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ISOTOPES FACILITIES DEACTIVATION PROJECT AT OAK RIDGE NATIONAL LABORATORY

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ABSTRACT

The production and distribution of radioisotopes for medical, scientific, and industrial applications has been a major activity at Oak Ridge National Laboratory (ORNL) since the late 1940s. As the demand for many of these isotopes grew and their sale became profitable, the technology for the production of the isotopes was transferred to private industry, and thus, many of the production facilities at ORNL became underutilized. In 1989, the U.S. Department of Energy (DOE) instructed ORNL to identify and prepare various isotopes production facilities for safe shutdown. In response, ORNL identified 19 candidate facilities for shutdown and established the Isotopes Facilities Shutdown Program. In 1993, responsibility for the program was transitioned from the DOE Office of Nuclear Energy to the DOE Office of Environmental Management and Uranium Enrichment Operations' Office of Facility Transition and Management. The program was retitled the Isotopes Facilities Deactivation Project (IFDP), and implementation responsibility was transferred from ORNL to the Lockheed Martin Energy Systems, Inc. (LMES), Environmental Restoration (ER) Program.

As part of the LMES ER Program, the mission of the IFDP is to place former isotope production facilities at ORNL is a safe, stable, and environmentally sound condition that is suitable for an extended period of minimum surveillance and maintenance as quickly and economically as possible. The IFDP is now in its third full year as part of the LMES ER Program. Deactivation has been completed in 12 facilities, another has been transferred back to the Office of Nuclear Energy, and work is progressing in the remaining 6 facilities. Significant quantities of radioactive materials have been removed from facilities with corresponding reductions in their associated hazard classifications. Surveillance and maintenance costs in IFDP facilities have been reduced from approximately $6 M in 1994 to an estimated $3.7 M in 1997. The IFDP is currently scheduled to be completed in 2002 at a total cost of $46 M.

I. INTRODUCTION

Eighteen facilities are currently in the Isotopes Facilities Deactivation Project (IFDP) (Table 1). To complete its mission, IFDP must execute those activities required to deactivate and place each facility in shutdown condition. A deactivated shutdown facility is one in which (1) hazardous materials and waste and transferable radioactive contamination have been removed from accessible areas, (2) containment structures are in sound physical condition, (3) energy sources in the facility have been deenergized to the extent practical, (4) use and occupancy of the building have been terminated, and (5) the facility is structurally sound and weather tight. IFDP identified all activities required to achieve these conditions in IFDP facilities and has managed the execution of the project accordingly. Existing building-specific procedures are being utilized and modified as required to conform to Environmental Restoration (ER) Program policy.

II. PROJECT BACKGROUND

In 1989, the U.S. Department of Energy (DOE) instructed Oak Ridge National Laboratory (ORNL) to prepare various isotopes production facilities for safe shutdown. In response, ORNL identified candidate facilities for shutdown and established the Isotopes Facilities Shutdown Program (IFSP). A program plan[1] and management plan[2] were prepared and approved by DOE.[3] The objective of the program was to evaluate and execute all required tasks in the isotopes facilities required to place them in a radiologically and industrially safe condition and to minimize the required surveillance and maintenance (S&M) of the facilities. The program was managed by the Office of Nuclear Energy and executed by the Chemical Technology Division (CTD) of ORNL. Implementation of the program began in fiscal year (FY) 1991 and was to be concluded at the end of FY 1994. All facilities were to be transitioned into the Decontamination and Decommissioning (D&D) Program upon completion of the IFSP. The program was executed as

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Table 1. Scheduled shutdown facilities

