February 25-29, 1996
Tucson, AZ
Waste Management 96 Conference

Submitted to:

Nicole R Sigurd, Benchmark Environmental Corp.
Suzanne L. Hirt, Benchmark Environmental Corp.
Michelle L. Burns, EM/E0

Authors:

Title:

Reactor Decommissioning Project

Waste Minimization Value Engineering Workshop for Los Alamos National Laboratory Omega West

Vienna 95-4294
ABSTRACT

The Los Alamos National Laboratory Pollution Prevention Program Office sponsored a Value Engineering (VE) Workshop to evaluate recycling options and other pollution prevention and waste minimization (PP/Wmin) practices to incorporate into the decommissioning of the Omega West Reactor (OWR) at the Laboratory. The VE process is an organized, systematic approach for evaluating a process or design to identify cost saving opportunities, or in this application, waste reduction opportunities. This VE Workshop was a facilitated process that included a team of specialists in the areas of decontamination, decommissioning, PP/WMin, cost estimating, construction, waste management, recycling, Department of Energy representatives, and others. The uniqueness of this VE Workshop was that it used an interdisciplinary approach to focus on PP/WMin practices that could be included in the OWR Decommissioning Project Plans and specifications to provide waste reduction.

The OWR Decommissioning Project is currently in the planning and preliminary assessment phases. Preliminary waste projections were estimated and the Laboratory’s Solid Radioactive Waste Management Group established a maximum volume of waste that will be accepted for disposal from the OWR. The decommissioning of a nuclear facility, such as the OWR, is expected to generate very large quantities of waste, including low-level radioactive waste (LLW), low-level mixed waste (LLMW) and hazardous waste (HW). Many of these waste materials (i.e., concrete, steel, wood, soil) may have a potential for recovery, recycle, and reuse. Because the high cost of waste management and the limited capacities for treatment, storage, or disposal of HW, LLW, and LLMW, all practical efforts need to be done to reduce the volume of waste generated.

The VE Team evaluated the Preliminary Decommissioning Project Plans and recommended specific PP/WMin work practices that can be incorporated into the final Project Plans, operations, and contract specifications to reduce the volume of waste generated and increase the opportunity for material recovery. The VE Team considered decontamination, source reduction, recycling, and volume reduction techniques and technologies that are currently available at the Laboratory, within the Department of Energy, and in the commercial private sector. Emerging technologies or research and development technologies were not considered. VE Workshop results included:

- Over 13 recommendations and action items identified
- Specific PP/WMin practices that can be immediately incorporated to result in an estimated waste volume reduction of 84,712 ft³ of LLW, sanitary waste, and Toxic Substance Control Act waste and save approximately $1.17 million in waste management costs
- Potential PP/WMin practices that could reduce an additional 44,190 ft³ of LLW
INTRODUCTION

The Pollution Prevention Program Office (P^O) at the Los Alamos National Laboratory (the Laboratory) pilot tested an effort to integrate individuals with pollution prevention and waste minimization (PP/WMin) expertise into environmental restoration (ER) and decommissioning programs. The objective of the integration was to demonstrate that PP/WMin techniques can be (and have been) applied to the Laboratory’s ER and decommissioning activities to minimize the volume of waste requiring subsequent treatment, storage, or disposal and to reduce waste management costs. In addition, the effort identified potential tools and systematic approaches for reducing wastes from ER and decommissioning activities.

As part of this effort, a Waste Minimization Value Engineering Workshop was conducted to focus on reducing wastes and recycling materials from the planned decommissioning of the Laboratory’s Omega West Reactor (OWR). The Value Engineering (VE) Workshop was sponsored by Laboratory’s P^O and the Department of Energy (DOE) Office of Environmental Management, in cooperation with the Laboratory’s Environmental Restoration Program, Decommissioning Project. Benchmark Environmental Corporation planned and participated as team leader in the workshop; and the workshop was lead by an independent certified VE facilitator.

The VE Workshop evaluated the Preliminary Project Plans for the OWR Decommissioning Project and recommended over 13 specific PP/WMin work practices that can be incorporated into the project plans and specifications to reduce the volume of waste generated. This paper presents the results of the Waste Minimization Value Engineering Workshop and discusses the use of VE as a tool to minimize the waste generated from future DOE decommissioning projects.

