WM'00 Conference, February 27-March 2, 2000, Tucson, AZ

ENVIRONMENTAL RESTORATION PROGRESS IN HANFORD'S 100, 200, AND 300 AREAS

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ABSTRACT

The Hanford Site's Environmental Restoration (ER) Project is the successful product of an experiment in focused work scope definition, incentivized performance-based contracting, and innovative technical and business management approaches conducted jointly by the U.S. Department of Energy, Richland Operations Office and its ER contractor team led by Bechtel Hanford, Inc. Since its inception in mid-1994, the ER Project has aggressively tackled the management and cleanup of the Site's extensive inventory of aging surplus nuclear facilities and contaminated waste sites. It has achieved many measurable and cost-effective results during this time and set in place the framework and conditions for ongoing performance success. This is in large part due to cooperative relationships and trust among many different government, regulatory, contractor, and public entities; willingness to apply proven commercial practices; disciplined control of cost and schedule baselines; the ability to adjust to changing conditions; relative consistency in annual Federal funding; and most importantly, the right kind of qualified and motivated people working together to plan and carry out the work.

INTRODUCTION

The Hanford Site's Environmental Restoration (ER) Project was initiated almost six years ago by the U.S. Department of Energy (DOE), Richland Operations Office as a demonstration of new contracting and work execution approaches to accelerate cleanup of the Site's immense inventory of contaminated facilities, structures, soils and groundwater.

While elements of the site characterization, feasibility studies, planning, and some cleanup activities had begun in prior years, the full focus of this effort really took hold mid-way through calendar year 1994 with the inception of the Environmental Restoration Contract (ERC).

Today, I'd like to focus on the real headway being made through this "demonstration project". However, to appreciate the progress, it's important to first establish a base understanding of the conditions that exist and how they came to be what they are.

HISTORICAL PERSPECTIVE

Hanford has always had its challenges.

Let's remind ourselves of what it was like back in the early 1940s. The nation's Defense Department launched the top-secret Manhattan Project in a race against time to produce a new type of weapon to help ensure the survival of the free world. The mission was to design, construct, and operate a complicated network of first-of-a-kind nuclear laboratories, fuel fabrication lines, reactor facilities and processing plants, stretching the known limits of science and technology. One of the primary sites chosen for these purposes was the remote Hanford area on the Columbia River in southeastern Washington state.

No one could be certain if the blueprints were right, or whether the systems and processes would even work. There was no time for second-guessing; the priority was to build and produce at all costs. As we know, the mission outcome was successful–an amazing accomplishment of technology, human effort, and national resolve.

World War II no sooner ended when another “war” brought a new sense of urgency and longer-term challenges. The pressing mission of the Cold War arms race greatly increased the demands for manufacture of nuclear weapons-grade materials, stressing the machinery, systems and structures beyond their original designs. To expand output capacities, technological developments were accelerated. Existing facilities were retooled and newer and more advanced facilities were added to the 560-square mile Hanford Site complex. Their operation posed ever-increasing requirements to store and to dispose of vast volumes of contaminated liquid and solid process wastes.

When the Cold War concluded after nearly five decades, the need for large-scale generation of weapons material at Hanford ceased. Production and processing facilities still in operation were shut down, adding to an overall inventory of thousands of contaminated defense-related structures, systems, and waste disposal sites across the country. As with the Manhattan Project, the Cold War mission had been successfully accomplished, but at a cost yet to be defined. At the Hanford Site alone, the legacy of the nuclear defense production era included:

- 9 graphite moderated nuclear reactors and their associated facilities
- 5 massive nuclear fuel re-processing ("canyon") facilities
- 177 underground storage tanks containing over 55 million gallons of liquid high-level radioactive waste
- 2,100 metric tons of deteriorating nuclear fuel
- 11 metric tons of plutonium
- 1,400 identified solid and liquid waste sites
- 5 million cubic yards of contaminated soil
- 100 square miles of contaminated groundwater.

During the 1970s and 80s, the American public had become more knowledgeable and concerned about nuclear safety and radioactive waste management issues. Events such as the accidents at Three Mile Island and Chornobyl certainly served to heighten those concerns in general. In 1989, the DOE declared a new mission for the nation’s nuclear defense complex: Environmental cleanup. Focus shifted to the environmental condition of the government’s formerly secret facilities and properties. An educated and interested public was eager to understand the legacy and the extent to which contamination problems existed. They were also anxious to correct any negative effects of past operations and practices.