Facility	Building number
Krypton-85 Enrichment Facility	3026-C
Metal Segmenting Facility	3026-D
Alpha Powder Facility	3028
Source Development Laboratory	3029
Radioisotope Production Laboratory—C	3030
Radioisotope Production Laboratory—D	3031
Radioisotope Production Laboratory—H	3118
Radioactive Gas Processing Facility	3033
Radioactive Production Laboratory Annex	3033-A
Alpha Handling Facility	3038-AHF
Radioisotope Packaging and Shipping Facility	3038-M
Isotope Materials Laboratory	3038-E
Fission Product Development Laboratory	3517
Tritium Target Preparation Facility	7025
Radioisotopes Production Laboratory—E	3032
Radioisotopes Area Services	3034
Storage Cubicle	3093
Storage Pad	3099

planned until mid-FY 1992, when a shortfall with anticipated FY 1993 funding was identified. DOE instructed the IFSP to reduce activities to levels necessary for minimal S&M of the facilities. The program entered FY 1993 with no new appropriations but was subsequently funded by the DOE Office of Environmental Management and Uranium Enrichment Operations (EM&UE). It was determined in FY 1993 that the EM&UE Office of Facility Transition and Management (EM-60) would manage the program. Before acceptance of the IFSP, EM-60 commissioned an Independent Technical Review (ITR) of the program. The scope of the ITR was to assess the IFSP and make recommendations that might enhance facility safety, accelerate the deactivation of these facilities, and minimize deactivation costs.

The review was initiated in September 1993 and concluded with the issuance of a final report in January 1994. As a result of recommendations in the ITR report, DOE transferred local program oversight from the DOE ORNL site office to the Office of the Assistant Manager for EM&UE. The program was retitled the Isolation Facilities Deactivation Project (IFDP), and implementation responsibility was transferred from CTD to the ER Program at ORNL. The first action of the IFDP was to develop and implement a management plan and develop a path forward for the project. This paper summarizes the project and its management.

III. PROJECT APPROACH

The basic mission of the IFDP is to place former ORNL isotopes production facilities into a safe, stable, and deactivated state with lowest possible S&M costs while maintaining safety envelopes adequate to protect the safety and health of the workers and public. Specifically, the IFDP will accomplish this by

- establishing a baseline S&M program consistent with surplus and post-deactivation facility liabilities,
- ensuring facility acceptance into the DOE Headquarters Office of D&D (EM-40) D&D Program, and
- minimizing waste generation.

Execution of this mission began with a project definition phase focused on the identification of technical, cost, and schedule objectives and development of integrated plans to accomplish the objectives. The project definition phase resulted in the publication of three documents: (1) *Project Management Plan for the Isotopes Facilities Deactivation Project at Oak Ridge National Laboratory,*[4] (2) *Work Plan for the Isotopes Facilities Deactivation Project at Oak Ridge National Laboratory,*[5] and (3) *Lifecycle Baseline Summary for ADS 6504IS Isotopes Facilities Deactivation Project at Oak Ridge National Laboratory.*[6] The Project Management Plan was prepared to comply with the intent of U.S. Department of Energy Order 4700.1 "Project Management Systems" and documents the objectives, defines organization relationships and responsibilities, and outlines the management controls system to be used in the management of the project.

A. Work Plan Development

The Work Plan documents the objectives, technical requirements, and work plans for the execution of the project. The first IFDP Work Plan represented the best technical judgement of engineers and technicians experienced in the past operations and knowledgeable in current conditions of these facilities. To ensure a consistent

method of developing technical requirements, a facility end-point determination process was developed.

1. End-point determination process. The end-point determination process is based on the model used to define the necessary deactivation activities for the PUREX and UO_3 facilities on the Hanford Reservation in Richland, Washington. The end-point determination process incorporates Kepner Tregoe decision analysis into the existing DOE deactivation guidance framework. The result is a structured, defensible record of the process used to define deactivation end points. The process requires that potential end points are ranked relative to one another as how well each satisfies the project objective. The objectives for deactivation are as follows:

- Comply with regulations and requirements
- Comply with stakeholder commitments
- Reduce risks to the public and environment (beyond regulatory requirements)
- Minimize S&M costs and risks
- Minimize deactivation cost and risks
- Minimize D&D costs and risks