BACKGROUND

The Laboratory’s Environmental Restoration Program assesses and cleans up sites and facilities that have been contaminated from past DOE activities, including the safe decontamination and decommissioning of nuclear facilities that are no longer active. ER activities in general, and decommissioning activities in particular, have the potential to result in large quantities of low-level radioactive waste (LLW), low-level mixed waste (LLMW), and hazardous waste (HW). There is a real challenge to reduce (or avoid) waste that will require subsequent treatment, storage, and disposal for several reasons including: limited on-site and off-site capacities for waste treatment, storage, and disposal; and the high cost of radioactive and hazardous waste management.

In 1995, the P^O began integrating with the Laboratory’s Decommissioning Project Office (DPO) to incorporate waste reduction practices, where appropriate, and to evaluate existing tools or systematic approaches for incorporating PP/WMin as a standard practice in future projects. Jointly, the P^O and the DPO identified VE as a potentially effective tool for decommissioning projects to identify and incorporate PP/WMin practices. The OWR Decommissioning Project was selected as a test case for the VE process.

The OWR Decommissioning Project was selected because it was in the planning and preliminary assessment stages and the project was expected to generate large quantities of waste, including radioactively contaminated soil, equipment, building debris, concrete, scrap metal, and personal protective equipment. It was then proposed to conduct a VE Workshop on the OWR Decommissioning Project that would focus on recycling and waste minimization practices that could be incorporated into the project plans and specifications.
VE WORKSHOP OBJECTIVES

VE is an organized, systematic approach for evaluating a process or design to identify cost saving opportunities. The process uses functional analysis to challenge the designers, engineers, and project planners to consider alternative approaches that provide the same function. VE has traditionally been applied to engineering design projects in the conceptual, Title I, or Title II phases and it has provided significant return-on-investment of the costs spent to conduct the study and implement the VE recommendations.

The VE Team included decommissioning representatives, PP/WMin representatives, cost estimators, construction specialists, decontamination specialists, waste management, recycling specialists, and other appropriate technical personnel.

The primary objective of the VE workshop was to identify and recommend specific work practices (e.g., segregation) and PP/WMin practices that can be incorporated into the Decommissioning Project Plans and operations to reduce the volume of waste generated and increase the opportunity for material recovery. The specific objectives included:

- Identify and prioritize specific decommissioning activities that are expected to generate waste
- Identify recycling opportunities and work practices that will reduce waste or increase material recycling
- Identify available technology or services needed to implement the PP/WMin practice
- Develop draft language for specifications or procedures to guide implementation of the waste minimization or waste reduction ideas
- Develop preliminary cost estimates for the practices with the highest potential and evaluate, by return on investment (ROI) or other cost analysis, which are the most feasible
- Recommend PP/WMin practices that the OWR Decommissioning Project should implement

The workshop focused on minimization, decontamination, and recycling concrete, steel, metals, and soil, which are expected to be the highest waste volumes. The VE Team considered recycling, decontamination, and volume reduction techniques and technologies that are currently available at the Laboratory, within the DOE, or in the commercial private sector. Emerging technologies or research and development technologies were not considered.

Preliminary documents reviewed by the VE Team included the Preliminary Project Plan (1), Characterization Plan (2), and Waste Management Plan (3). Preliminary waste projections were estimated and the Laboratory's Solid Radioactive Waste Management group established a maximum volume of waste that will be accepted from the OWR. Waste acceptance may be contingent on the expansion of the current on-site disposal area.

OWR DECOMMISSIONING PROJECT SUMMARY

The OWR Facility was originally constructed in 1943 and housed five nuclear reactors between 1943 and 1995. The first nuclear reactor was a low-power, water-boiler type reactor and was the first reactor in which enriched uranium-235 was used as fuel to achieve a self-sustaining nuclear reaction. After several conversions, the final water-boiler reactor was completely shutdown in 1974 and eventually dismantled in 1989. A 25 kW, fast-neutron research reactor, which used plutonium fuel surrounded by mercury coolant, was constructed on-site and brought to full power in 1949. This reactor was dismantled in 1954 after discovery of a fuel element failure leading to plutonium contamination of the mercury coolant (1;4).
The final reactor, the OWR, was built on top of one of the previous water boiler reactor's foundation and is still present. The OWR is a tank-type reactor, which has a full power rating of 8 megawatts (MW) thermal. The reactor is light-water moderated and cooled and used aluminum clad, MTR-type fuel elements. A coolant leak in an underground pipe was identified in 1992 and the OWR was shut down. The pipe and another pipe have since been removed. The remaining pipe stubs connected to the reactor are welded shut or capped. The OWR has not operated since discovery of the leak (1).

