In Situ Decommissioning Project Risk Management – 14596

Maria Elena Crespo, Project Enhancement Corporation, and Charles A. Negin

ABSTRACT

The American Reinvestment and Recovery Act of 2009 (ARRA) provided the opportunity for the acceleration of several in situ decommissioning (ISD) projects across the DOE complex by DOE's Office of Environmental Management (EM). Among these were large facilities including two production reactors at SRS, fuel processing facilities at INL, and the lower structure of the U Canyon at Hanford.

In situ decommissioning work can be challenging, since it involves placement of massive quantities of grout. The ISD of EM's facilities faced not only the typical challenges of new construction projects; but, the added difficulty of contamination and radiation, constrained by the intricate configuration of the types of facilities, and complexities created by conditions resulting from being unoccupied for an extended period of time.

The experience of these projects shows that the risks posed by ISD are comparable to projects where demolition leads to the final end state. The risk management experience and resulting lessons learned will greatly benefit Federal Project Directors, project managers, engineers, and planners of future permanent entombment of contaminated facilities.

INTRODUCTION

Background

"In situ decommissioning" and "ISD" are used to communicate the general concept of permanent entombment[1] as the decommissioning end-state of a facility within the DOE Complex. The American Reinvestment and Recovery Act of 2009 (ARRA) provided the opportunity for the acceleration of several ISD projects across the DOE complex by DOE's Office of Environmental Management (EM). Among these were large facilities including two production reactors at SRS, fuel processing facilities at INL, and the lower structure of the U Canyon at Hanford.

These projects were first of a kind and unique compared with past projects within EM's scope. ISD has risks not normally seen during decommissioning since it involves management for procurement, on-site batch plants, and placement of massive quantities of grout. As a result, ISD of EM's facilities faced not only some typical challenges of new construction projects; but, the added difficulty of conducting those operations in contaminated and radioactive areas, further constrained by the intricate configuration of the types of facilities, and complexities created by conditions as a result of being unoccupied for an extended period of time.

Purpose

The purpose of this paper is to address the question: Are in situ decommissioning projects riskier than typical decommissioning involving cleanout and demolition? This is further addressed with the following questions:

- Did the project risk management differ significantly from comparable decommissioning projects involving cleanout and demolition?

---

[1] In "entombment," radioactive contaminants are permanently encased on site in a structurally sound material, such as grout, and appropriately maintained and monitored until the radioactivity decays to a level permitting restricted release of the property.

- What types of risks were analyzed and were any of them significant?
- What occurred that was unforeseen and how were these occurrences handled? Did they have an impact to cost and schedule?
- What lessons can be learned for risk management of future ISD projects?

These questions are discussed in three ways: 1) at EM headquarters, 2) the risk management for a representative ISD project, and 3) describing unanticipated situations that occurred during the conduct of ISD projects at the three sites. The questions are answered in the conclusions.

RISK MANAGEMENT AT HEADQUARTERS

Project Risk Management was an essential aspect of the ISD projects, at headquarters as well as in the field; this was especially the case because they were first of a kind and unique compared with all other past projects within EM's scope, combining the challenges of traditional decommissioning with those of new construction as described later in this paper.

Risk management was conducted at DOE-EM headquarters by those responsible for managing EM's ARRA program. Before the sites were granted the funding allocated to their projects, each had to submit a rigorous checklist to prove to HQ they were ready for project execution. This checklist encompassed different areas of project execution. The sites had to present their Risk Mitigation Plans, Vulnerability Assessments, Safety Assessments, and Safety Compliance Plans, among others. All these areas needed to be completed and submitted to HQ before the funds could be disbursed.

Risk and contingency planning was extremely important compared with typical project management practices. This was because of the funding constraints imposed by ARRA reporting. Specifically, redistribution of funding across projects was not permitted.

The Recovery Act was unprecedented in its transparencies and clarity in reporting progress towards goals. To this end, HQ conducted monthly project reviews with all the sites during which each project was assessed for its performance. Risk was an essential part of these reviews; each site had the opportunity to convey to HQ the mitigation strategies they were conducting and if they were unforeseen challenges with the project. These timely reviews provided HQ the oversight to ensure successful project execution.

