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PRAGMATIC AND COST EFFICIENT D&D

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ABSTRACT

A great deal of effort is expended by remediation professionals in the pursuit of new technologies to assist them in performing their tasks more efficiently. These individuals understand the cost savings associated with volume reduction and waste minimization and routinely incorporate these practices into their planning. However, the largest cost component on many D&D projects is labor. Increasing the efficiency of work force utilization is frequently the most overlooked technique that can be instituted and which can easily offer major cost savings. Granted, some D&D jobs require highly specialized tools and equipment which are quite expensive. Decreasing these costs is often not an option or will yield minimal results. Conversely, the increase in worker efficiency can usually decrease costs dramatically.

During the performance of the Safe Shutdown Project at the Fernald Environmental Management Project (the Fernald site), a process improvement initiative was instituted in support of the development of the Ten Year Plan. Costs associated with the removal of hundreds of thousands of pounds of nuclear material from formerly utilized equipment, piping, and ductwork in nuclear facilities at the Fernald site were analyzed. This analysis indicated that the labor component was large enough to merit further inspection. A new approach to the activities was instituted and the results were significant. A macroscopic overview of all work activities utilized work evolution control (sequencing), building segmentation, and efficient use of engineering controls to streamline the D&D process. Overall costs on the first facility were reduced by over 20%. The increased labor efficiency resulted in decreased Personal Protective Equipment costs for field personnel.

This approach will be discussed in detail. Much of the process improvement initiative can be applied to remediation projects throughout the DOE Complex.

HISTORICAL PERSPECTIVE - SAFE SHUTDOWN

Safe Shutdown at Fernald is a CERCLA Removal Action whose mission is to mitigate hazards to the public and environment by removing gross quantities of nuclear and hazardous materials from former processing facilities onsite. The focus is on the nine nuclear facilities whose primary radiological contaminants are Uranium and Thorium. The work scope also requires isolation of all energy sources from the facilities and for a general decontamination to be performed. Although it is not the primary objective, Safe Shutdown is an integral and substantive portion of the "classic" D&D of these facilities. (Additional equipment removal subsequent to Safe Shutdown and building demolition are considered the "D&D" scope at the site.)

Safe Shutdown was initiated in FY1994. Originally, this project was estimated to be a $100 million effort with a duration of 20-25 years. Over 420,000 pounds of holdup material must be removed during the project. All of the facilities in question are in a state of disrepair and contain a multitude of industrial hazards in addition to the radiological and chemical hazards. As-built engineering drawings are generally not available and little configuration control exists for any of the utilities.

Due to approximately 40 years of activity in these buildings, the amount of surface contamination, both fixed and removable, is significant. Inaccessible areas are often literally packed with material which had become airborne and eventually settled and had never been removed. The mere activity of walking through the buildings often created elevated airborne radioactive concentrations.

Corroding pipes, tanks, and ductwork create a maze of leaking acids, bases, and other reagents used for the processing of uranium compounds. Bare conductors, leaking roofs, deteriorated platforms, debris and stored materials all contribute to industrial hazards in the facilities. Bird droppings and carcasses create a significant biohazard as well.

COST SAVINGS INITIATIVE & EVALUATION

In August of 1995, the Fluor Daniel Fernald Leadership Team issued a directive to find innovative ways to reduce project costs and to compress the remediation schedule to 10 years for the entire site. This was to be accomplished, obviously, without compromising the safety of site personnel and without increasing any offsite consequences due to site activity. The existing overall schedule for remediation of Fernald was more than 25 years at a projected cost of billions of dollars.

This was an extremely bold and calculated move. It required very detailed scope definition and forced long range planning efforts to be finalized. The time for action was imminent, leaving little room for procrastination. Safe Shutdown needed to find a "step change" in costs and needed to do it quickly.

