

Site Characterization of ORNL D&D Facilities

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INTRODUCTION

Site characterization for decontamination and decommissioning (D&D) planning purposes was done for two surplus facilities at Oak Ridge National Laboratory (ORNL) in late 1993 and early 1994. This site characterization includes measurements of radiological and chemical contaminants, assessment of general structural conditions, and investigation of unknown conditions within the buildings. It will serve as input to decisions on D&D engineering, D&D task sequences, radiological and contamination control, and waste management.

This paper presents the methods used to investigate these facilities and discusses the preliminary results as they apply to D&D planning. Investigation methods include gross alpha, beta, and gamma surveys; directional gamma surveys; gamma spectroscopy; concrete coring; photography; and collection of soil and miscellaneous samples that are analyzed for radiological and chemical contaminants. Data will be analyzed using radiological models to sort sources and estimate exposure rates and waste volumes due to D&D.

The former Waste Evaporator Facility (WEF), consisting of two concrete cells and an operating gallery, once contained a liquid radwaste evaporator. Subsequently it was used for an incinerator experiment and as a dressing area for remediation work on an adjacent tank farm. The building has been partially decontaminated. Figure 1 is a photograph of the WEF.

The Fission Product Pilot Plant (FPPP) is a small concrete building containing two cells. It was used to extract isotopes of ruthenium, strontium, cesium, cerium, and other elements from liquid waste. This facility is highly contaminated. In 1960 all doors into FPPP were sealed with concrete block and mortar, and concrete block shielding was added to the external walls making them up to five feet thick. Prior to this study, almost nothing was known about the interior of this building. Figure 2 is a photograph of FPPP.

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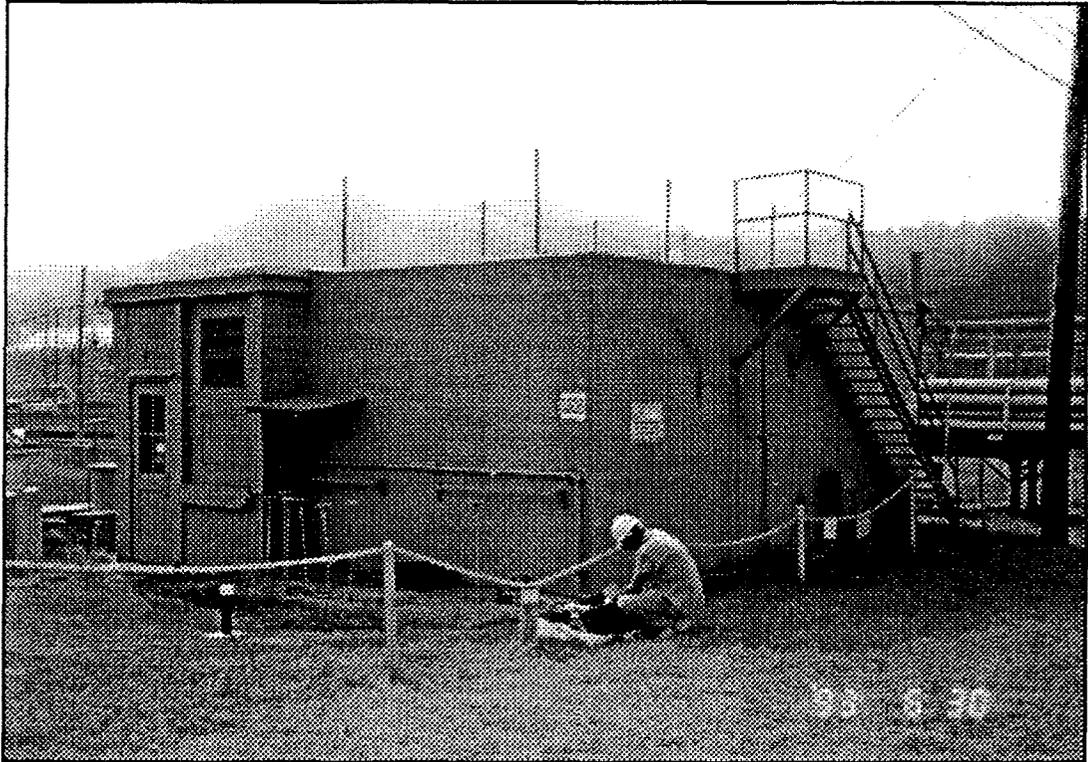