The end-point determination process requires that each potential end point be evaluated against the objectives by individually considering the following five evaluation areas:

- Major hazards (e.g., nuclear criticality, explosion, collapse of structure, falling debris)
- Radiation fields (from source material or substantial radioactive contamination)
- Dangerous materials (e.g., radioactive materials, hazardous materials, excessive debris, wastes)
- Contamination (radioactive and hazardous)
- S&M (e.g., access requirements, facility upgrades, fire protection)

Implementation of the process is accomplished by first dividing the facility into clearly defined areas and systems, which are then classified into one of the following cases:

Case 1 Internal spaces for which routine access is required for S&M
Case 2 Internal spaces for which routine access is not expected for S&M
Case 3 External spaces
Case 4 Systems/equipment to remain operational
Case 5 System equipment to be mothballed
Case 6 Systems equipment to be abandoned in place

After this classification, a listing of potential end-points is developed within each evaluation area for each area or system. The potential end points are them ranked relative to one another on a scale of 1 to 10 according to how well each satisfies the individual objective. The objectives themselves are weighted relative to each other on a scale from 1 to 10 according to the importance of the objective within the evaluation area. A score for each potential end point is calculated by multiplying the ranking by the objective weight and summing over all objectives. The highest score is the recommended end point.

Upon definition of end-point conditions, technical requirements were generated to document the IFDP's approach to fulfilling the end-state conditions and meeting requirements for turnover to the EM-40 Office of Environmental Restoration D&D Program. Applicable requirements set forth in the DOE *Decommissioning Resource Manual*,[7] issued August 1995, will be met.

The IFDP ensures that imminent hazards to personnel or the environment are controlled through partial closure, removal, isolation, mitigation, or stabilization. The IFDP also ensures that structures can be maintained in a safe condition with removal of immediate threats to human health and safety or implementation of appropriate compensatory measures (e.g., barriers, access controls, administrative controls).

The IFDP's end states result in the classification of IFDP facilities as nonoccupied facilities. As such, compliance with DOE Order 6430.1A "General Design Criteria" is not required. IFDP activities ensure that access during the surveillance phase is not required at a frequency greater than necessary to maintain the nonoccupied status. IFDP will be completed when all facilities are turned over to the EM-40 D&D Program for basic S&M and eventual D&D. The final status of IFDP facilities at the time of turnover to the EM-40 D&D Program is summarized in Table 2.

2. Facility deactivation process. Upon completion of the list of project technical requirements, a basic approach to deactivation of facilities was established. This process is illustrated in Fig. 1. The following is a list of specific goals to be accomplished in completing each step in Fig. 1.

Step 1. Characterize facility conditions: This activity is required to assess existing environmental, safety, and health risks associated with a facility and baseline existing S&M costs.

Step 2. Prioritize deactivation activities (procedures): On the basis of the information obtained in step 1, activities will be identified that will reduce environmental, safety, and health

Table 2. General facility status after deactivation

Facility area	Area status description
	Access areas
Operating/administrative area	• Remove loose, hazardous, and flammable material • Remove and dispose of radioactive inventory • Appropriately label radiation hot spots • Appropriately mark and label areas of fixed contamination • Remove zinc bromide from hot cell viewing windows
	No access areas
Manipulator hot cells	• Remove waste and debris from hot cells • Wash down the interior of the hot cells • Drain liquid from the hot cell windows where the liquid is not required for shielding, such as in lead glass windows • Maintain cell ventilation
Glove boxes	• Remove all material and debris from the glove boxes • Seal all ports externally • Maintain the ventilation where the boxes are connected to the cell ventilation or hot off-gas systems because these will be operational to support other facilities • Where the glove boxes are on local ventilation or other systems that will not be maintained, isolate and seal the box
	External areas
Roofs	• Assure the structural integrity of the roof and establish an S&M program to maintain the integrity
Exterior walls	• Eliminate sources of water and seal holes in the exterior of the building to prevent vermin intrusion
	Operational systems
Cell ventilation system	• Remove in-cell filters in hot cells • The system will continue to operate because it provides ventilation to other facilities that will not be deactivated
Local ventilation system	• Shut down local ventilation systems after the ventilation inlets have been appropriately dispositioned (hoods or other inlets)
Fire protection system	• Minimize combustible materials • Convert sprinklers to manually actuated dry system
Radiation monitoring system	• Abandon the radiation/air monitoring systems in place and re-evaluate the monitoring requirements based on the final deactivated condition of the facility
	Mothballed systems
Cranes/fork trucks	• Abandon in place
	Abandoned systems
Hot drains	• Plug all drains
Electrical system	• Lock-out systems within the building except for the lighting and equipment required to support S&M
Utilities	• Disconnect the supply line external to the facility