It is important to remember that the design of these nuclear defense production facilities, the processes that were performed, and the waste disposal practices used were acceptable for the time when they were conceived. These plants were not built with eventual decommissioning or environmental cleanup in mind. The people responsible for the facility operations did realize the importance of worker, public and environmental safety, and did what they believed to be prudent and in the national interest. But they did not know the future, and they did not fully grasp the consequences of some operational decisions and actions. What we know today is that some of those operations and practices have left an environmental cleanup legacy of enormous proportions, and an equally immense financial burden. That legacy is our challenge to work with now.

ER DRIVERS AND CHALLENGES

Aspects of Hanford's ER scope today are similar to, but also very different from the initial construction phase for these facilities and waste sites. In many respects today's mission is much more challenging. In the cleanup era, we're working in a very open climate, with extensive new requirements and cleanup criteria; closely involved oversight agencies and auditing entities; ever-tightening funding restrictions; and heightened sensitivity and expectations from site stakeholders, interest groups, and the public at large.

Most of the deactivated and surplus facilities are 40, 50, or more years old. Their structures, equipment, and supporting infrastructure are deteriorating. Our knowledge of process systems and facility conditions is sometimes sparse because the veteran operating crews are gone.

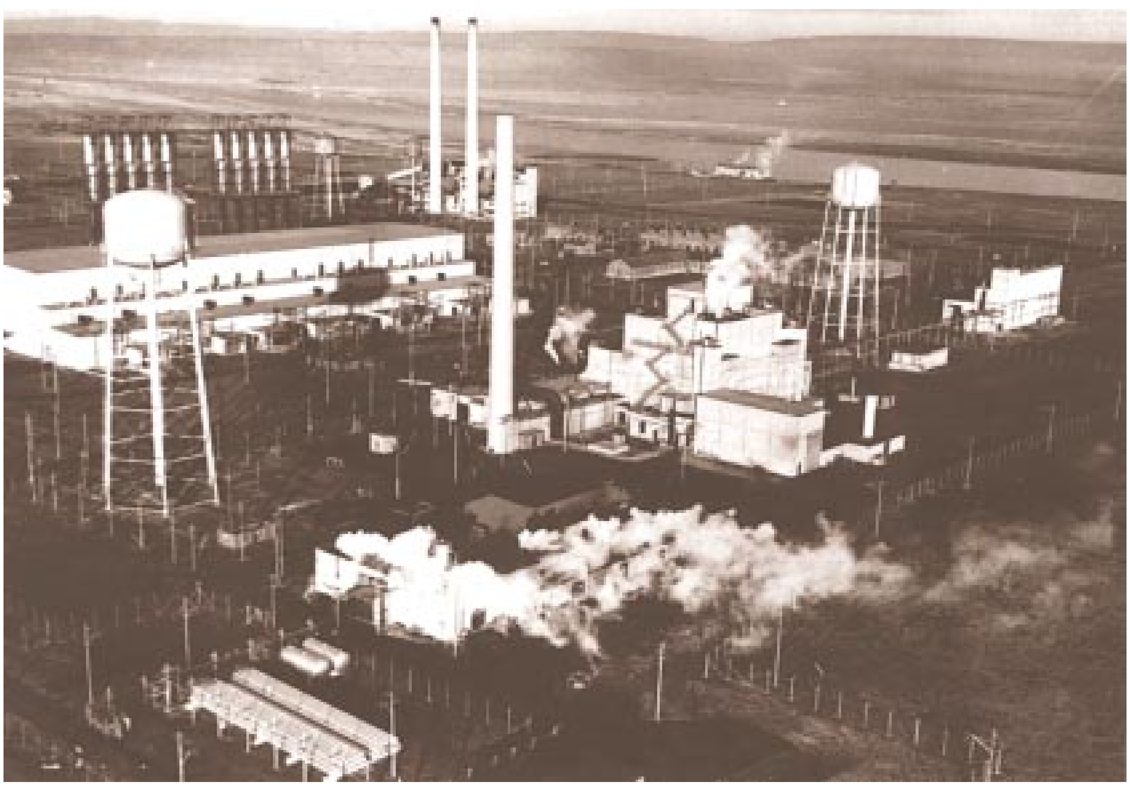

Figure 1. Like Self-Sufficient Cities. Hanford's B Reactor during operation, one of the Site's nine plutonium production reactor complexes built along the Columbia River.

Accurate records are lacking and detailed technical baseline information does not exist for all waste sites and facilities. Frequently, what we know is what we learn and record as part of shutdown, deactivation, and assessment.

