DECOMMISSIONING OF SURPLUS FACILITIES AT ORNL*

T. E. Myrick and J. H. Coobs
Martin Marietta Energy Systems, Inc.
Oak Ridge, Tennessee 37831

ABSTRACT

The Surplus Facilities Management Program (SFMP) at Oak Ridge National Laboratory (ORNL) is part of the Department of Energy's (DOE) National SFMP, administered by the Richland Operations Office. This program was established to provide for the management of certain DOE surplus radioactively contaminated facilities from the end of their operating life until final facility disposition is completed. As part of this program, the ORNL SFMP oversees some 75 facilities, ranging in complexity from abandoned waste storage tanks to large experimental reactors. This paper describes the scope of the ORNL program and outlines the decommissioning activities currently underway, including a brief description of the decontamination techniques being utilized.

INTRODUCTION

The Surplus Facilities Management Program (SFMP) was established at ORNL in 1976 in order to provide collective management of surplus radioactively contaminated sites under ORNL control on the Oak Ridge Reservation. The principal objective of the ORNL SFMP is to provide safe, cost-effective control of those facilities included in the program through (1) routine facility maintenance and surveillance, (2) comprehensive program and project planning, and (3) timely implementation of decontamination and decommissioning (D&D) activities. Facility acceptance into the program was based initially on the need to provide for disposition of abandoned or "orphaned" sites. Acceptance criteria for the SFMP now place additional restrictions on facility conditions and programmatic responsibilities for decommissioning. Currently, the program is responsible for the management of 75 facilities at the X-10 site. These facilities have been grouped into 16 SFMP decommissioning projects, based on previous operating history, location, or facility type. These projects are listed in Table I, according to these groupings. The surplus facilities are located throughout the Laboratory site, in both the main plant area (Bethel Valley) and the adjacent Melton Valley. The variation in facility physical conditions, radionuclide inventories, and hazard potentials is indicative of the wide scope of activities carried out over the past 40 years of ORNL operations. The complexity of the sites ranges from single abandoned waste storage tanks to large experimental reactor systems. Residual contamination contained within these facilities varies from relatively insignificant amounts of surface contamination to kilo-curie quantities of fission products remaining in process equipment.

Since the ORNL SFMP inception in 1976, four decommissioning projects have been completed and the facilities removed from SFMP control. These projects consisted of the: (1) Standard Pile and DOSAR Accelerator, (2) Building 3026-C Radiochemical Waste System, (3) Intermediate-Level Waste Transfer Line, and the (4) Curium Source Fabrication Facility. These completed D&D activities are summarized in Table II and a document record of project reports provided in Ref. 1.

TABLE I

Facilities Currently Managed by the ORNL SFMP

Administrative Grouping	Project
Isotope Group	Fission Product Development Laboratory
	Metal Recovery Facility
	Storage Garden 3033
	Waste Evaporator Facility
	Fission Product Pilot Plant
	Shielded Transfer Tanks (5)
Radwaste Group	Waste Holding Basin
	Gunite Storage Tanks W5-W10
	Waste Storage Tanks:
	Waste Tank WC-1
	Waste Tanks WC-15, WC-17
	Waste Tanks W1-W4, W13-W15
	Waste Tank W11
	Waste Tanks TH1-TH3
	Waste Tank TH4
	Old Hydrofracture Facility
Reactor Group	ORNL Graphite Reactor
	Molten Salt Reactor Experiment
	Low Intensity Test Reactor
	Homogeneous Reactor Experiment
	ORR Experimental Facilities:
	Reactor Experiments
	ORR Heat Exchanger

Each of these completed projects represents an important step in the growth of the SFMP at ORNL. Although the first two projects were relatively small in scope, they provided valuable experience in D&D project management. In two of the four projects (Projects 1 and 4), a significant savings was realized through reuse of materials, equipment and facilities following decommissioning work. In the

*Research sponsored by the Office of Defense Waste and Byproducts Management and the Office of Terminal Waste Disposal and Remedial Action, U. S. Department of Energy, under contract DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.