In 1994 the fuel and all control blades were removed from the OWR and the OWR was placed in a safe shutdown mode. The reactor vessel has been drained of all coolant. During de-fueling operations, the fuel elements were inspected and no damage had occurred.

Decommissioning activities will address the ancillary buildings, facilities, and equipment; remove the reactor vessel and biological shielding; and survey, decontaminate, and demolish the main building. Decommissioning activities will include: asbestos abatement; detailed radiation surveys; decommissioning of contaminated components and separation of radioactive and nonradioactive materials; detailed radiation survey for material or equipment release; demolish or dispose of material or equipment; and backfill to grade. After decommissioning activities are complete, the site will be turned over for Resource Conservation and Recovery Act facility investigation and corrective measure activities (1).

A preliminary characterization was performed in early 1995. The OWR characterization is consistent with the operation of a nuclear reactor which used enriched uranium as a fuel. Activation products, radioactive contamination and primary coolant isotopes include cobalt-60, nickel-59, nickel-63, strontium-90, and cesium-137. Radiological contamination includes high levels of radioactivity internally located at the fuel element grid plate and nearby ports in the reactor tank (2600 R/hr, primarily activated cobalt-60 in experimental ports). Contaminated areas include: reactor tank tops; building roof; concrete-capped floor; painted areas (fixed contamination); ion exchange resin, pumps, filters, and piping; primary surge tank; three underground storage tanks; cooling tower heat exchanger air handling blower and exhaust stack; and building walls and floors (less than 5000 dpm/100 cm²). Contamination inside the primary system, lead shielding, and foundation concrete is unknown (2).

Projected waste generation from the Preliminary Decommissioning Project Plans is shown in Table I. No recycling or waste minimization requirements were identified for the project specifications, however, ten very general PP/WMin practices identified in the preliminary plans include (3):

- Conduct routine briefings
- Segregate wastes to avoid mixing and cross-contamination
- Remove contamination and reuse equipment and supplies
- Remove visible and radioactive contamination from disposable items before discarding
- Avoid the use of organic solvents during decontamination
- Use drip, spray, squirt bottles or tanks for decontamination rinses
- Use impermeable materials such as plastic liners or mats and drip pallets to prevent the spread of contamination
- Practice contamination avoidance
- Reduce waste volume
- Consider waste treatment and recycling operations

VE WORKSHOP ACTIVITIES AND RESULTS

The steps for planning and conducting the VE workshop are shown in Figure I. The VE Workshop was conducted over three days and followed a typical VE Job Plan as outlined in Figure I step 3.
Table I. Preliminary Waste Volume Estimates for the OWR Decommissioning Project (3)

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Estimated Volume</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Level Radioactive Waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete</td>
<td>44,707 ft³</td>
<td></td>
</tr>
<tr>
<td>Soil</td>
<td>25,920 ft³</td>
<td></td>
</tr>
<tr>
<td>Steel</td>
<td>7,689 ft³</td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td>3,590 ft³</td>
<td></td>
</tr>
<tr>
<td>Personal protective equipment</td>
<td>5,160 ft³</td>
<td></td>
</tr>
<tr>
<td>Wastewater and other liquids</td>
<td>8,000 gal</td>
<td></td>
</tr>
<tr>
<td>Hazardous Waste</td>
<td></td>
<td>None currently identified, however, lead paint is expected which may produce HW or LLMW.</td>
</tr>
<tr>
<td>Elemental lead (Potentially activated)</td>
<td>200 ft³</td>
<td></td>
</tr>
<tr>
<td>Asbestos</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radioactive</td>
<td>25 ft³</td>
<td></td>
</tr>
<tr>
<td>Nonradioactive</td>
<td>4,505 ft³</td>
<td></td>
</tr>
<tr>
<td>Sanitary waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete</td>
<td>44,707 ft³</td>
<td></td>
</tr>
<tr>
<td>Steel</td>
<td>12,518 ft³</td>
<td></td>
</tr>
<tr>
<td>Diesel Fuel</td>
<td>560 gal</td>
<td>Potential use as fuel</td>
</tr>
<tr>
<td>Machine Oil (nonhazardous)</td>
<td>150 ft³</td>
<td></td>
</tr>
<tr>
<td>Nickel-Beryllium Reflector</td>
<td>12 ft³</td>
<td></td>
</tr>
<tr>
<td>Bismuth Shield</td>
<td>12 ft³</td>
<td></td>
</tr>
</tbody>
</table>
Figure I. Planning and Conducting the Workshop