Some of the outdated components in these buildings we still rely on today for ER, such as overhead cranes in the fuel reprocessing canyons, the elevators on the front and rear faces of the reactor blocks, and certainly ventilation and containment systems. Often, that reliability factor is either gone or waning.

Hanford's ER efforts have faced significant technical challenges, such as:

- What to do with abandoned nuclear reactor facilities that are too radioactively contaminated to affordably and safely dismantle in the near term, yet continue to physically deteriorate– significantly increasing risks to workers and the environment as well as the costs of repairing and maintaining them in an acceptable condition.
- How to fulfill the driving need for large-scale cost-effective waste disposal, with enough capacity to handle estimated millions of tons of contaminated soil and debris generated from ER work, yet situated as far as possible above and away from groundwater, and carefully engineered to contain any further spread of contaminants.
- How to remove large quantities of highly radioactive resins from an old storage basin at minimum cost and with minimum exposure to workers.
- How to decontaminate and safely deactivate two large and highly radioactive reactor fuel storage basins, with residual fuel fragments, abandoned equipment and components, miscellaneous scrap materials, fine-grained sediments, and huge volumes of murky contaminated water.
- How to attack the threat of subsurface radioactive and hazardous contaminants moving through soil and underlying groundwater into uncontaminated areas, and eventually to the Columbia River.

THE "PROJECTIZATION" OF ER

Much of the DOE's purpose in creating the ERC as a "demonstration" was to apply more commercial-like business practices to the cleanup work at Hanford. DOE management perceived that significant efficiencies could be gained by approaching the work in a manner similar to how engineering and construction projects were conducted in non-government industry. To do this, DOE extracted the ER-specific work scope from the Site's Management and Operations (M&O) contract and offered it through competitive solicitation as a separate prime contract, with different terms and conditions. The primary differences were to be:

- Placing much greater emphasis on competitively solicited and lump sum fixed price subcontracting of the field work
- Changing to a largely performance-based, results-oriented fee earning scheme tied to measurable accomplishments
- Putting the contractor's funds at risk instead of the Government financing the work through a letter of credit

- Operating under the DOE's financial accountability rule, making the contractor more directly liable for its own mistakes
- Encouraging the outsourcing of support services where savings could be demonstrated, and
- Approaching the complete scope of work as a project, with a beginning, a middle, and an end.

PROJECT-LEVEL PLANNING AND CONTROLS

The Hanford Site's ER planning efforts prior to the inception of the ERC sought to incorporate the complete site inventory of surplus facilities and waste sites into an overall summary plan. That plan, although preliminary in nature, did for the most part reconcile with DOE-Headquarters programmatic listings for Hanford. It also factored in the initial ER preferences and requirements of the Hanford Site's Federal Facility Agreement and Consent Order–referred to as the Tri-Party Agreement (TPA)–between DOE, the U.S. Environmental Protection Agency and Washington State Department of Ecology.

Shortly after the start of the ER Project in the summer of 1994, the signatories to the TPA and the new ERC Team (prime contractor Bechtel Hanford, Inc. and subcontractors CH2M Hill Hanford, Inc., IT Hanford, Inc., and Thermo Hanford, Inc.) worked together to reassess Hanford's ER priorities in light of projections of limited future funding. This partnering effort, which also incorporated input from Tribal Nations and site stakeholders, resulted in a refocused strategy that emphasized using available annual cleanup funds to "shrink" the Site from the outside in. This meant that most ER activities would be concentrated along the Columbia River in the 100 and 300 areas of the Site, with only interim actions performed in the 200 Areas on the central plateau. Given that direction, the ERC Team began a thorough top-down re-planning of the ER scope.

Concurrent with those activities, the ERC Team also carefully re-examined–from the bottom up–the cost and schedule estimate bases and planning assumptions for ER that had been previously developed. The most visible product from this comprehensive top-down/bottom-up planning activity was a tool we call the ER Long Range Plan, which has been continually maintained and updated since 1994. The Long Range Plan is an iterative "living document" used to guide, measure, and communicate progress. In essence, it integrates and embodies on a single sheet:

- The goals and objectives of the TPA
- DOE's Hanford Site and supporting ER strategic plans
- A formalized prioritization logic developed to support these strategies
- Input from site stakeholders and Tribal Nations on work priorities
- DOE-Headquarters long-term funding guidance
- The ER technical work scope and summary work breakdown structure, and
- ERC's execution plan, based on logic, cost estimates, detailed schedules, quantity information, and staffing requirements.