TABLE II

Completed ORNL SFMP Projects

Project	Scope of Decommissioning Activities	Decommissioning Planning/Operations			Waste Volumes (m^3)		
		Time Span	Estimated Cost ($ X 10^3)	Materials Reuse Potential ($ X 10^3)	Solid TRU	Solid LLW	Liquid
1. Standard Pile and DOSAR Accelerator	Dismantlement of graphite pile; disassembly of accelerator and associated eqipment.	FY 78-79	$ 82	$ 130	-	<1	<1
2. 3026-C Radiochemical Waste System	Removal of contaminated tanks, piping and controls; entombment of remaining structure.	FY 80	$200	-	-	14	<1
3. Intermediate-Level Waste Transfer Line	Removal of 700 ft of pipe from floodplain; entombment of two leak sites.	FY 81-83	$550	-	0.7	112	<1
4. Curium Source Fabrication Facility	Removal of in-cell equipment; decontamination of cells and operating areas to levels for reuse.	FY 82-83	$700	$12,000	13	-	50

Standard Pile and DOSAR Accelerator Project, graphite blocks, cadmium sheeting, and over 500 items of equipment, tools, and other supplies were returned for salvage and/or reuse. The estimated replacement cost of these materials exceeded the cost of the decommissioning efforts. On an even larger scale, the decontamination of the Curium Source Fabrication Facility and subsequent reuse by another program resulted in a savings of over $11 million by eliminating the need for new facility construction. These two examples highlight the potential savings to DOE that can be realized from decommissioning surplus facilities.

The current activities of the ORNL SFMP consist of (1) routine maintenance and surveillance of all facilities included in the program, (2) decommissioning activities at the Fission Product Development Laboratory (FPDL) and the Metal Recovery Facility (MRF), (3) initiation of alternatives assessment for decommissioning the Molten Salt Reactor Experiment (MSRE), and (4) site characterizations and assessments of the contaminated ponds at the Old Hydrofracture Facility, Waste Holding Basin, and Homogeneous Reactor Experiment. Brief summaries of these activities follow.

PROJECT SUMMARIES

Facility Maintenance and Surveillance

Routine maintenance and surveillance are provided to assure that all SFMP facilities remain in a safe condition until final disposition activities are undertaken. This task has the highest priority of any of the SFMP project tasks and will be a continuing part of the program. Surveillance activities include radiological monitoring, operational system checks, containment ventilation checks, and other tasks as appropriate for the facilities. Routine maintenance is provided to assure containment system performance and structural integrity, and to prevent radionuclide migration. Major facility alterations or improvements are conducted, as required, to correct structural degradation problems or to eliminate a significant safety concern. The majority of the M&S budget for ORNL is used to maintain the four experimental reactors.

Fission Product Development Laboratory

The Fission Product Development Laboratory (FPDL) was a full-scale processing facility operating from 1958 to 1975 for separating up to megacurie quantities of ^{90}Sr, ^{137}Cs, and ^{144}Ce for a variety of source applications. Due to the significant radionuclide inventory remaining in the facility, the high M&S costs necessary to assure radionuclide containment, and the potential for reuse of the facility by other programs, the decommissioning of the inactive portions of the FPDL was given a high priority by the SFMP, with D&D operations being initiated in May 1983. These activities are anticipated to take approximately 5-1/2 years to complete, at an estimated cost of $3 million.

The objectives of the current D&D efforts at the FPDL[2] are to (1) remove all excess contaminated process equipment from the unused portion of the facility, (2) decontaminate these areas to acceptable levels for reuse, and (3) place these portions of the facility in a standby mode, awaiting other applications. Since the FPDL is in an operable condition with portions of the facility presently being used for radioactive processing and ORNL decontamination operations, no plans are being made for the complete decommissioning and dismantlement of the building. Such final facility disposition will be delayed until the end of the useful life of the facility (15-20 years).

Metal Recovery Facility

The Metal Recovery Facility (MRF) Decommissioning Project is following similar lines as the FPDL by making space available for other ORNL programs. Decontamination of this former pilot and small-scale nuclear fuel reprocessing plant was initiated in FY 1984 and is focusing on cleanup of the process cells, dissolver room, fuel handling canal, and abandoned waste tanks.[3] Decommissioning efforts involve process equipment removal, decontamination of cell surfaces, dismantlement and removal of surplus ancillary equipment, and general facility cleanup. Prior to completion of the cell decontamination efforts, the facility will be analyzed for its reuse potential and plans made to either turn over the site to an operating program or completely dismantle the building to make room for future ORNL needs. This project is expected to take approximately 5 years to complete, at a total estimated cost of approximately $6 million.

Molten Salt Reactor Experiment

The Molten Salt Reactor Experiment (MSRE) was a homogeneous-fueled reactor built to investigate the potential applications of molten salt reactor concepts. The MSRE operated from 1965 to 1969. Following shutdown, the fuel and coolant salts were drained to storage tanks within containment cells and isolated. The scope of the proposed decommissioning activities at the MSRE involves two major tasks: (1) fuel and flush salt disposition, and (2) facility decontamination and decommissioning.[4] Prior to initiation of these tasks, significant technical effort will be required to assess the feasible options for the site and determine the most viable, cost-effective solution. Fuel and flush salt disposition will be a complex undertaking, with the ultimate decision on disposal options dependent upon both technical and political constraints. The choice for fuel disposal will, in turn, significantly impact the available options for facility decommissioning.