1 Planning
   - P2/ER Representative
     1) Scoping
     2) Task Schedule
     3) Roles and Responsibilities
     4) Determination of Final Product
     5) Budget
     6) Outline Process
     7) Identify Performance Measures

2 Preparation/Information
   - P2/ER and D&D Representatives
     1) Workshop Agenda
     2) Obtain Preliminary Information
     3) Assemble/Interview VE Team Members
     4) Prepare Workbooks/Information
     5) Distribute Information to VE Team Members

Conduct Workshop

3a Information
   - Facilitator
     1) Overview of Purpose (including scope (in and out) and products)
     2) Review/Clarification of Preliminary Data
     3) Set Objectives of Workshop
     4) Set Goals of Workshop

3b Brainstorming
   - VE Team
     1) Identify Waste Minimization/Pollution Prevention Work Practices
     2) Identify Materials for Cleaning, Reuse, and Recycle
     3) List All Ideas

3c Evaluation and Screening of Ideas
   - VE Team
     1) Review Each Idea
     2) Eliminate Unworkable Ideas
     3) Categorize and Modify Each Idea

3d Development of Ideas
   - VE Team
     1) Judge Each Idea
     2) Determine if Idea Will Work
     3) Estimate Waste Reduction and Life Cycle Cost (Savings)
     4) List Advantages
     5) List Disadvantages

3e Development of Workshop Recommendations
   - VE Team
     1) Recommendations for Improved Work Practices
     2) Recommendations for Material Decontamination, Recycling, and Reuse
     3) Draft Outline Procedures and Specifications
     4) Set specific Recycling Goal (in percent)

4 Issue VE Report
   - P2/ER Representative and VE Team Leader
     1) WM/PP Ideas for Omega West Project
     2) Workshop as a WM/PP Tool

5 Implementation of Ideas
   - D&D Representative
     1) Issue Report/Recommendations to Decision Makers
     2) Obtain Approval
     3) Put Specifications in RFP
     4) Sign Contract
     5) Begin Work Using Approved Methods

6 Evaluation of VE Process
   - P2/ER Representative
     1) Participant Feedback
     2) Were Worthwhile Ideas Developed
     3) Was Process Worthwhile
The VE Team developed over 13 recommendations that should be included in the Decommissioning Project Plans and have a high potential for waste reduction:

- Seven recommendations can be immediately implemented and reduce waste generation by an estimated 84,712 ft³ (27,472 ft³ of LLW and 57,225 ft³ of sanitary waste, and 15 ft³ of TSCA waste), with an estimated project savings of $1.17 million in avoided waste management costs.

- Two recommendations for radioactively contaminated concrete, to potentially avoid 17,676 to 44,190 ft³ of LLW concrete (saving $0.79 to $1.98 million in waste management cost). These recommendations were considered to be technically feasible and had very high potential for LLW reduction, however they required longer implementation and negotiation efforts to resolve potential regulatory acceptance barriers.

- Four recommendations are applicable to reduce or avoid LLW, but were non-quantifiable from a waste avoided and cost savings perspective.
  - Dedicate one person with authority to make waste management, minimization, recycling decisions and to provide technology direction or assistance, as necessary.
  - Build incentives for reaching specific source reduction, volume reduction, and recycling goals into the contract (i.e., contractor keeps proceeds from recycle; establish media-specific incentives and goals; provide bonuses for project managers; and give waste management dollars to project up front).
  - Change Laboratory or DOE rules so that consistent interpretation of rules is possible throughout projects. For example: allow free release of waste below limits; allow waste form averaging; allow the use of explosives; set realistic waste acceptance standards for disposal.
  - Include specific requirements in project specifications, prior to request for proposal, such as requiring project specific waste minimization and salvage plans; disallowing disposal of specific recyclables; requiring volume reduction before waste packaging; specify how waste will be characterized to meet criteria for disposal.

The nine quantifiable recommendations are identified in Table II. Cost savings include only project related waste disposal costs, entire cost to the DOE complex were not quantified.