The first step in attempting to meet this requirement was to conduct an in-depth evaluation of all routine activities performed in the project. Considered were the following:

1) Utility Disconnects

Over 4,000 electrical disconnects and pipe draining and isolations had to be performed to gain configuration control and isolate energy sources to allow the safe removal of holdup material. A large percentage of this work had to be performed above grade and required the erection of safe work platforms.

2) Removal of Holdup Material

In order to safely remove the hundreds of thousands of pounds of nuclear and hazardous material that was left in the processing equipment, piping, ductwork, and tanks, workers dressed in elevated levels of personal protective equipment (PPE). The work to build containment structures, drape the immediate area for contamination control, and to physically remove the material in facilities with no heating or cooling was arduous. Heat stress and cold stress limited the hours of productive work that personnel could accomplish daily. Staging equipment and supplies to support the activity while in multiple layers of anti-contamination clothing and respirators was extremely time consuming.

3) Removal of Salvageable Equipment

Any equipment with the potential of reuse for other projects onsite or within the DOE complex, and any equipment that was not contaminated and was designated for removal by the site Property Management Department, had to be dismantled and removed from the facilities. This often equated to an extremely large portion of the equipment in a particular building.

4) Gross Decontamination

Any remaining equipment and the facility itself had to have a gross decontamination performed to minimize any residual removable contamination to prepare the facility for a D&D subcontractor. Because intrusive work into contaminated systems would be performed by the subcontractor and no interim habitation of the facilities would be allowed, no discrete endpoint levels of contamination were mandated.

5) Removal of Debris and Stored Material

During the course of Safe Shutdown activities in a facility, large volumes of contaminated debris, stored equipment, spare parts, and various supplies had to be removed and properly dispositioned.

After in depth review by a multi-disciplined team, some efficiencies were identified. Projectization of all disciplines into the Safe Shutdown program was instituted. This assisted in streamlining of approvals and more importantly, allowed each group to assist in the development of the project mission. This enabled all personnel to accept the mission. Still, this was far short of the desired "step change" in project costs.

A PRAGMATIC SOLUTION

Safe Shutdown, while instituting the new initiatives, continued to pursue ways to increase productivity and reduce cost. Various approaches were analyzed, including scope reduction. This approach would decrease the costs for Safe Shutdown, but would increase the costs for the D&D projects, yielding no overall cost savings. This was quickly rejected. Another approach was the utilization of new technologies such as improved sectioning equipment and better HEPA ventilators and vacuum equipment. These items did improve efficiencies and, more importantly, increased the safety envelope for our personnel. Again, the required decrease in cost and schedule was not there.

During a session to discuss just such issues, the Radiological Control Manager for the site shared an observation that helped us solve the puzzle. He had just returned from a tour of a facility onsite that was in the process of D&D by a subcontractor. The entire facility, four stories tall with an open bay from roof to floor in the center, was an airborne contamination area. At least seven different activities were being performed simultaneously in the building. All personnel were wearing multiple layers of anti-contamination clothing and respiratory protection. His observation was that out of the seven activities, only two would require the elevated levels of personal protective equipment based on the potential of each creating sufficient airborne activity with no other factors influencing the work area. Stated another way, if these two activities were not creating elevated airborne contamination, and if previous activities in the area had not created these levels, only minimal personal protective equipment (PPE) would have been required for the majority of tasks ongoing in the building.

The majority of costs to perform Safe Shutdown and D&D at the Fernald site is directly attributable to labor. By increasing efficiencies in any manner, significant cost savings could be realized. For example, if the remaining five activities listed above could be performed with minimal personal protective equipment, the costs would plummet. This led us to pursue an entirely new evaluation of our activities. A macroscopic view of the facility and all remediation within its boundaries could produce the required decrease in costs and schedule.