Further, HQ developed a RA Risk Assessment/Risk Mitigation tool to consider risk. This tool identified risk for each particular project, as well as, the same types of risks across the board for a wide range of EM project types, of which a few were for ISD. The ISD project at the P and R reactors at the Savannah River site considered 17 risk factors in five categories of: people, processes, governance, technology, and project specific. Of the 17 there were three factors most directly related to the conduct of work in the field, as follows:

- In the Technology category with the risk factor of "Systems" the risk was identified as the use of unproven technologies could result in delays. This was assessed as "low" based on the conclusion that the project was not dependent on unproven technologies. It is observed that in fact there was a need for special technology with grout mix that would not create excess hydrogen generation from aluminum components in one of the reactors. This, however, did not require development; only proof of principle.
- In the Project Specific category with the risk factor of "Regulatory Vulnerabilities" the risk was identified as uncertainty whether or not review and approval by the EPA-HQ could be accomplished on the schedule needed. This was assessed as low because regulatory concurrence for the project had already been achieved via CERCLA prior to ARRA having been instituted. In fact this was the case for ISD projects at all three sites because EM management at the sites had achieved regulatory (and stakeholder) acceptance.

- In the Project Specific category with the risk factor of "Safety and Health Considerations" a risk was identified related to the use of subcontractors for a considerable portion of the work, resulting in a higher than normal potential for safety incidents during familiarization with EM's work and safety expectations. This was assessed as "medium" and therefore a mitigation plan was implemented that included specifically assigned technical representatives and a permanent evaluation board was established. During implementation, a conscious decision was made to limit subcontractor staff on work that involved potential radiological exposure; the prime contractor conducted those tasks.

Headquarters ARRA program risk management contributed to the success of the ISD projects. All were completed within cost and schedule. Further, efficiencies in field project management made funding available that was used to conduct additional scope within the same project as directed by EM headquarters.

RISK MANAGEMENT AT THE P REACTOR PROJECT

The significant project risks in the P-Reactor risk assessment are addressed in this example. Some of these are specific to ISD and others would apply to any decommissioning project. For purposes here, risks identified that were reported fall into two groups.

Group 1

The first group included the following:

- Batch plant will not be ready on schedule
- Bids for stack removal is higher than planned
- More concrete core bores than planned would be required for grout placement
- Underestimate of the grout quantity needed to provide the disassembly basin cap
- Underestimate of the grout quantity needed to fill areas within the facility
- Plugging of grout lines during grout placement
- Difficulties with the Disassembly Basin water evaporation
- Security plan is inadequate for the planned work
- The safety analysis is not adequate
- Inadequate characterization of systems

These were judged to be very low and were closed; they were not included in the contingency calculation. They did not occur during the project.

Group 2

Ten risks in a second group were those used for contingency calculations. They included the following, any of which could lead to cost and schedule impacts:

- Sufficient specialty personnel (Industrial Hygienists and Rad Con Techs) will be required to support the P-Reactor Decommissioning. There is a risk that these skills may not be available.
- Area Completion plans to use subcontractors to execute a considerable amount of decommissioning work scope. This work will be planned and executed following Site procedures. To support execution of Decommissioning scope, additional personnel with various levels of experience will be added to the Site workforce. The ARRA baseline includes training for all new

personnel, and assumes that they will comply with site work, safety, and radiological control procedures. There is a risk that due to the large increase in site activity and large number of inexperienced workers, a safety and/or radiological incident may occur that would require investigation, resulting in a delay or shutdown of the project.