The MSRE decommissioning project will be, by far, the most complex and costly single effort undertaken by the ORNL SFMP. Studies are being initiated in FY 1985 to analyze the project issues and constraints in detail, in an effort to identify the most logical course of action for subsequent facility maintenance and surveillance and future decommissioning efforts.

Characterization of Contaminated Ponds

The Waste Holding Basin (3513), Old Hydrofracture Facility (OHF), and Homogeneous Ractor Experiment (HRE) contain inactive contaminated pond sites. The 3513 pond is an unlined, earth-bermed structure of a nominal 1.6 x 10^6-gal. capacity, containing approximately 250 Ci of radioactivity as well as detectable quantities of PCBs and heavy metals. The OHF pond is smaller, only 100,000-gal. capacity, but contains a similar quantity of residual radioactivity and hazardous wastes. The pond at the HRE is an unlined 300,000-gal. holding pond containing some 50-100 Ci of radioactivity. The pond was filled with clay and rock and capped with asphaltic concrete in 1970. The ponds are structually sound, but do represent potential sources of contamination to the surrounding environment in their current conditions. The State of Tennessee has requested that these and other open ponds at the ORNL site be assessed and appropriate actions taken to alleviate any long-term hazards. In response to this request, site characterizations are being conducted in FY 1985 at these three facilities in order to determine their current status and recommend alternatives for interim stabilization or permanent disposition.

DECOMMISSIONING TECHNIQUES

The decontamination and decommissioning activities currently underway at the FPDL and MRF are similar in concept to the remote maintenance tasks carried out during facility operation. When equipment maintenance was required, or process alterations necessary, in-cell decontamination and equipment removal were performed. The present D&D projects simply expand the scope of these routine maintenance functions to provide complete removal of all excess in-cell equipment, with subsequent decontamination of the bare walls to specified limits. With both of these facilities being proposed for reuse in nuclear work, the acceptable release levels are much higher than for more restricted release scenarios often used in guiding D&D operations. Residual contamination levels up to 300 dpm/100 cm^2 alpha and 0-.25 mrad/h direct readings are allowed for areas which are to remain regulated zones, while hot cell decontamination is halted when levels are reached that allow reasonable personnel access (< 1 rad/h beta-gamma, <30,000 dpm/100 cm^2 transferable alpha). Areas to be released for uncontrolled worker access are cleaned to < 30 dpm/100 cm^2 direct alpha and 0.05 mrad/h beta-gamma.

Decommissioning the hot cells in the MRF and FPDL involves removal of all excess equipment and residual waste materials present in the cells. The initial work is conducted remotely using specially designed tools, manipulators (when available), and high-pressure sprays, as appropriate. Once radiation levels have been reduced sufficiently, direct access to the cells is secured and additional decontamination performed (high pressure sprays, in-situ electropolishing) to allow for safe removal of all excess equipment. Solutions used in the high-pressure spray decontamination procedures include nitric acid, sodium hydroxide, oxalic acid, and commercial decontamination agents. In-situ electroplishing is performed using a portable DC power supply and a ceric nitrate solution. After each cell is decontaminated to an acceptable level, maintenance personnel remove the excess piping or other equipment using a variety of cutting tools, including reciprocating saws, hydraulic cutters, and plasma arc cutting torches (torch is described in more detail below). In-cell equipment is normally dismantled in-place, segmented as feasible within the cell, surveyed for proper waste classification, and appropriately packaged for on-site disposal or storage as TRU waste. Equipment that cannot be segmented within the cell is packaged for transfer to a separate staging area for cutting, further decontamination, packaging and disposal. Once the major equipment has been removed from a cell, the remaining wall supports, penetrations, and other excess services are then stripped out or capped to provide an unobstructed surface for subsequent cell decontamination activities.

Final decontamination of the cell interior surfaces and all contaminated areas external to the cells is being accomplished through the use of scarification and chemical washing techniques. For those cells of concrete construction without liners, the plans are to remove the surface layer of concrete containing the majority of the contamination, dispose of this waste, as appropriate, and then reseal the surface with an epoxy paint to fix any residual activity and provide a clean surface for future cell applications. This concrete scarification is to be accomplished utilizing an ultra-high-pressure water jet scarification system, as detailed below. For the stainless steel lined cells, roof structural supports within the cells, and the out-of-cell areas, routine ORNL decontamination techniques (primarily chemical washing) are being utilized. Decontamination solutions are collected, neutralized as appropriate, volume reduced and disposed of via the ORNL hydrofracture process (described in a companion paper). When final decontamination is completed, the facilities will be placed in a standby condition under routine maintenance and surveillance until a reuse application is determined and implemented.