Figure 1, ORNL Old Waste Evaporator Facility

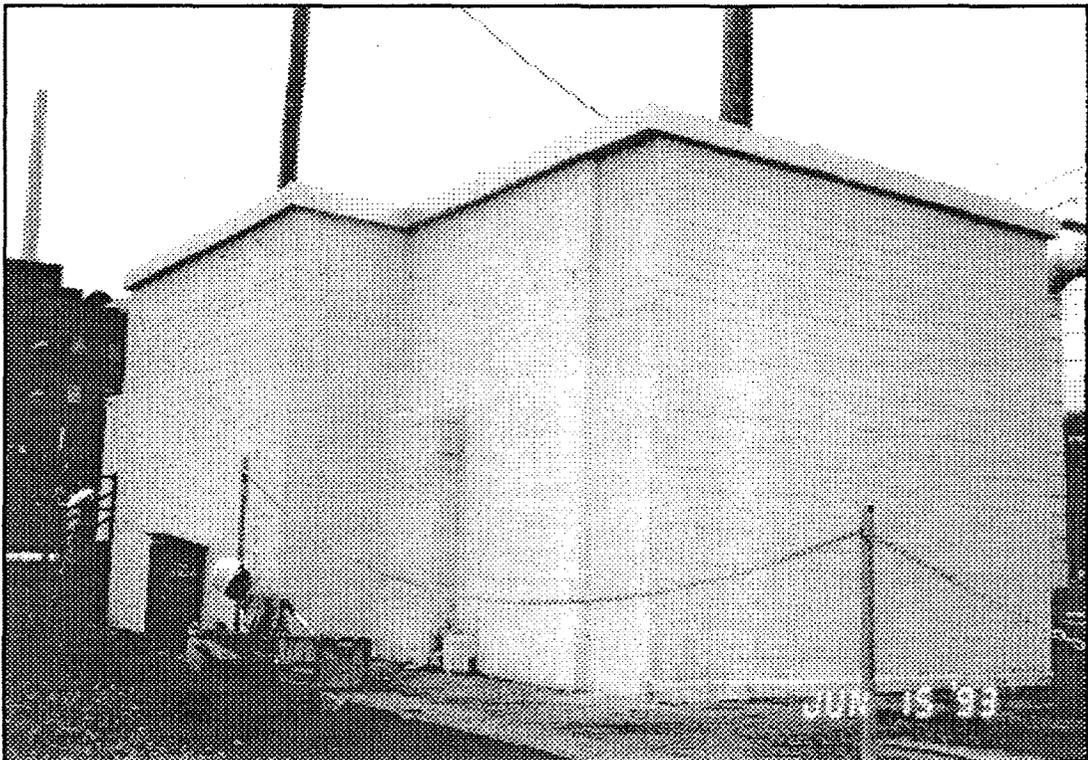


Figure 2, ORNL Fission Product Pilot Plant

APPROACH

The objective of the D&D site characterization at ORNL is to determine the nature and extent of radioactive and hazardous materials and other industrial hazards in and around the WEF and FPPP facilities. The information collected during this effort will be used in subsequent planning to develop a detailed approach to D&D of the facilities: specifically, to

- 1) evaluate and design a cost-effective and ALARA D&D approach
- 2) determine the level and type of personnel protection necessary for D&D workers, including industrial/chemical hazard protection
- 3) estimate the types and volumes of wastes generated during D&D activities and support decisions on waste disposal.

To meet these objectives a series of inspections, radiological measurements, and sample collection and analysis were planned.