- The reactor vessel is to be filled with grout with a specialty grout will be required because of the aluminum components. There was a risk with the new grout that unanticipated execution problems might be encountered (e.g., radiological, placement of grout, production of the grout, and delivery to the field).
- The above ground disassembly basin structure will be demolished. The structure has been characterized. There is a risk that some unexpected radiological contamination (airborne) may be encountered when demolition begins, resulting in cost and schedule impacts.
- Site Services are required to provide support for various operations/processes. This support is in the form of trucking, heavy equipment, rigging, temporary power/communications, etc. There is a risk that these particular site services cannot be provided to support the need in time.
- The project utilizes other construction craft to supplement Site forces. There is a risk that those construction support personnel will not be available when needed caused by external factors.
- Support equipment for all self-performed work will use equipment supplied by an external sources. There is a risk that sources will not be able to provide the equipment in time.
- Government Furnished Services and Information (GSFIs such as CD2/CD3 approval, etc.) will be required to support the various work activities. There is a risk that the required/requested GFSIs will not be provided in a timely manner or at the level of detail necessary to perform the work scopes.
- Grout will be used to provide the cap for the Disassembly Basin. The estimate indicates a specific amount of the grout based on the design of the Disassembly Basin. There is a risk that the basin cap design may change.
- The rail line project has acquired an additional locomotive from Oak Ridge to use during Batch Plant operations. There is a risk that one or two of the locomotives in the locomotive fleet breakdown during the peak of the batch plant operations which would have a negative impact on the production of grout.

Of these ten, three risks that were of most concern were: a) increase in safety or radiological incidents, b) reactor vessel grout requirements, and c) locomotives availability. Of these three, the largest contributor to the contingency calculation was the risk of an increase in safety or radiological incidents

PREEMPTIVE RISK AVOIDANCE

Advanced engineering tasks served to minimize risks. For example, the U Canyon staff conducted engineering studies well in advance of the actual need; these were essential for planning the best path forward. Six major studies were conducted; of these, two that were especially important for support of the field work are the following.

Reactivation of Systems and Equipment

At U Canyon, many of the systems, equipment and areas such as ventilation system, the canyon crane, railroad tunnel, and electric power required to support the ISD preparation activities had been out of service and not maintained for a lengthy period of time. Due to the age of these systems, the availability of replacement parts was a concern. Engineers assessed the options for each function and recommend a path forward that minimized potential for schedule impacts. In cases for which refurbishment/reactivation of existing systems was chosen, essential components were identified and purchased in advance; provisions for back-up capability (i.e., mobile cranes, localized ventilation units) were included in the project planning.

Optimization of Placement of Items to be Grouted within the Structure

After its active mission, U Canyon served as a staging and storage area for a wide assortment of equipment from other canyon facilities. The majority of this material was placed on the canyon deck; items with higher radiation levels were randomly placed inside the process cells. The sizes and weights of this material range from very small (lbs) to very large (tons). Concern was raised as to whether this material could be placed in the process cells, which also contained original process equipment as well as the higher radiation level materials; and whether significant size reduction efforts would be required. By conducting a comprehensive engineering study utilizing still photographs and video footage, engineers were able to evaluate the sizes of the legacy items compared with the available space within the process cells to determine the exact placement location and orientation for each piece. They were able to ensure that all of the material stored on the canyon deck could be placed in the process cells. The upfront planning determined that size reduction was not required, and it eliminated the need for multiple handling of equipment and minimized the number of times the process cell cover block had to be removed. The results of the study were used in work planning and execution.

CHALLENGES EXPERIENCED DURING PROJECT EXECUTION

As important are the unanticipated situations that arose for all three projects that could have had cost and schedule impacts. Project personnel do not refer to these as risks. Rather, they expect unanticipated challenges to arise in the course of conducting the project that must be overcome. This was proven to be the case for the following four examples in which the resulting actions and change of plans successfully mitigated any impact.

Removal of Tank D-10 at U Canyon

Tank D-10 was placed in U Canyon Cell 30 in 1965. It was moved from the REDOX canyon; it contained REDOX ventilation tunnel flush solution. It is important to note that this tank was the only significant source of TRU in the canyon. A criterion of not having to address the broader question of residual TRU greater than 100 nCi/g (3,700 Bq/g) was one of the reasons that U Canyon was selected as the ISD prototype at Hanford.

Based on initial sampling years prior under difficult access conditions, the tank was estimated to contain a little less than 21 oz (600 g) of plutonium (Pu) in 200 gallons (760 l) of liquid. This translated to a TRU concentration greater than 100 nCi/g (3,700 Bq/g) when averaged over the volume of the cell in which the tank was installed. Averaging the content over the total volume of all the grouted cells, which otherwise would have met the concentration criterion, was judged as not acceptable because the customary method for TRU concentration calculations use the volume of the waste package. In this case, that would be the individual cell volume.

