APPLIED SYNERGY IN WASTE MANAGEMENT ACTIVITIES FOR DECOMMISSIONING AT THE LOS ALAMOS NATIONAL LABORATORY

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ABSTRACT

Numerous challenges had to be overcome for the Decommissioning and Decontamination (D&D) of the Omega Reactor Facility in Technical Area 2 (TA-2) of the Los Alamos National Laboratory (LANL) in Los Alamos, New Mexico. The facility contained an 8-megawatt research reactor, offices, experimental areas, and several laboratories. The largest source of radioactive material was the bio-shield and the reactor support systems and structures.

The primary structure in TA-2 was the 21,300-square-feet Building 1. This structure housed five nuclear reactors between 1944 and 1995. The last reactor used in TA-2 was the Omega West Reactor (OWR). OWR was a tank-type research reactor that had a full power rating of 8 MW thermal. It was a light-water moderated reactor that used aluminum-clad, MTR-type fuel elements. Initial criticality occurred in 1956. In 1992, an OWR safety mechanism triggered a reactor scram due to high power. An investigation determined that a coolant leak caused the scram and it was shutdown permanently. In 1994 the fuel and control blades were removed and the reactor was drained and placed in safe shutdown mode. Following the Cerro Grande (Los Alamos) Fire in May of 2000, LANL and the Department of Energy (DOE) elected to remove the facility at TA-2. The Cerro Grande Rehabilitation Project was undertaken, in part, to clean-up contaminated sites and potential hazards that could be caused by flooding following the fire.

While incorporating safety, quality and overall operational effectiveness and efficiency, Duratek integrated federal and commercial experience and expertise in order to manage a wide variety of waste types and quantities generated by the D&D project. This required the extensive experience of Duratek personnel in commercial treatment, storage, transportation and disposal facility to manage the waste associated with the OWR D&D. Duratek's waste management efforts led to the execution of the first commercial, off-site, low-level radioactive waste (LLW) transportation and disposal campaign from LANL.

The first major challenge of the project was the development of sound waste characterization such that the wastes could be removed and packaged in an uninterrupted manner. Duratek deployed a waste management program that utilized the following general procedure to ensure safe and compliant disposition of all materials from the Omega West Reactor site;

1. Documentation of available process knowledge regarding facility design and operation.

2. Use of containment, classification and controlled disposition of all identified hazardous material in accordance with federal, state and local requirements.

3. Providing transportation and disposition of non-hazardous materials in accordance with state and local requirements.

4. Re-use of non-radioactive materials whenever possible.

Transportation and packaging of reactor components was the second major challenge for the D&D effort. The source term of the core was packaged and transported in 15 liners and disposed in the on-site burial facility in compliance with all Waste Acceptance Criteria (WAC) and U.S. Department of Transportation (DOT) regulations. One of the more complex waste items generated by the D&D was an 8,000-curie beryllium reflector.

In addition, more than 651 m^3 of waste in TA-2 was characterized, packaged and transported to a licensed, commercial disposal site without incident. As a secondary benefit, LANL was able to define the practical benefits and flexibility of having access to both an on-site and an off-site LLW disposal facility. In the case of the Omega West Project, a balanced disposal approach allowed for sound, long-term decision-making and efficient use of disposal facility resources and time.

INTRODUCTION

In 2002, Duratek was awarded a subcontract by Framatome-ANP to execute waste management services for the Omega West Reactor Decontamination and Decommissioning (D&D) Project at Los Alamos National Laboratory. Fieldwork began in August, 2002 and the reactor building foundation slab was removed in July 2003, resulting in the completion of most of the work in less than 12 months.

The Omega West Reactor D&D Project posed several unique and challenging waste management obstacles. One primary challenge was the development of a detailed characterization of the waste materials at the site. This effort included the development of an extensive activation analysis report ("Activation and Dose Rate Study of Components of the Omega West Reactor in Support Of Its Decommissioning" January 26, 2003, Nolan E. Hertel, Ph.D, P.E.). The report was needed in order to assign type and quantity of activity to various structures and equipment associated with the reactor.

The second major challenge of the project was the transportation and packaging of the waste. Much of the LLW generated by the project could be transported in standard bulk packaging. However, a significant portion (51 m^3) of LLW required the use of a shielded cask to transport the waste to LANL's on-site landfill at TA-54 in Area G. An abbreviated environmental restoration effort was also conducted after the removal of the reactor building in July and August of 2003, which generated about 283 m^3 of LLW.

This paper describes how commercial radioactive waste management practices were seamlessly incorporated into the D&D project. In addition, an analysis is provided of the major waste management challenges encountered, including a description of how these challenges were overcome. In addition, a brief summary of lessons learned on the project are included.