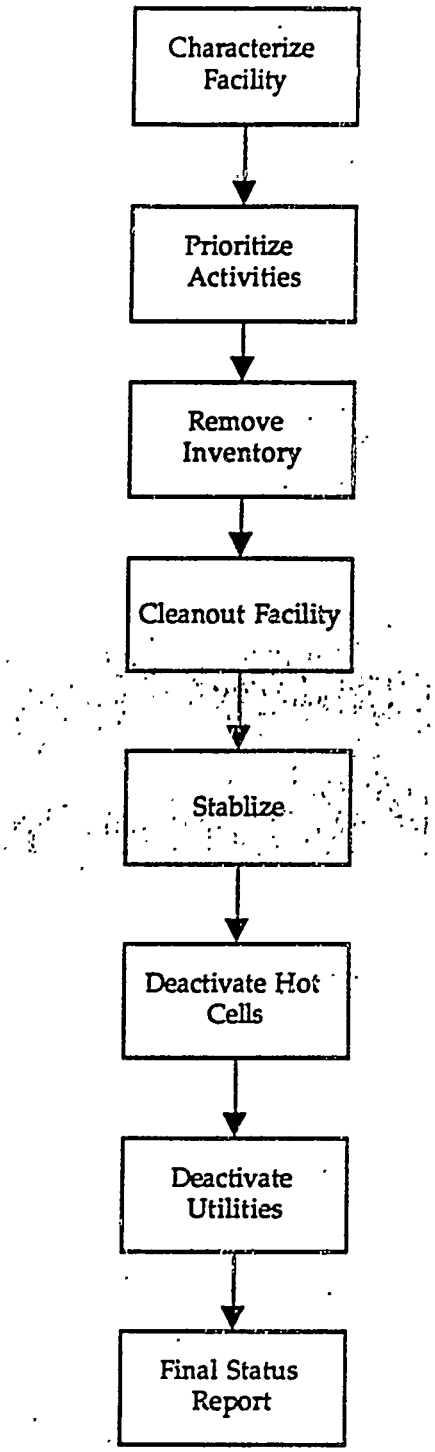

Fig. 1. Deactivation process for surplus facilities.

risks and S&M costs. These will be prioritized according to risk reduction and cost savings.

Step 3. Remove inventory: This step is required to meet EM-40 acceptance criteria. This reduces the hazards classification of a facility and allows a reduction in facility safety documentation. It will also reduce the S&M costs associated with maintaining an inventory list.

Step 4. Clean out facility: This step will salvage usable equipment and is a good housekeeping practice. Abandoned equipment such as old office furniture and storage cabinets will be removed. Neat, orderly facilities draw far less attention from auditors. This also eliminates combustible materials from facilities, which in some cases will reduce fire protection requirements.

Step 5. Stabilize facility: A structurally sound facility is required by the EM-40 facility acceptance criteria. Removal of contamination will reduce hazards to S&M personnel, reduce background levels, ensure longer life for seals and glove boxes, reduce the frequency of filter changes, and minimize the potential for a release to the environment. Because drains will be plugged, all sources of liquids must be eliminated, and thus, all services to hoods and glove boxes must be taken out of service.