PRODUCTIVITY FACTORS & ESTIMATING APPROACHES

To assist in the understanding of how large an impact wearing escalated levels of PPE has on project costs, Table 1 is presented. This is a chart that was developed by using empirical and site specific data from Fernald for similar work. The premise of the chart is that there are certain activities which must occur when one wears PPE that will decrease the amount of productive time that a worker can devote to a job. Items like donning and doffing of PPE, along with the mounting and checking of Breathing Zone Air Samplers (BZs) will take two (2) hours per ten (10) hour day. Mobilization and demobilization of personnel and equipment to the work site consumes approximately one (1) hour. When elevated temperatures are encountered, a minimum of 30 minutes per day will be required for "cool down" of personnel. With no other factors considered, the worker only has 6.5 hours remaining to perform work.

Decreased mobility and vision impairment will further reduce the efficiency of the worker. A factor of 0.75 is used for modified Level D (MOD D), whereas a factor of 0.56 is used for Level B. As the chart shows, less than five (5) hours of work can be expected per ten (10) hour day in MOD D, and less than four (4) hours in Level C. However, in Level D, with no PPE required, nine (9) hours of work should be expected. The difference is dramatic.

The productivity factors are obtained by dividing the ten (10) hours per day by the number of productive hours. This yields a minimum productivity factor of 1.1 for Level D, and a maximum factor of 2.75 for Level B. When performing labor estimates for D&D work at Fernald, estimating guides, like *The Richardsons Rapid System - Process Plant Construction Estimating Standards or Means Facilities Construction Cost Data*, are used to determine the number of hours required to perform a task in a clean, non-contaminated environment. Those hours

per task are multiplied by the appropriate productivity factor to obtain the estimates for performing work when encumbered by PPE in a contamination area. (A 100 man-hour job in a clean area would require 275 hours when wearing Level B PPE.)

A MACROSCOPIC OVERVIEW

After the discussion with the Radiological Control Manager, further review of the state of activities in the facility undergoing D&D revealed numerous considerations. The first was that many activities which had been performed early in the project had been intrusive into grossly contaminated equipment. These activities had spread contamination throughout the facility and had created significant airborne levels. No consideration had been given to optimization of work sequencing. Therefore, without a work interruption to perform a detailed decontamination, all future work was destined for elevated levels of personal protective equipment. Decontamination would not be a minor task. The facility had over 100,000 square feet of surface area, most of which was seriously contaminated. Although there was little chance of instituting change during the D&D of the building in question, Safe Shutdown could institute more efficient actions in its future activities.

The challenge was to discern a way that was safe and acceptable to radiological control personnel to perform our activities in minimal levels of personal protective equipment. This would not only decrease costs, but would minimize the potential of serious injury to personnel due to decreased mobility while wearing personal protective equipment. One can easily see the benefits of minimizing PPE to the greatest extent possible, if it can be done without adversely impacting the safety of personnel.

By stepping back and looking at the overall approach to the remediation activities in a particular building, certain items became evident. Due to the nature of the material to be removed and the extreme difficulty in the removal activity, generation of airborne contamination during the cleanout of some equipment could be minimized but not totally eliminated. For the majority of activities, however, airborne activity could be eliminated by instituting pragmatic engineering and administrative controls.

Safe Shutdown immediately began sessions with the Radiological Control Department to lay out a strategy. The approach that was developed follows:

A) Intrusive Work
By eliminating intrusive work into contaminated systems to the greatest extent possible, airborne contamination potential was reduced considerably. Removal of some equipment, piping, and ductwork intact was achievable due to quantification by Non-Destructive Assay (NDA). Packaging with minimal size reduction was instituted where possible. Next, when intrusive work had to be performed, it was delayed until late in the project. During intrusive work, containment was built to isolate the activity. HEPA filtered ventilation was used to capture dust and material. We have named this sequencing approach Work Evolution Control.

B) Building Segmentation
When required, intrusive work was accomplished in a single section of the building with little impact on other activities. Isolating one area of a building allowed intrusive work to be performed while work requiring minimal PPE was being conducted in the remainder of the facility. By building a containment wall in one portion of the building for minimal cost, large labor efficiencies were obtained in the rest of the building.