PROJECT CHALLENGES

Given the history of the site, including the construction and operation of a number of test reactors, the first major challenge of the project was to assemble sound characterization information. Historical records were brought together and reviewed by LANL and the team of contractors working on the project. Acceptable knowledge (AK) was used to characterize waste as the properties of the raw materials were known or the process used to produce the waste was known. Analyses were conducted when it was not possible to characterize waste based on AK. All waste analyses were performed according to regulatory requirements, specific disposal site Waste Acceptance Criteria (WAC), Environmental Protection Agency (EPA) guidelines, and DOE orders.

The waste streams anticipated during site D&D of TA-2 and TA-61 were determined by review of the Omega West Reactor Preliminary Characterization Report that was prepared by LANL in 1995. This report included historical operational data, radiological surveys, RCRA surveys, lead surveys, asbestos surveys, and construction photos, engineering records, and drawings. This information provided the basis for the process knowledge for determining the expected waste volumes and types of contamination of the facility.

This information was essential for forecasting the type of waste packaging that would be needed to successfully D&D the facility. The wastes could be removed and packaged in an uninterrupted manner. Duratek deployed a waste management program that was designed to ensure safe and compliant disposition of all materials from the Omega West Reactor site.

In order to safely and compliantly plan and execute all waste management activities at the Omega West Reactor D&D Project, Duratek developed and implemented a detailed Waste Management Plan. Duratek’s Project Manager, Jack Reust, developed the Waste Management Plan and used it as a tool throughout the project. This plan was developed specifically for the project and described all types of waste that were anticipated and approximate volumes of each. The plan included the identification of all known/suspect RCRA hazardous waste, asbestos, PCBs, etc.

WASTE MINIMIZATION

The goal of the waste minimization effort for TA-2 and TA-61 was to economically preserve natural resources and reduce the need to treat, store or dispose of regulated wastes. The challenge was to accomplish the project by segregating waste, eliminating certain waste products, and recycling other waste materials in an innovative and cost-efficient manner. Recycling for the project was focused on the re-use of concrete and soil as backfill in the restoration of the reactor site. The material allowed the site to be returned to the original grade of the terrain. Segregation was the primary means of achieving waste minimization for this demolition project. The project exceeded Pollution Prevention goals by avoiding cross-contamination of radioactive and non-radioactive materials and thereby found acceptable re-use for large amounts of non-radioactive concrete.

WASTE SEGREGATION

A full range of characterization methods was used to ensure that all waste was appropriately characterized at the point of generation. The demolition of all structures was conducted using a phased approach. This approach ensured the proper segregation and control of regulated wastes thereby reducing the potential for cross contamination, which would generate mixed waste forms or contaminate solid waste requiring costly disposal options. The process divided the site into (1) clean, (2) potentially hazardous, and (3) radiological areas. The basic approach that was applied to all demolition activities was as follows:

- Abatement of asbestos and asbestos contamination
- Removal of hazardous materials and components
- Completion of detailed radiation and contamination surveys
- Removal and disposal of non-regulated materials, obstructions and components

- Decontamination and release of surface contaminated materials
- Removal and packaging of radioactive and mixed materials and components

Verification surveys of non-radioactive materials and release

- Prompt removal and disposal of the released facility, structure, or equipment

Certain tasks were unique to the Omega Reactor area due to the presence of activated core components and the surrounding biological shield. The approach was the same but the details for the "Remove and package radioactive and mixed materials and components" step were geared toward source term reduction in order to maintain personnel exposures "as low as reasonably achievable" (ALARA). The general approach for core component and biological shield demolition was as follows:

- Removal of beam ports, sleeves and instrument packages
- Removal of upper internals and loose material from vessel
- Removal of all core components
- Demolition biological shield
- Removal, packaging and shipment of the fuel storage pool
- Removal of remaining coolant piping
- Removal of sub-floor and reactor pedestal

Although Duratek did not perform the physical D&D activities involved in the removal of the reactor beam ports, internals and other core components, Duratek did provide the prime contractors with detailed information about the amount of radioactivity associated with these components and systems in order that thorough planning could be accomplished in advance of the D&D and waste packaging. Other contractors on the project used a variety of equipment including a robotic D&D system as well as standard heavy equipment such as a trackhoe equipped with a 'stinger' (hydraulically operated jackhammer). The Activation Analysis Report and detailed surveys performed by the radiation protection contractor were used to determine the type and quantity of shielding that would be required for each of these major D&D steps. Portable shielding, including lead blankets and modular concrete blocks, were used throughout the reactor systems D&D. The D&D contractors utilized a track-hoe outfitted with a hydraulic jackhammer to demolish the bioshield of the reactor. Whole body dose to the workers was minimized through the use of a mobile, remotely operated all wheel drive demolition system that utilized a variety of size reduction implements and other attachments. This system was beneficial to the project as much of the specialized D&D work could be accomplished without having workers in the immediate area.