Step 6. Deactivate hot cells: Deactivation of hot cells will decrease future S&M costs. This will allow removal of monitrons and continuous air monitors from facilities. The service life of manipulator boots and in-cell filters will be extended. Plugging of all drains is required by the Oak Ridge Federal Facility Agreement. With all drains plugged, it is essential that all possible pathways for introduction of liquids into cells be eliminated, and thus, all penetrations and access ports must be sealed.

Step 7. Deactivate utilities in facilities: This eliminates utility costs and future maintenance of these systems.

Step 8. Prepare final facility status report: The EM-40 acceptance criteria requires that the facility conditions be documented at the time of turnover. Procedures for S&M are required by DOE Orders on Conduct of Operations.

3. Project baseline. The final step in the project development process is the preparation of a lifecycle baseline summary. All work initially identified was organized in the framework of a work breakdown structure (WBS). Responsibility for performance of each WBS element was assigned and cost and schedule estimates prepared. This work was documented in *Lifecycle Baseline Summary for ADS 6504IS Isotopes Facilities Deactivation*

Project at Oak Ridge National Laboratory.[6] The initial baseline had IFDP completing all activities by the end of FY 2000 at a total project cost of $51 M. Shortfalls in annual budget requests have stretched the project schedule to a FY 2002 completion, but as a result of the removal of ORNL Building 3047 from the project scope, total project costs are now $46 M. The current project schedule is illustrated in Fig. 2.

IV. PROJECT STATUS

The IFDP has made steady progress in the deactivation of facilities, with 12 of the 18 being fully deactivated and significant strides being made in others under deactivation. Transfer of these 12 facilities to the EM-40 D&D Program is in progress. The project adopted a strategy of deactivating small facilities early to gain experience with deactivation and then applying what was learned to the deactivation of more complicated facilities. This has worked well. Another early decision that has worked well is focusing on the removal of the radioactive material inventory from facilities to reduce safe documentation requirements. At the time of facility shutdown, 10 of the 18 facilities in the project had sufficient inventory to be categorized as "Nuclear Facilities" per the inventory limits of DOE-STD-1027. The collective inventory included dozens of isotopes—in solid, liquid, and gaseous form—containing approximately 3 Mci. Presently, IFDP still retains 1 "nuclear" facility with a total inventory of approximately 1.4 Mci. The vast majority of the remaining material is ^{90}Sr contained in 5 radiothermal electric generators (RTGs). The balance of the inventory is in the form of ^{90}Sr and ^{137}Cs sources stored in hot cells in Building 3517. Current efforts toward disposing of this material consist of obtaining permission to ship the RTGs to the site chosen for storage of surplus U.S. Department of Defense RTGs and to package sources in an RTG-equivalent container to allow storage at the same site. Another major metric of progress is the reduction in S&M costs of facilities. In FY 1994, the total annual S&M costs were in excess of $6 M. This has been reduced to $3.7 M in FY 1997 and is projected to be $3.0 M in FY 1998.

Plans are on schedule for the deactivation of the 6 remaining facilities by the year 2002. The remaining activities include the deactivation of a number of glove boxes in Building 3038-E, the clean out and stabilization of a remote barricade area in Building 3038-AHF, and deactivation of utilities and the fire protection system in all areas of Building 3038. In Buildings 3026-C and 3026-D, most contamination control activities have been completed, and structural deactivation activities are being initiated. This includes the demolition of an abandon ventilation duct on the building exterior and a number of structural repairs needed to allow safe S&M in the 55-year-old wood frame structure. In addition, the fire protection system is to be converted to a manually actuated dry pipe system to allow deactivation of the buildings' steam heat system. Present activities in Building 3517 are focused on the removal of the remaining inventory of surplus isotopes. Currently, the project is designing a storage container, which will provide equivalent shielding and containment to a licensed RTG, although it will not be licensed. The containers are to be sufficient for outdoor storage without additional shielding and will be capable of being loaded into a licensed Type B carrier for shipment to another site. Current plans are to procure the containers in FY 1999, load and ship the material in FY 2001, and complete deactivation and stabilization activities in FY 2002.