Of the methods described above for decommissioning of ORNL facilities, the plasma arc torch and ultra-high-pressure water jet systems are proving to be the most useful new techniques. General system descriptions have been provided in the following sections for these two techniques. For additional, more specific information, the vendors listed (or others that are available) should be contacted.

Plasma Arc Torch System

The plasma arc torch system is being utilized for rapid cutting of metal piping, vessels, supports, etc., where personnel exposure is a concern and where adequate containment ventilation is available. This technique is based on producing an arc of DC current through a plasma gas (N_2 or Ar/H_2) to a grounded work piece (see Fig. 1). With the use of a secondary gas stream to remove the melted metal, extremely fast cutting of most metals can be accomplished. In the present application in the FPDL cells, remote cutting of 2-5 cm (1-2 in.) stainless steel pipe or sheet steel is accomplished in a matter of a few minutes, rather than 15-30 minutes using mechanical cutting methods. Personnel exposures during cutting operations have been reduced up to a factor of ten over previous operations with the use of this system.

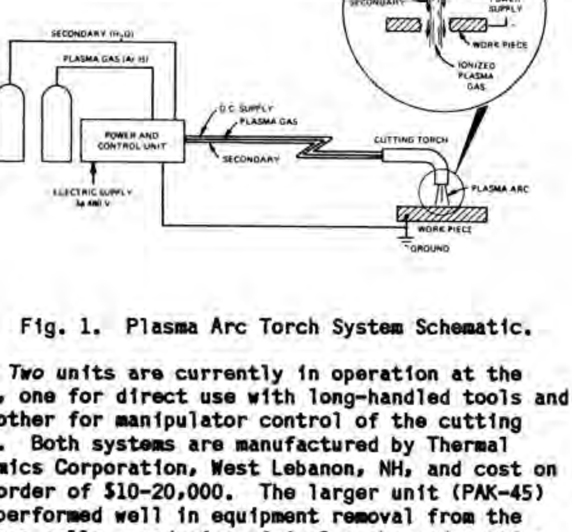

Fig. 1. Plasma Arc Torch System Schematic.

Two units are currently in operation at the FPDL, one for direct use with long-handled tools and the other for manipulator control of the cutting head. Both systems are manufactured by Thermal Dynamics Corporation, West Lebanon, NH, and cost on the order of \$10-20,000. The larger unit (PAK-45) has performed well in equipment removal from the process cells, producing minimal smoke and cutting assorted piping and heavy tank walls as required. The smaller unit (PAK-10) is perfectly suited to manipulator operation due to the lighter-weight torch head. Both straight and 90-degree torch heads have proven useful in this application. The most significant operational deficiency in the system is the durability of the torch head. The head must be routinely rebuilt or replaced to maintain optimal performance.

Ultra-High-Pressure Water Jet System

The ultra-high-pressure water jet system utilizes a concentrated water stream to provide the necessary cutting force for removal of concrete or cutting of a variety of materials. In this system, ultra-high-pressure water (up to 35,000 psi) is provided by an intensifier pumping system at low flow rates (4-6 lpm; 1-1.5 gpm) for discharge through a small-diameter (0.05 cm; 0.018 in. typical) orifice. In the scarification mode, the water jet system utilizes a rotating nozzle to focus the jet against the surface, easily fracturing the upper layer of concrete (see Fig. 2). A vacuum shroud is then used to contain and collect the water spray and contaminated concrete debris. By using a rotating nozzle with two or more orifices, a consistent pattern of adequate scarification width can be obtained. The depth of surface removal is controlled, principally through the traverse speed of the nozzle across the surface. At a typical standoff distance of 2.5 cm (1 in.), a 5 cm (2 in.) width cut of 0.3 cm (0.125 in.) depth can be obtained at a traverse speed of 90 cm/min (36 in./min).