The first challenge of the project was the verification of the historical knowledge and data to ensure that waste was properly segregated and characterized for disposal. During the project, the instrument ports and packaging process produced several unplanned waste streams to be identified, including PCB oil, PCB articles, cadmium, and mercury wastes.

WASTE CHARACTERIZATION

The approach to segregation defined the need for characterization as the waste was generated. Waste technicians provided oversight of the containers as they were loaded to ensure non-conforming items were removed or dispositioned at the point of generation. These technicians also provided for identification of waste stream and inventory for performing container characterization.

Radiological aspects of waste characterization were divided into two general categories and approaches: activated and contaminated materials. Wastes to be generated were then divided into the two categories: activated materials and contaminated materials. This advanced planning and coordination allowed for proper waste segregation and packaging upon removal.

The contaminated waste stream was characterized by smears and actual samples of the waste stream. Waste samples were collected from the various areas and combined as a composite. These samples were sent off site for a complete suite of analysis in accordance with Envirocare criteria and 10 CFR 61 constituents. The sample results were used to develop scaling factors based on general contamination and radiation levels to allow the waste package to be assigned a total activity by radionuclide. To confirm this process, smears of the various contaminated areas were collected and analyzed to ensure the radionuclide distribution was understood. This data was used to verify the data observed in the waste samples was in the same ratio as the surface contamination around the facility. The results of this characterization sampling indicated that the approach of scaling was valid because the isotopic distribution and general ratios were consistent throughout the facility.

The activated waste stream was established by activation modeling conducted by Dr. Nolan E. Hertel, P.E. of Georgia Institute of Technology**.** The core components were modeled based on the best available historical operational data. Additionally, this modeling was used to provide activation data on the individual types of material on or near the reactor for characterization of activated metals and materials found in the beam ports or instrument packages. From this modeling, radiological control values were determined for segregating the waste based on dose rate for NRC Class A, Class B and Class C wastes. A portion of the Class A waste was packaged for disposal off site at Envirocare. The waste that was Class B and Class C was packaged for on-site disposal. Records of these materials were maintained for determining the total curie content of the respective container. For the higher activity materials a container was modeled to establish that all waste was Class C or less for that loading process.

WASTE PACKAGING AND WASTE VOLUMES

Project planning and waste forecasting projected the largest volume of waste expected to be generated from the demolition would be non-regulated building rubble, concrete, asphalt and miscellaneous debris. The next largest category of waste would be low-level radioactive waste. Comparatively smaller volumes of other hazardous wastes would include asbestos, PCB and lead.

Project planning was used as a tool to predict waste volumes on a waste type basis. Waste estimations that were developed included a roll-up of volumes anticipated from one location to another over the course of the entire project. Waste types were forecasted based upon assumptions concerning ability to decontaminate metal and concrete (Table I). Actual volumes reflected that some of the decontamination assumptions were not valid. Also, additional quantities of soil and concrete that had been anticipated to be non-radioactive were, in fact, contaminated and required disposition as radioactive waste.

Table I Actual versus forecasted waste volumes for the Omega West Reactor Decontamination and Decommissioning Project.

Waste Type	Projected (m^3)	Actual (m^3)
Low Level Waste	353	1033
Low Level Mixed Waste	0	13
Hazardous Waste	107	80

One of the challenges was the amount of space available for moving large containers around the project site. Movement at the site was tightly confined because the site is in a narrow canyon between eroded walls of volcanic ashflow tuff. To work more efficiently within this confined space, the project team selected and procured two types of containers: 1.8 x 1.2x 1.2 m metal boxes for lighter density radioactive materials such wallboard, fixtures, and components, and 1.8 x 1.2 x 0.6 m metal boxes for the higher density radioactive materials such as the bio-shield and structural steel. These containers worked fine for the initial phases of the project but later in the project as the buildings were demolished and more space became available, bulk radioactive materials were able to be loaded into 19 m^3 roll-offs for shipment to the burial facility. When the bio-shield was demolished, special casks had to be procured to shield highly radioactive material. The casks were loaded onto open-top, 3.9 m^3 cylindrical containers that were transported to the disposal site. The bulk of the activity within the bioshield was activated reinforcement steel. During D&D of the bioshield, the bulk of the concrete separated from the steel. This physical separation aided the segregation process and allowed for separate packaging of that portion of the steel which had been activated through years of operation. This also allowed for more accurate determinations to be made regarding the contents and activity of each waste package.