The initial plan was to absorb the liquid contents of Tank D-10 and transfer the resulting material into containers for shipment to WIPP. The tank would then be grouted in place. The residual material would be stabilized with grout within the cell. Subsequent characterization of the tank contents when better access was gained showed that: a) contained more than 500 gallons (1,900 l) of remote-handled TRU mixed waste, b) waste in the tank contained a hard, crystalline material that the first probe could not penetrate, and sludgy solid rather than liquid, as previously thought, and c) both the solid and liquid phases within the tank contain concentrations of TRU in excess of the above limits. To mitigate the situation, absorbent was added to stabilize the free liquid, the tank was removed with contents in place, and it was placed in interim storage elsewhere on site. Figure 1 shows removal from the cell, placement in the transport container, and removal from the U Canyon railroad tunnel.

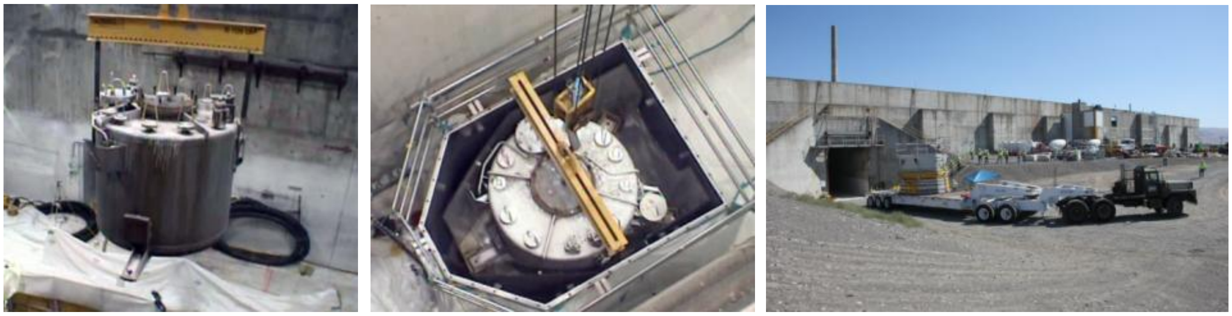

Figure 1 Removal of Tank D-10 from U Canyon

Availability of Flyash

Flyash is an essential ingredient for grout that will readily flow through narrow openings and inside of pipes and ductwork (“flowable grout”). At Idaho and Hanford, the delivery of flyash was often on the work schedule critical path. At Idaho this was partially a result of the limited use of coal plants for electricity because of the plentiful availability of hydroelectric power during the time when these projects were conducted meant that concentrated effort was needed to ensure sufficient flyash was delivered when needed.

This was one of the many challenges in managing the logistics management for the placement of very large amounts of grout needed for these projects. Anticipating an impact as a result of prior year's snowpack seems like an obscure risk element.

Lead Encased Enclosures at INL

Original planning was to remove all steel-encased lead “blisters” used for removal of sample containers attached to the outer walls of process cells in Building 601. These are shown in Figure 2. Because of the lead, the intent was to remove the lead to satisfy RCRA requirements. However, removal of many blisters would have been extremely difficult because of tight access and radiation exposure to workers, definitely not ALARA.

Blisters on grade level were removed by demolishing an exterior wall and using an excavator to rip out and handle the sample blisters. The exterior wall was re-formed and rebuilt with structural concrete. A waiver was obtained to leave the lead in place associated with the blisters in difficult to access locations. Worker safety and potential personnel exposure outweighed the benefit of removal.

Figure 2 Sample Blisters in CPP-601

Robust Ancillary Structures at P and R Reactor at SRS

In support of the decommissioning of the P-Area and R-Area reactors, the above-grade portions of the Disassembly Basin structures were demolished and replaced with a concrete cap after the completion of filling the basins to grade-level with grout. Mechanical demolition was achieved with track hoes fitted with hydraulic rams for breaking up the concrete, and track hoes fitted with sheers for cutting metal components.