The VE Workshop findings and recommendations were presented to Laboratory program managers (i.e., Environmental Restoration, Decommissioning, Waste Management) and DOE representatives. There were no major objections to the recommendations. Admittedly, some might be difficult to implement, but none were identified as entirely unreasonable or impracticable. One issue raised was that this workshop did not identify any new techniques, but identified practices that currently existed at different locations and for different projects on-site. The VE Team acknowledged that fact, but felt that the information might not have been as quickly and effectively shared with the OR Decommissioning Project personnel if left to chance and not gained through a formal process like VE. Without such an organized formal approach, the pressure of a project schedule, other work load pressures, and personal agendas often combine to inhibit such sharing and application development.
<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Waste Type</th>
<th>Waste Projection (ft³)</th>
<th>Estimated Volume Reduction (ft³)</th>
<th>Percent</th>
<th>Cost Savings ($K)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Immediately Available and Implementable</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLW Soil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Reduce source by field screening and layer excavation to minimize soil removed during pipe and tank excavation, and - Reuse contaminated soil as fill for other LLW packaging</td>
<td>LLW</td>
<td>25,920</td>
<td>12,960</td>
<td>50</td>
<td>520</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PPE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wood</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Noncontaminated concrete</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Crush and reuse on site</td>
<td>Sanitary</td>
<td>44,707</td>
<td>44,707</td>
<td>100</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Noncontaminated metal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Salvage for recycle</td>
<td>Sanitary</td>
<td>12,518</td>
<td>12,518</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fluorescent light and PCB ballasts</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Specify recycling in contract</td>
<td>TSCA</td>
<td>15</td>
<td>15</td>
<td>100</td>
<td>Nominal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Longer Term Implementation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Contaminated Concrete</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Leave Building 1 foundation in place or entomb until future reuse can be negotiated and implemented, or - Rubble and negotiate for approval to monitor and release for use in contaminated areas (e.g. reactor facility floors, foundations, parking lots)</td>
<td>LLW</td>
<td>44,190</td>
<td>17,676</td>
<td>40</td>
<td>791</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (excluding longer term)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LLW</td>
<td>34,670</td>
<td>27,472</td>
<td>79</td>
<td>1,110</td>
</tr>
<tr>
<td></td>
<td>Sanitary</td>
<td>57,225</td>
<td>57,225</td>
<td>100</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>TSCA</td>
<td>15</td>
<td>15</td>
<td>100</td>
<td>Nominal</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>91,910</td>
<td>84,712</td>
<td>92</td>
<td>1,173</td>
</tr>
</tbody>
</table>
CONCLUSIONS

On the basis of the results from the VE Workshop and Management Briefing, it was concluded that VE is an effective tool for incorporating PP/WM into decommissioning projects. Further, the VE Workshop itself was beneficial to the participants and to the OWR Decommissioning Project. However, improvements can be made to the VE workshop process and the process appears to be most effective for large projects (e.g., high waste generation, high cost).

As a PP/WM tool, the VE process was effective in developing specific ideas for reducing waste, including LLW and sanitary waste, and for reducing (or avoiding) waste management costs. In addition, the process increased awareness of PP/WM requirements and practices, and it enhanced communication between the Laboratory’s decommissioning project and the P&O as it provided an opportunity for the interested parties to influence practices that are integral to their day-to-day responsibilities.

Over 70 percent of the VE Team reported that the workshop was valuable and they would recommend using the process again on large-scale (i.e., waste generation, cost). Over 60 percent believed waste would actually be reduced as a result of the workshop’s recommendations if implemented; the other participants believed it was too early to predict the actual benefits. The cost savings identified during the VE workshop far exceed the cost of planning and conducting the workshop; and the cost for implementing the VE recommendations is expected to provide a high return-on-investment in terms of avoided waste management cost to the OWR Decommissioning Project.

Lessons learned from the workshop are summarized below and should be considered in the planning of future VE studies:

- The process can be streamlined to shorten the length of the workshop.
- The process can be combined with existing project technical review milestones or project planning and design meetings.
- Project management commitment is needed to ensure follow-up to the recommendations developed during the workshop.
- Active participation by all interested parties must be encouraged (or enforced).
- More advance notice should be given to participants and complete background data provided prior to the VE workshop.

In conclusion, VE can and should be used for large waste volume decommissioning projects as a tool in ensuring that the decommissioning activities are planned and evaluated with an eye toward PP/WM and that decisions made with respect to PP/WM are documented.

REFERENCES

(1) Omega West Reactor Preliminary Project Plan. Los Alamos National Laboratory, Los Alamos, New Mexico.