The ERC Team introduced a project-based planning and controls system at the outset of the contract featuring an ER-specific work breakdown structure, cost and schedule hierarchy and baselines, rigorous change control process, and supporting procedures. That system has helped to ensure financial accountability and control, eliminate "surprises", and maintain the integrity of the Long Range Plan. Planning and Controls staff routinely work with the individual ERC project teams and functional departments, and with DOE's ER oversight organization, other Site contractors, and regulators in the year-round cycle of: Multi-year and detailed annual work plan preparation, Financial Plan management, cost account and schedule monitoring, trend projections and variance analysis, progress reporting, evaluation of potential problem areas and funding impacts, and corrective action recommendations.

TECHNICAL WORK APPROACH

The ERC Team realizes the importance of blending plant operations knowledge with the newer aspects of environmental sciences, engineering, and health and safety (H&S) related disciplines required for cleanup work. A key to our success is the melding of all of these elements into a results-oriented construction-type project management approach. It's an approach similar in drive and character to Hanford's original construction phase, but tempered by the clear recognition that we must: Define the technical scope, understand and analyze the hazards, control the hazards, perform the work safely and cost-effectively, and implement lessons learned.

Figure 2. Controlling Hazards. An ERC decommissioning project team uses engineering controls, personal protective equipment, and task-specific work instructions to carefully remove a cover block and access plutonium-contaminated piping.

To go into these facilities and waste sites “blindly" would be unsafe for workers and the environment, and wasteful in terms of time, money, and physical resources. Conversely, we cannot spend too much time and effort up front studying the problem in great detail without getting on with the work; that also would be wasteful. Based on Integrated Safety Management System (ISMS) principles, we approach the ER work using a disciplined and procedure-driven process. This includes:

- Thoroughly researching existing relevant records (e.g., drawings, specifications, procedures, plans, technical reports, surveys, and photographs).
- Drawing on first-hand knowledge of current and former workers who are familiar with the specific processes and operations of facilities or waste sites.
- "Walking down" and visually inspecting the facility/site and then documenting our technical baseline of the conditions, hazards and risks.
- Gathering new data on physical and contaminant conditions to fill any fundamental information gaps:

  - for facilities, this may involve direct sampling in accessible areas, or using remotely controlled robotic equipment mounted with cameras and instruments in high radiation zones;
  - for waste sites, it may involve use of subsurface detection and imaging equipment, inserting instrument probes down new or existing boreholes to obtain readings, or digging sample excavation pits).

These steps aid us in bounding the envelope of risks associated with our scope. This allows us then to proceed with planning and performing the cleanup work in a safe, informed, and controlled manner. In applying this approach to actual ER work activities, we:

- Develop, review, and finalize our plans and work instructions with a strong bias toward safety of the worker, public, and environment.
- Engineer controls to eliminate or mitigate the hazards.
- Train and prepare for the full range of possible risks, and instruct each employee to immediately stop work if and when unexpected conditions or unacceptable risks are encountered (never exceeding the limits of the approved work scope and controls).
- If needed, reassess and re-plan activities using new information and engineering controls (reaching out to confer with other technical experts, as appropriate).
- Proceed again when the project team has completed its assessment, documented the changes, trained the work force, and declared readiness.

PERFORMANCE COUNTS

In the reality of today's ER mission, a particular programmatic challenge we face is becoming increasingly important. That is to successfully balance assessment and decision-making with measurable cleanup accomplishments. We've learned that we must continually succeed on both fronts in order to satisfy the expectations of the public, local stakeholders, Tribal Nations, Government oversight agencies, regulatory authorities, and elected state and Federal representatives. Through the influence and actions of these entities, our annual budget requests are evaluated and scrutinized, and funding is ultimately determined and appropriated. It can be a trying process; but in the end, the strongest allies in the effort to demonstrate progress and sustain the ER work are our visible cleanup results, proven cost efficiencies, and safe performance record.

We speak of progress at Hanford today in terms of three critical "outcomes": 1) Restore the River Corridor, 2) Transition the Central Plateau, and 3) Put DOE Assets to Work for the Future. The ER Project is actively engaged in helping to achieve each of these. Our extensive soil remediation, facility decommissioning, and groundwater management work in the Site's 100 and 300 Areas gets right at the heart of the River Corridor outcome. Similarly, our contaminated soil cleanup work, ER waste disposal operation, facility decontamination, maintenance and surveillance activities, and groundwater pump and treat systems in the 200 East and West Areas help fulfill the Central Plateau outcome. Lastly, we are helping to put DOE assets to work by sharing the results of these successes and lessons learned with others in the DOE Complex who face similar cleanup problems, and with other U.S. Government entities, U.S. commercial industry, and international governments and industry.