C) Enhanced Detailed Planning
To ensure that Work Evolution Control was maximized in Safe Shutdown, the planning effort was enhanced dramatically. A multi-disciplined team was brought together to ensure "no surprises". The team included wage personnel such as chemical operators, millwrights, pipefitters, etc, as well as engineers, radiological control, industrial safety, industrial hygiene, nuclear safety and quality assurance personnel. The mission was not only to assure that the quality of the approach for each piece of equipment was superlative but also that the overall building approach was optimized. The participation by the entire team minimized the inefficiency of starting and stopping work activities because a new path forward had to be determined due to inadequate planning. After detailed plans for each piece of equipment were generated, the team was asked to prioritize all activities based on radiological control considerations and then on overall logistics. This approach yielded a superior strategy for each building.

THE RESULTS

In retrospect, the new approach seems quite simplistic. The solution to most problems usually is. However, it was not immediately obvious. And, even with the answer in hand, we discovered that implementation of a good idea isn't easy. One must consider that the concept of maximizing the use of personal protective equipment to virtually eliminate any risk to personnel is prevalent on a great fraction of the D&D jobs ongoing today. Many radiological control personnel, in particular, will opt for a "better safe than sorry" conservative tactic. Additionally, schedule compression is not easy to sell to the D&D workers when it usually portends a decrease in their job longevity. Following a concerted effort, the team members accepted our approach and made it a success.

The results of the new approach within Safe Shutdown have proven that the safety of our personnel has not been compromised. A dramatic increase in productivity and the compression of our schedule has been accomplished. The first building in which this was implemented was Plant 5. A decrease in cost of approximately 25% ($1.2 MM) was achieved. The project duration was decreased by 10 weeks. For over eighty percent of that duration, airborne activity levels remained in the 2-4% Derived Air Concentration (DAC) range.

Total costs are now projected at $37 MM for the Safe Shutdown Project. Duration is now anticipated to require only 5 years. Our current status is that of 70% complete.

CONCLUSION

Although the application of Work Evolution Control and other initiatives from this example may not be directly applicable to all D&D projects, the approach certainly can be. Continued vigilance in the pursuit of process improvements will often reap considerable rewards.

Breaking free of the existing paradigms of methodologies for D&D activities is mandatory. This is true in the development of new ideas and, as importantly, in the implementation. In essence, project management truly requires talent in optimization of your program and in the selling of your ideas to other departments onsite. Convincing your workforce to embrace these initiatives is an art unto itself.

Attempt to set aside time in your busy schedule every week to consider new approaches. Strive to utilize the knowledge of all of your employees in determining the optimum path forward. You may be pleased with the results.

Table 1 - Productivity Factors for PPE Levels

Calculations	PPE Levels			
	D	Mod "D"	C	B
Work Day	10 Hours	10 Hours	10 Hours	10 Hours
Cool Downs	0	<.5>	<.5>	<.5>
Dress & Undress	0	<2.0>	<2.0>	<2.0>
Mobilize & Demobilize	<1.0>	<1.0>	<1.0>	<1.0>
Hours Remaining	9 Hours	6.5	6.5	6.5
Efficiency Factor	1.0	x.75	x.61	x.56
Productive Hours	9.0	4.875	3.965	3.636
Productivity Factor	1.1	2.05	2.522	2.750
Use	1.1	2.1	2.5	2.75

Assumptions

1. Four ten hour days per week
2. Two 15 minute cool down periods per day Note: (Based on 50% of yearly temperatures of below 40 degrees and above 80 degrees.)
3. Four Dress and Four Undress Periods at 15 Minute Each (Includes mid-morning, lunch, & mid-afternoon)
4. Four 15 Minute Round Trips to Mobilize and Demobilize. Note: Time spent enroute to and from dress out and work area.

PPE Levels

D	No Anti-contamination Clothing
Mod "D"	One Piece Coverall, Disposable Outer Booties, Tyvek Overall, Boot Covers, Inner and Outer Gloves, Hard Hat
C	Same as Mod "D" with Respirator & Cartridge
B	Same as Mod "D" with Supplied Air System

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