Upon completing the characterization of the reactor components, the project team engaged the Duratek Commercial Processing Group in designing and fabricating a steel liner that would accommodate certain OWR components with expected dose rates of 1000-curies. Some of the components were as large 1.5 x 1.2 x 1.2 m. The Commercial Processing Group was selected because it already had experience designing large (1.2 x 1.5 m) liners and lids. The selected liner design provided optimum usage of shipping containers, which were secured with 56-inch lids.

The on-site Duratek team also managed the procurement and construction of a specially fabricated pressurized container for the disposal of the Omega West 8,000-curie beryllium reflector (Fig. 1). This container was procured to meet LANL's on-site LLW waste acceptance criteria.

Fig. 1 Handling a specially designed pressure vessel for the packaging of an 8,000-curie beryllium reflector

Overall, waste management activities for the OWR D&D project included a detailed plan for controlling and segregating identified waste materials. The team worked together to minimize the amount of contaminated materials using consistent communications and coordination between the various contractors on daily basis. Duratek's Waste Management Project Manager ensured that all waste was packaged in accordance with each disposal facility's waste acceptance criteria and that work was performed as approved during daily project meetings.

As part of the OWR project, Duratek packaged more than 1,104 m^3 of waste. The largest volume of waste was low-level waste, a small volume was low-level mixed waste, and a moderate volume was hazardous waste (Table 1). The buildings and structures constituted 50 per cent of the waste and demolition was completed by May of 2003. This waste was dispositioned prior to the end of May, and the remainder of the waste was generated through the short remediation process.

LESSONS LEARNED

At the start of the project, the volume of waste in TA-2 and TA-61 was underestimated by a factor of three because of the large amount of debris and concrete that could not be decontaminated and released for recycle or re-use. Although the situation was minor in nature, one shipment of LLW to Area G landfill received a deficiency report because of the high level of contamination. The contractors responsible for filling the containers immediately corrected the problem and put in place controls to prevent a similar occurrence; and, no non-conforming waste was disposed of because of the incident. On future reactor D&D projects involving concrete shields, contractors should sample the entire thickness of these shields to determine the depth of irradiation. This information is critical in determining the amount of waste that will be disposed of.

As a result of higher than expected LLW generation, Duratek changed the waste packaging and transport approach from the use of 2.7 m^3 metal boxes to re-usable 19 m^3 intermodal containers (see Fig. 2); while this increased the rate of LLW being shipped off-site, it resulted in a new waste acceptance criteria issue because Duratek planned initially to package all LLW debris in the 2.7 m^3 boxes with the maximum length of debris not exceeding 2.4 meters. When the larger intermodals were adopted for use, some of the pieces of debris were sized to better fit them. This resulted in problems at the disposal site where these items were out of specification according to the original LLW disposal criteria. But in general, the vast majority of LLW debris met the LLW disposal site's size criteria, requiring only minimal size reduction at the disposal site. Clearly, the disposal site criteria should have been revised to accommodate the larger pieces of debris prior to using intermodal containers for transporting debris. As a result of the larger waste volumes and the more restrictive shipping schedule, the transition from the 2.7 m3 metal boxes to the 19 m3 re-useable containers was more cost-effective and efficient.

Fig. 2 Intermodal container used for the packaging and transport of bulk LLW.

The key to successful management of each and every waste stream encountered was the careful use of the project's Waste Management Plan. This allowed for precise controls of all wastes and adherence to the applicable waste acceptance criteria of each waste facility selected for use. These controls included the use of independent oversight personnel who were charged with reviewing waste profiles, waste shipping documentation and waste disposal information. This provided a sufficient degree of separation between personnel performing the work in the field and those providing programmatic support. Since the Omega West Reactor Site is part of LANL facilities property, all waste shipping paperwork had to be processed through LANL's LLW shipping program office.

CONCLUSION

The project was completed ahead of schedule and under budget. From a safety standpoint, the project was completed without a Lost Time Accident, and with only one OSHA recordable injury in the waste management group. DOE, LANL, and the contractors involved in the project, including Duratek, were very pleased with the project's safety record.

Fig. 3 TA-2, former site of Omega West Reactor at LANL

Although more LLW was generated than was forecasted, Duratek quickly transitioned the packaging and transportation method allowing the project to continue to proceed without delay. Duratek was very pleased to perform a very thorough evaluation of the project in advance allowing more accurate planning and budgeting for the DOE and LANL. At the end of the project, the site was returned to a natural state with little evidence of previous structures having existed on the site (Fig. 3).