Figure 3. Cost-Efficient and Safe Disposal. The Environmental Restoration Disposal Facility has already received over 2 million tons of contaminated soils and material from ER Project sites along the Columbia River Corridor.

Here is where we have put our emphasis, and where our main successes have come over the past six years:

- Waste Site Remediation. Excavated and removed almost 1.8 metric tons (2 million tons) of contaminated soil and other buried materials from former liquid and solid waste disposal sites along the Columbia River in the 100 and 300 Areas. Cleaned up 85 individual waste sites to regulatory standards. Transported the low-level radioactive and hazardous material to the Central Plateau portion of the Site for safe disposal. Several large waste sites near the river are simultaneously being excavated this year. As each is completed it is backfilled with clean soils and restored to blend with the natural surroundings.

- ER Waste Disposal and Management. Constructed, operate, and recently doubled the capacity of the Environmental Restoration Disposal Facility (ERDF) on Hanford's Central Plateau. Re-scoped the initial facility design to eliminate costly extras and introduce an "expandable" concept. This allowed ERDF to be rapidly and efficiently constructed then subsequently enlarged as needed. Receiving only Hanford ER low-level wastes, it was opened 3 months ahead of schedule and $80 million under the original budget. To date, over 2 million tons of waste materials have been safely disposed in the facility. Two additional ERDF cells will be in use later this year. Transportation and disposal costs are the lowest in the DOE Complex.

- N Reactor Deactivation. Fully deactivated N Reactor, the "youngest" and largest of Hanford's nine plutonium production reactor facilities along the Columbia River. Safely removed more than 4,000 curies of radioactivity, including cleanout of the facility's highly contaminated nuclear fuel storage basins, and placed it in a stable condition awaiting eventual decommissioning.

- Reactor Interim Safe Storage. Safely placed C Reactor, another former plutonium production reactor, into a state of Interim Safe Storage (or "cocooning"). This precedent-setting action dramatically reduced C Reactor's "footprint" by demolishing 81 percent of the original facility, leaving the reactor block within its shield walls and capping it with a new corrosion-resistant roof. The remaining enclosure has a minimum 75-year design life, and only minor annual surveillance costs. C Reactor was acclaimed in 1999 by the Project Management Institute as a finalist for International Project of the Year. Its success has led the way for two more of Hanford's reactors–F and DR–to undergo the cost-effective process simultaneously this year, another DOE first. It is planned that all but one of the reactors will be similarly dispositioned; plans call for historic B Reactor to become a museum.

- Other Facility D&D. Recent activities range from the quick explosive demolition of the 61-meter (200-foot)-tall D and DR reactor exhaust stacks, to the painstakingly slow and cautious decontamination and dismantlement of the 233-S Plutonium Concentration Facility. Other past accomplishments of note include complete demolition of the 108-F Biology Laboratory, 190-C and 190-D Pumphouses, 183-H Solar Basins, 104-B Tritium Vault, and various outbuildings, water towers, retention basins, outfall structures, and pipelines. Contaminants encountered range from asbestos, lead, PCBs, toxic and volatile chemicals, to low- and high-level radioactive materials.

- Transitioning Facilities to ER. In transferring the huge PUREX and B Plant fuel reprocessing facilities into the ER scope, we worked in advance with other Site contractors to first define acceptable "end point" criteria. We then monitored the accomplishment of those cleanup objectives until the conditions were met for each, transition was declared complete, and the facilities were turned over. Both plants are now part of the ER Project baseline, and are currently the responsibility of ERC's Surveillance and Maintenance project team.

- Facility Surveillance and Maintenance. Maintained shutdown facilities and inactive waste sites in a safe condition to reduce the risk to people and the environment. These activities include basic structural and system repairs (e.g., building roofs, electrical power and lighting systems, ventilation systems, security and containment systems) to minimize industrial and environmental hazards; and the prevention and control of contamination spread by invasive animals, vermin, weeds, and loose surface soils.