Inspection activities included extensive photography, measurement of as-built dimensions, inspection by a structural engineer, and inspection by an industrial hygiene specialist for lead paint and asbestos. Extensive photography was employed to document the current state and condition of the facilities. These photographs will be used to help plan D&D activities, and are particularly valuable for work at a government facility where different contractors will do different phases of the work. Photographs will allow new participants in the D&D activities to quickly familiarize themselves with the buildings with minimal personnel radiation exposures. Measurement of as-built dimensions was necessary in this case as no as-built drawings were available and because modifications were made to the structures during their operating lives. These measurements may not be necessary in a well-documented facility. Inspections by specialists such as a structural engineer and an industrial hygienist add insight to the conditions and hazards that may be present and help to plan for these conditions.

Field measurements of the radiological conditions in D&D buildings are, of course, of primary importance. Measurements can be conveniently divided into "general area" and "location-specific." General area measurements executed as part of this characterization include exposure rate surveys, directional gamma measurements, thermo-luminescent dosimeter (TLD) trees, and gamma spectroscopy. The exposure rate surveys, conducted by health physics (HP) technicians, provide the general area exposure rates that are needed to conduct ALARA planning and task sequencing for D&D operations. Directional gamma measurements and TLD trees provide radiation profiles that will be used to model radiological sources within the buildings. Gamma spectroscopy provides isotopic information used both for radiological modeling and waste management planning. All of these general area measurements are amenable to both direct surveys and remote measurements where human access is impractical or not ALARA.

Location-specific measurements were done on potentially contaminated structural surfaces within the buildings. Measurements would consist of field counts as well as smears to quantify loose contamination. A protocol was developed for these measurements to help ensure quantitative results under field conditions. First, calibrated field instruments are source- and background-checked before each days use. Second, at each selected location the measurements are as follows:

- 1) Using a 10 cm x 10 cm square template outline, and number the location
- 2) Using a 0.68-cm stand-off spacer, conduct an alpha measurement consisting of three integrated counts
- 3) Using a 10-cm stand-off spacer, conduct a beta/gamma (open window) measurement consisting of three integrated counts
- 4) Using a 10-cm stand-off spacer, conduct a gamma (closed window) measurement consisting of three integrated counts
- 5) Collect a smear sample inside the 10 cm x 10 cm outline
- 6) Photograph the location.

Third, the field instruments are source- and background-checked at the end of each days use. Primary instruments for these measurements were the Eberline HP-270 beta/gamma detector and the Eberline AC-3 alpha detector, both with the Eberline ESP-2 counter. The smear samples collected would be analyzed for gross beta/gamma, gross alpha, and gamma isotopes (spectroscopy), with the addition of strontium-90 if gross beta levels were high and could not be accounted for by gamma spectroscopy results.

In planning the pre-decontamination measurement approach for facilities, data needs must be kept in mind. Most importantly, it is not necessary to do massive, grid-based, statistically complete surveys prior to decontamination. That very expensive type of survey is only necessary after D&D to free-release the facility for re-use. With this in mind, a biased approach to location-specific field radiological measurements was planned for the ORNL facilities. By concentrating on contaminated or potentially contaminated areas, worst-case scenarios can be used for planning and conservative assumptions will go into radiological engineering decisions. A preliminary inspection and HP survey was used to identify contaminated areas. Subsequently, the majority of selected measurement locations were radiological "hot spots," discolored areas, or structural surfaces with obvious deterioration. Some non-descript locations were measured to provide balance to this conservative approach.

The sampling portion of the characterization had three objectives: 1) identify radio-isotopes present, including certain transuranic isotopes, 2) identify depth-of-penetration of radionuclides into concrete surfaces, and 3) screen for the presence of hazardous chemicals. Samples would consist primarily of concrete cores and sub-foundation soil samples, with provisions made for collection of miscellaneous opportunity samples that may be identified in the field. Because of the small size of these facilities, and the high cost of laboratory analyses,

sampling activities were limited to just a few in each room or cell. Laboratory analyses would include a full suite of radionuclides and hazardous chemicals. Analysis of radionuclide penetration into concrete surfaces was done by taking core samples of the concrete. These core samples were analyzed by slit-scanning with a High Purity Germanium gamma spectroscopy system. Slit scanning is done by shielding the detector so that only a small 1/8-in. or 1/4-in. slice of the core is measured. Each 1/8- or 1/4-in. increment is measured down the length of the core to develop a contamination profile.