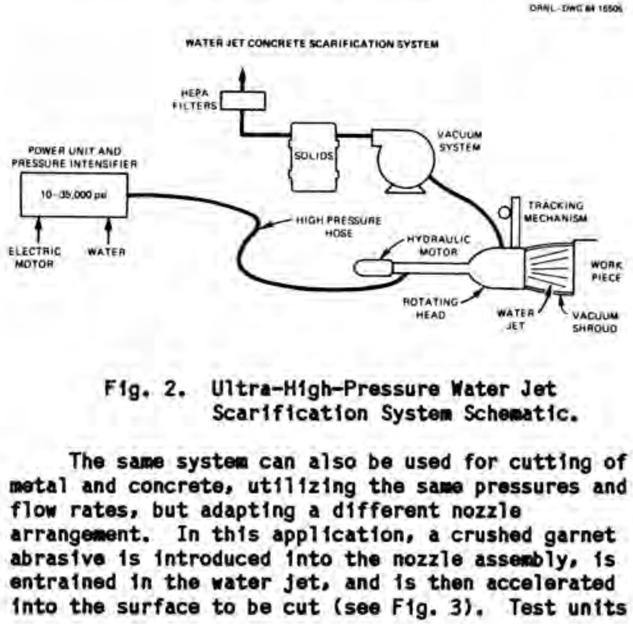

Fig. 2. Ultra-High-Pressure Water Jet Scarification System Schematic.

The same system can also be used for cutting of metal and concrete, utilizing the same pressures and flow rates, but adapting a different nozzle arrangement. In this application, a crushed garnet abrasive is introduced into the nozzle assembly, is entrained in the water jet, and is then accelerated into the surface to be cut (see Fig. 3). Test units

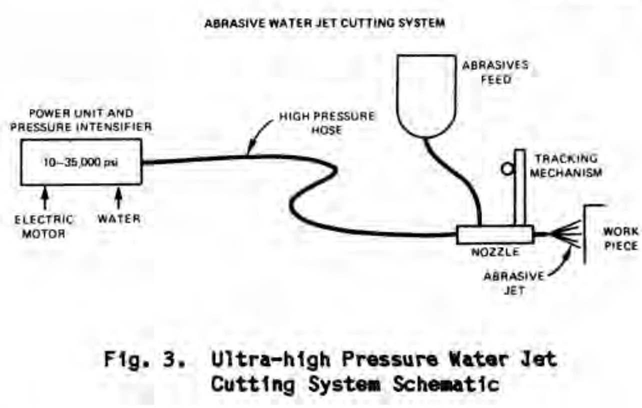

Fig. 3. Ultra-high Pressure Water Jet Cutting System Schematic

have cut steel up to 15 cm (6 in.) thick and concrete over 30 cm (12 in.) thick. Use of this system, however, produces a significant amount of overspray and spent abrasive which must be adequately controlled and disposed of.

The water jet system in use at ORNL was purchased through Flow Industries of Kent, Washington, although other manufacturers are available. The complete scarification and cutting (minus the special tracking mechanism for in-cell applications) cost approximately $100,000.

FUTURE PLANS

A comprehensive long-range schedule and cost estimate for ORNL SFMP decommissioning activities has been developed and is documented in Reference 1. As detailed in this plan, final disposition of the current inventory of surplus ORNL facilities will require on the order of 20 years of dedicated operations. Resource requirements in support of this program are expected to increase in a step-wise fashion during the next five years of the program, utlimately resulting in a fairly levelized work force on decommissioning activities. The total estimated cost (FY 1985 dollars) for decommissioning of ORNL facilities is $103 million. Continuation of work beyond the scheduled end point would be dependent upon the availability of funds and the addition of projects during the interim years. The waste volume projections for the program point to the significant impacts that decommissioning activities will have on the ORNL waste disposal systems during the next 20 years. Although the annual waste generation rates are not expected to result in any major disruptions of routine ORNL activites, the total volume of solid waste (2.3×10^4 m^3) represents a significant allocation of the currently available on-site storage and disposal space.

REFERENCES

1. T. E. MYRICK, "The ORNL Surplus Facilities Management Program Long Range Plan", ORNL/TM-8957, Oak Ridge National Laboratory, September 1984.

2. T. E. MYRICK, R. W. SCHAICH, F. V. WILLIAMS, "Fission Product Development Laboratory Cell Decommissioning Project Plan", ORNL/TM-8779, Oak Ridge National Laboratory, August 1983.

3. T. E. MYRICK, R. W. SCHAICH, J. R. DeVORE, "Metal Recovery Facility Decommissioning Project Plan", ORNL/TM-9018, Oak Ridge National Laboratory, March 1984.

4. F. J. PERETZ and W. R. REED, "Preliminary Decommissioning Study Reports Volume 5: Molten Salt Reactor Experiment", X-OE-231, Vol. 5, Oak Ridge National Laboratory, September 1984.