includes the sharing with each HAMTC represented employee on the ER Project a portion of the annual performance-based fee received by BHI. There are four criteria used to determine the value of the shared fee each employee receives:

- The final score of BHI's annual performance appraisal – this is the percent of the total annual fee received by BHI compared to the total fee pool available. The final score is based on DOE's rated evaluation of performance in the areas of safety, quality, schedule, and cost.
- The number of lost time accidents during the performance period.
- The OSHA recordable injury rate for the performance period.
- The number of hours worked by the employee on the ER Project during the performance period.

The results of the Alliance and the sharing for success can be measured by improved safety performance, reduced employee concerns, and fewer grievances. From 1998 to 1999, the OSHA recordable case rate decreased from 3.65 to 1.56, the number of employee concerns were reduced from 12 to 6, and grievances from 72 to 33.

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Manage or Eliminate Risks

The complexity of decommissioning a nuclear plant presents a large degree of uncertainty and risk. Managing or eliminating as much risk as possible requires the participation and coordination of all elements of the owner's and the contractor's organizations involved in the decommissioning in the decision-making process for the entire duration of the decommissioning project. Of particular importance is the integration of the procurement and technical organizations in order to provide effective procurement planning and align subcontracting strategies with the technical and operational requirements of the project. Procurement, technical support, and project personnel need to be involved early in the planning stages of the project. This will allow them to define "what if" scenarios, develop procurement strategies, and prepare clear and concise specifications that will minimize uncertainties and eliminate "loose ends" that often represent financial risk. On large subcontracts, bidders are often asked to submit "what if" pricing with up-front adders or deductions in order to minimize change order negotiations later in the project. Reducing uncertainties and financial risks as much as possible up front reduces the need to include large contingencies when establishing the baseline cost and schedule for the project. (1)

For the C Reactor ISS Project, risk management was an integral part of managing the project and a major consideration throughout the decision-making process for the project. The very concept of constructing a SSE for the large, radiologically contaminated, retired plutonium production reactors that are located within a few hundred meters of the Columbia River was driven by the need to reduce risk to workers, the public, and the environment. Risk management was a consideration that was applied to developing the "cocooning" concept, to engineering design, to preparation of the baseline cost and schedule, to demolition of the ancillary facilities, to construction of the SSE roof, and to the identification and mitigation of industrial hazards during the final stages of the project. The development and approval of the "cocooning" concept for the C Reactor ISS Project involved DOE, regulators, stakeholders, and BHI. The project baseline cost and schedule, project work plans, and procurement plans were developed through close coordination between workers and managers from all the elements of the BHI organization that would have responsibility for any part of the project.

Risk management on the C Reactor project also included minimizing risks and exposures to all involved personnel. The highest potential for risk to the C Reactor Project work force was posed by radiological exposures, followed by industrial safety hazards associated with demolition work and construction of the SSE roof. The total project work force was located at the C Reactor job site, including project management, engineering, planning and scheduling, waste management, radiological engineers, and safety personnel. Daily plan-of-the-day meetings were held with all craft, subcontractors, and non-manual work force. Near-term schedule objectives and specific tasks for the day were discussed in detail. These daily meetings were an important factor in keeping project personnel aware of the risks involved in the work they were doing.

In dealing with radiological hazards, the project team used an approach that used historical data as a baseline and then updated work plans to reflect current sampling data. The baseline work plans were prepared based on old historical sampling records and knowledge of reactor operations that had occurred decades ago. The project's radiological sampling plans used the historical data as a starting point for obtaining current data profiles of conditions. The new data were then used to modify work packages and schedules to incorporate as-found conditions. Extreme precautions in personnel protection were used until actual plant conditions were verified.

As the C Reactor ancillary facilities were demolished, the physical size of the area where project activities took place became smaller. The competition for workspace between the BHI work force and subcontractors became greater. The daily planning meetings became more and more important to communicate each other's work effort, coordinate physical activities, distribute workspace, and identify and minimize the risk of industrial hazards. (2)