Table 1 summarizes the data needs, uses, and collection methods that defined the approach used for characterization of the WEF and FPPP at ORNL.

Table 1. Data needs, uses, and collection

| Data Needs | Specific Uses of Data | Data Collection Methods |
|--|---|---|
| General condition of building | Assess structural integrity; identify access limitations; identify industrial hazards | Visual inspection and photography; historic knowledge; drawings |
| Equipment identification and location | Design sequence of D&D actions; specify D&D procedures and methods | Visual inspection and photography; drawings |
| Radiation (i.e., alpha, beta, and gamma) dose or exposure rates | Identify radiation hazards and access limitations; specify D&D procedures and methods; estimate waste volumes | Direct radiation measurements; screening level air monitoring |
| Amount of loose and fixed contamination on building equipment surfaces | Evaluate effectiveness of pre-decontamination; plan protection against airborne releases; identify personal protection measures | Analysis of smear samples and correlated radiation measurements |
| Location of radiation sources and contamination (e.g., "hot spots") | Design sequence of D&D actions; specify D&D procedures and methods | Direct radiation scans; historic knowledge of process |
| Contaminant penetration into walls and floors | Design sequence of D&D actions; specify D&D procedures and methods | Scans and analyses of core samples |
| Contamination level in soils under and near the facility | Specify D&D procedures and methods; assess foundation removal and excavation hazards | Analysis of soil samples; historical soil sampling data |
| Isotope and hazardous chemical inventory | Determine waste management options and industrial hygiene controls. | Field gamma spectroscopy; sample analyses |

SUMMARY OF FINDINGS

Initial observations and inspections of WEF confirmed that contamination levels were low and that pre-abandonment dismantlement of equipment was completed. The full range of planned measurements and sampling were executed. The operating gallery area was shown to be almost clean, with only a few contaminated areas on the wall leading to the cells. The concrete cells were found to be slightly contaminated, with average readings of less than 10 mrad/h at 10 cm, and hot spots up to 65 mrad/h (open window). Alpha contamination was found to be insignificant. Preliminary results of concrete coring showed that radioactive contaminants had not penetrated into the concrete to any measurable degree. Field laboratory gamma spectroscopy showed that, as expected, the only significant gamma radiation source is cesium-137/barium-137m, and that low levels of strontium-90 are present. Initial screening of sub-floor soil samples showed no significant radiological contamination that would affect D&D planning. The most unexpected finding was that the concrete floor of the cell area is four feet thick with old, contaminated floor elevations under the current floor.

This characterization confirmed that D&D of WEF will be a relatively straightforward matter. Radiation and contamination levels are low enough that *remote technologies will not be required for decontamination, dismantlement, or waste management.* Pending the final chemical analytical results, it appears that the only significant waste management issue will be handling relatively small quantities of contaminated lead shielding present in the facility. Because of the low contamination levels, the extensive photography done during this characterization will be the most valuable information for D&D planning.

The FPPP was a total unknown before this investigation, and rumors of extreme conditions inside the building were confirmed by these measurements. The north cell was found to have general area exposure rates exceeding 20 R/h while the south cell measured 450 mR/h. This prevented manned entry and sample collection, and all measurements and photography were done remotely. Photography confirmed that all equipment is still in place and that the cells are extremely cramped. Remote smear surveys showed that loose contamination levels are very high, with one smear from the floor of the south cell measuring 1.2 rad/h. Directional gamma measurements showed that the floor was the most significant radiation source in both cells.

This characterization revealed that D&D of FPPP will be a significant challenge. Remote methods and extensive contamination control measures will likely be required. The directional gamma data will be used to model sources inside the cells for input to D&D sequencing. Waste management planners must consider remote-handled wastes and significant amounts of contaminated lead that were observed. Further characterization inside the cells must wait for partial decontamination to be completed.