The demolition proved to be a major challenge because of the robustness of the structure (in particular, the basin roof) and the presence of significant amounts of reinforcing steel. In order to overcome this problem, larger-sized track hoes capable of asserting more “muscle” for the demolition were brought in. Even with the larger equipment, demolition took almost twice as long to complete than estimated. The original estimate was for demolition to take about 8 weeks; however, the demolition of the P-Reactor Disassembly basin took approximately 16 weeks and the R-Reactor Disassembly Basin took approximately 18 weeks.

The Project Team recommended that for the remaining three reactors at SRS, the above-grade structure of the Disassembly Basin not be demolished. In lieu of a concrete cap, advantage could be taken of the robustness of the Disassembly Basin structure using it as the closure cap for the grouted basin below. All of the external openings on the above-grade structure would be closed to allow filling the entire above-grade void with concrete resulting in a monolith atop the grout-filled basin. The roof of the Basin structure is approximately 10 ft (3 m) above grade level, so in effect the closure cap, which for P-and R-Reactors was placed directly over the grouted basins, would be approximately 10 ft (3 m) high and several times thicker. The savings in demolition labor is estimated to offset the cost of the concrete required to fill the above-grade void space.

CONCLUSIONS

Project Risk Management was an essential aspect of these projects, especially because they were first of a kind and unique compared with all other past projects within EM's scope. All projects were completed within cost and schedule, with one of them having its scope and schedule adjusted due to changes in the planned end state, rather than because of an unanticipated risk.

This paper opened by asking four questions for assessing if ISD projects are riskier than typical decommissioning involving cleanout and demolition. Each is now addressed based on examples and observations discussed above.

Question and Answer 1:

Did the project risk management differ significantly from comparable decommissioning projects involving cleanout and demolition?

While the programmatic aspects of the requirements of ARRA created complications for EM headquarters management, these were handled in a manner that did not impact the field projects. In the field, several risk considerations were different compared with demolition type of decommissioning. Nevertheless, all ISD projects were performed within cost and schedule. It is concluded that ISD is no riskier than demolition, although many of the challenges are quite different.

Question and Answer 2:

What types of risks were analyzed and were any of them significant?

- Several had to do with the logistics and placement of large quantities of grout
- Many of the identified risks in the planning analyses were not realized while others occurred that were not anticipated.

Question and Answer 3:

What occurred that was unforeseen and how were these occurrences handled? Did they have an impact to cost and schedule?

There were several unanticipated challenges that arose across the three sites. A few are described above and there are others in presented in Reference 1. Whether or not these can be called risks depends on one's perspective. While risk analysts would say "yes," field personnel conducting the work expect "surprises" and consider resolving them as part of the job. The result of this attitude and their management in handling them was that all project were completed within cost and schedule.

Question and Answer 4:

What lessons can be learned for risk management of future ISD projects?

Of particular note is the considerable degree of advanced engineering conducted for these project. This was not engineering as for design of a new construction facility. Rather, the studies and analyses conducted were in recognition of the conditions of the facilities that had to be evaluated in detail to reduce the uncertainties for conducting the work; prime examples include radiation and contamination combined with impediments posed by an aged facility crammed with equipment.

Risk mitigation and risk contingency planning worked for all these projects. And, while some of the stated risks may not have arisen, other unanticipated challenges occurred, the net effect being sufficiently planned and funded projects.

The objective of Reference 1 was to capture the lessons learned from these projects in the form of reporting the experience of those who conducted the work. This reporting can serve to reduce risk for future projects by describing the many challenges that can be considered for future risk analyses and, perhaps more importantly, giving those future managers a "heads up" in what they may encounter.

REFERENCES

1. Negin, C.A., Urland, C.R, Szilagyi, A. P., DOE EM Project Experience & Lessons Learned for In Situ Decommissioning, U.S. Department of Energy, February 2012. This report can be downloaded from: http://energy.gov/em/downloads/doe-em-project-experience-lessons-learned-situ-decommissioning-feb-2013

ACKNOWLEDGEMENTS

The authors of this paper are using the results of work by those who conducted ISD projects at three sites in 2011-2012. Details of their experiences are report in Reference 1, which acknowledges many of the individuals that carried out those projects.