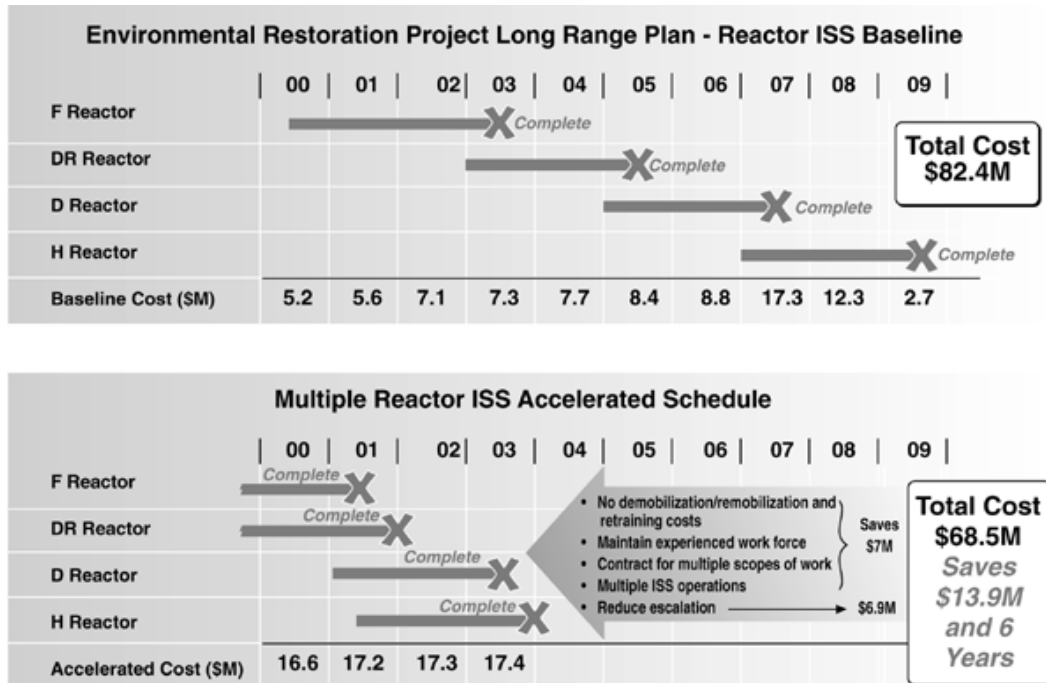
Project Acceleration Saves Big Money

Once a commercial nuclear plant is permanently shut down, it is no longer a revenue producer but -- instead -- a financial obligation for the utility's ratepayers and stockholders. Moreover, the longer it is before decommissioning begins, the more costs will be incurred. Significant savings can be realized by the utility by performing the decommissioning sooner rather than later. The CPC benchmarking study report showed that accelerating the decommissioning of shutdown nuclear plants can result in significant cost savings in the following areas:

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- The present value of today's work will be less than the cost of performing the same work in future years.
- Conducting nuclear plant decommissioning according to a current NRC-approved decommissioning plan under today's known regulatory climate, without concern for potential new, more costly regulations.
- Mortgage reduction by reducing the costs associated with utilities, security, maintenance and surveillance, and inspections.
- Labor cost reductions through the reassignment or separation of operating personnel not essential to the decommissioning operation. (1)

Following the completion of the C Reactor ISS Project, BHI initiated a plan to accelerate the ISS of the next four Hanford Site retired plutonium production reactors. The BHI plan demonstrates the conclusion described in the CPC benchmarking study report that "accelerated project completion saves significant dollars." The ISS of each of the next four reactors (F, DR, D, and H) is scheduled in the ER Project Long-Range Plan to be completed in 2003, 2005, 2007, and 2009, respectively, for a total estimated cost of \$82.4 million. (4) By using a multiple reactor ISS schedule instead of the series schedule as currently planned, a multi-reactor ISS project will complete the ISS on the next four reactors by the end of 2003 (that is at a cost of \$68.5 million). Compared to the \$82.4 million total cost estimate for the series schedule for the ISS of these four reactors, the accelerated multi-reactor ISS project will save \$13.9 million in costs and will accelerate the schedule by six years. The \$13.9 million in cost savings includes \$7 million in operating efficiencies and cost avoidance, and \$6.9 million in reduced escalation. Operating efficiencies will result from eliminating unnecessary duplication of management at multiple project sites, subcontracting for multiple scopes of work, and from retaining an experienced work force. Cost avoidance will result from not requiring demobilization, remobilization, work force reductions, and retraining of the new work force when the project is resumed. The \$13.9 million cost savings and the six-year reduction in the ER Project schedule (from FY 2009 to FY 2003) for the multi-reactor ISS project are shown in Fig. 4. In addition, the early ISS of these four reactors will result in a cost avoidance/mortgage reduction of \$2.5 million in facility S&M, which will occur during the nine-year schedule if the four reactor ISS projects are completed in series. The cost savings and avoidance that would result from accelerating the ISS for the next four Hanford Site reactors is the equivalent of completing the ISS of four reactors for the cost of three.



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Fig. 4. The Multiple Reactor ISS Project Baseline and Schedule.

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CONCLUSIONS

The CPC benchmarking study of D&D procurement practices used at commercial nuclear power plants identified a number of lessons learned and best practices that the private sector is using to provide a cost-effective approach to major D&D projects. The study also confirmed that DOE and its contractors are already utilizing many of those commercial practices, as part of DOE's initiative to bring needed contract reform to DOE's cleanup program.

The ER Contract at the Hanford Site, which was executed in 1994, has effectively implemented the original objectives of the contract reforms identified as needed if the new DOE cleanup mission is to proceed effectively. The C Reactor ISS Project at the Hanford Site, which was successfully completed in September 1998 under the Hanford ER Contract, demonstrated the principle of nine of the ten lessons learned and best commercial practices highlighted in the CPC study report. It is also of interest to note that, during the C Reactor ISS Project, utility representatives from two of the four power plants included in the CPC benchmarking study visited the C Reactor project team to observe progress being made and to discuss suggestions and recommendation the team could offer in support of the utilities' D&D planning.

The tenth lesson learned/best commercial practice highlighted in the benchmarking study report -- "project acceleration saves big money" -- can be very dramatically demonstrated by accelerating the ISS of the next four retired plutonium production reactors at the Hanford Site. By using a multiple-reactor ISS schedule, instead of the series schedule currently planned, the ISS of the next four Hanford Site reactors could be completed by 2003. This multi-reactor approach will save \$13.7 million in costs, and will accelerate the schedule for the ISS of four reactors by six years. This represents a 20% return-on-investment on the \$68.6 million cost of the multiple-reactor ISS project. In addition, the early ISS of these four reactors will result in a cost avoidance/mortgage reduction of \$2.5 million in facility S&M that will occur during the nine-year schedule if the four reactor ISS projects are completed in series.

The identified lessons learned and best practices that resulted from the D&D benchmarking study were only the beginning of what will be necessary to effectively drive the DOE EM to a successful completion. As concluded in the executive summary of the study report, "if the Department of Energy is going to achieve the strategic objective of the world's largest environmental clean-up of contaminated sites, then they are going to have to identify and implement leading edge thinking, practices and solutions." The study report should be "a starting point for continuous improvement of DOE and contractor's processes, practices, and initiatives to allow D&D to be performed safer, faster, better at reduces costs." (1)

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