V. SUMMARY

The IFDP has been a successful project for the DOE Office of Nuclear Material and Facility Stabilization. The project has completed the deactivation of 12 facilities and is on schedule to complete the remaining project scope by FY 2002. A reduction of over 50% in S&M cost of facilities has already been realized. Significant experience has been gained in planning and execution of the deactivation and stabilization of former nuclear facilities.

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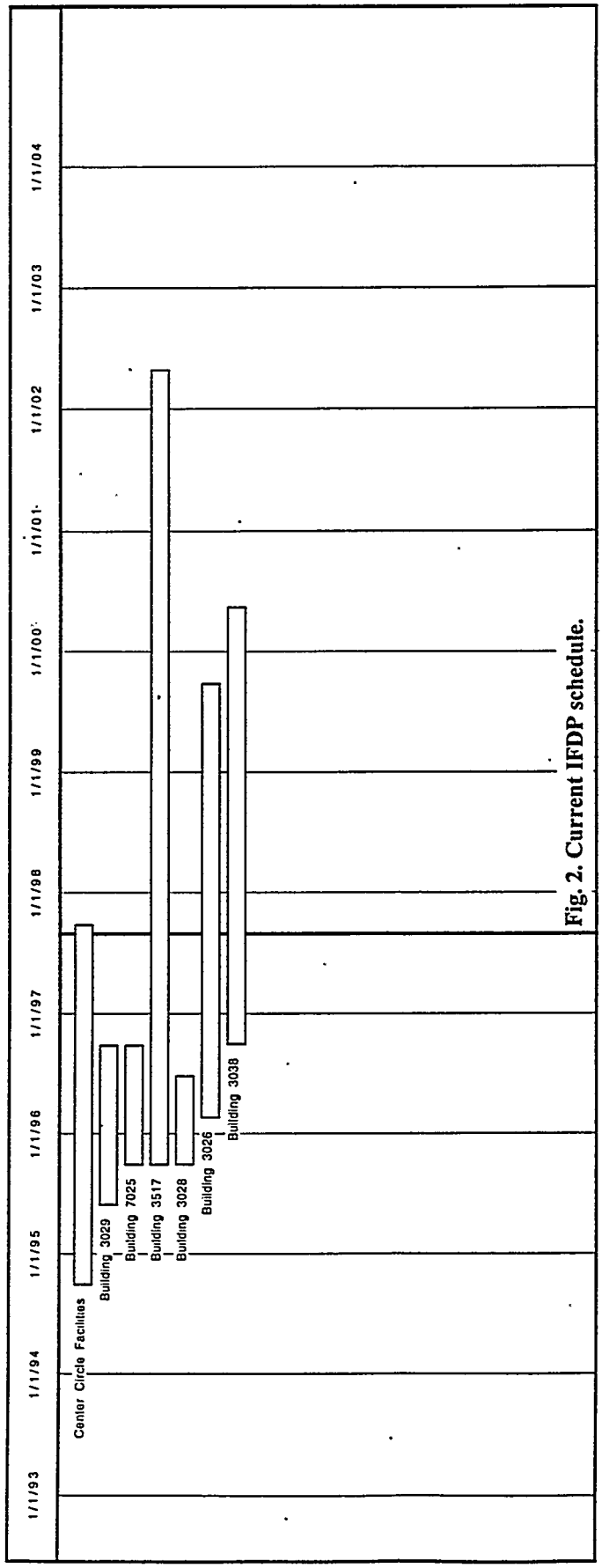

Fig. 2. Current IFDP schedule.