- Canyon Disposition Initiative. Actively involved in developing plans for the potential reuse of Hanford's nuclear fuel reprocessing ("canyon") facilities. The basic premise is to utilize these immense structures as repositories for contaminated waste generated during Hanford cleanup, instead of incurring the high cost of decontaminating and demolishing them. Each of the five "canyons" is situated in the immediate vicinity of other dedicated waste management facilities in the Site's 200 East and West areas. If approved and pursued, the initiative could save over one billion dollars in estimated cleanup costs.

- Groundwater Management. Operate five pump-and-treat systems in the 100 and 200 Areas, to date hydraulically pumping almost 3 billion liters (792 million gallons) of contaminated groundwater to the surface where it was treated to remove contaminants, then re-injected into the aquifer. Primary contaminants removed with these units are uranium, technetium, strontium, and chromium. The ERC Team also operated one soil vapor extraction system that removes carbon tetrachloride from the environment.

- Groundwater/Vadose Zone Integration. Coordinating the development of the first sitewide, integrated strategy to address Hanford's soil and groundwater contamination. This important work involves close cooperation between multiple site programs; DOE-HQ and RL oversight entities; site contractors; technological expert advisory panels; regulators; Tribal Nations; city, county, and state governments in Washington and Oregon; citizens advisory groups; and the public at large. Also developed a Science and Technology Roadmap to link Hanford scientists with cleanup managers to plan projects and integrate schedules.

- Science and Technology Deployment. Demonstrate and deploy a wide array of innovative ER-related technologies to reduce hazards, protect our workers, and achieve greater efficiencies. Examples include state-of-the-art personnel radiation protection and heat stress monitoring equipment; technologies to cost-effectively segregate soils and to characterize the subsurface in difficult geology; in situ treatment of contaminants in groundwater, such as chromium contamination in areas adjacent to the Columbia River; demonstration of in situ soils vitrification, asbestos material conversion, concrete cutting, and soil washing equipment; and use of the remotely controlled ANDROS robot to visually examine a "canyon" facility tunnel and obtain characterization data. During the C Reactor project, 20 innovative technologies were selected from more than 200 submittals and tested under field conditions. 13 technologies proved very beneficial for this sometimes-dangerous work, and are being applied to other site decommissioning tasks. The results are also being shared with other DOE sites, government agencies, and commercial industry.

A continuous self-imposed challenge within the ERC Team is to do what we do better:

- By believing in and continuously promoting Safety as a personal value, we build and maintain a solid foundation upon which our entire organization, and our work is grounded.
- Through open and honest dialogue with the client and regulatory authorities, we earn the trust needed for tackling environmental risks and solving encountered problems.
- By communicating openly with Tribal Nations, stakeholders, and the general public, we keep people informed about ER progress as well as difficulties faced.
- Through use of proven project management discipline and successful commercial business practices, we drive for effective and efficient results.
- By applying existing and emerging science and technology, we get at safer, better, faster, and cheaper outcomes.

As a result of all of these applied techniques and efforts, we are making meaningful and measurable ER progress at Hanford.

Figure 4. Visible Progress. The "X's" in this view of Hanford's reactor areas represent the significant Environmental Restoration progress being made along the Columbia River.

OUR MOST IMPORTANT RESOURCE

To make all these accomplishments happen, it has taken:

- Cooperative teaming relationships, trust, and commitment among a multitude of different government, private, and public entities
- Truly holding Safety as a personal value within the ERC Team
- Use of effective technical and business management methods
- Workable plans and the ability to adapt and adjust to changing conditions
- Relative consistency in funding support, and
- The key resource–the right kind of qualified and motivated people to plan and perform the work, and to achieve the results.

In some respects, the ER workers of today are like those who came to the secret Hanford Works in the 1940s at the outset of its construction. Their focus is on completing a mission. They also share a sense of dedication like so many others who contributed to the Site's operation over the intervening 50 years before large-scale cleanup really began. However, today's ER workers face their own particular obstacles and have a sense of purpose that is unique to the cleanup era. There's a similar sense of urgency, but not for building, operating, or applying science to the production of materials for the nation's defense. Instead, an urgency to protect the nation's resources from another kind of threat–the threat of radioactive and hazardous contaminants harming our environment and its residents.

The times are different. Missions and programmatic emphasis have changed dramatically, and pressures come from different sources now. Still, the one essential ingredient remains intact: People. Their individual and collective knowledge, their positive spirit, and their hard work have met every one of the Site's challenges to date.

Everything we've experienced to this point tells us that our people will continue to step up to Hanford's ER challenges. There is the combined potential of today's workers to take Hanford to the next level, to keep steadily advancing the cleanup progress–changing the Site, and making it available for other beneficial uses.