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**Energy Systems Environmental Restoration Program
ORNL Decontamination and Decommissioning Program**

**Site Characterization Plan for Decontamination and Decommissioning
of Buildings 3506 and 3515 at Oak Ridge National Laboratory,
Oak Ridge, Tennessee**

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ACRONYMS

ALARA	as low as reasonable achievable
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH	contact-handled
CLP	Contract Laboratory Program
CSL	Close Support Laboratory
CRDL	contract-required detection limit
CRQL	contract-required quantitation limit
D&D	decontamination and decommissioning
DOE	Department of Energy
DQO	data quality objective
E/PP	excavation/penetration permit
EPA	Environmental Protection Agency
ES&H	environmental, safety, and health
FWG	field work guide
GM	Geiger Mueller
HPGe	high-purity germanium
HWP	hazardous work permit
LLLW	liquid low-level waste
MCA	multichannel analyzer
ORNL	Oak Ridge National Laboratory
OU	operable unit
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PP	project procedure
QA	quality assurance
QAA	quality assurance assessment
QAAP	quality assurance action plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RH	remote-handled
RI/FS	remedial investigation/feasibility study
RPD	relative percent difference
RMAL	Radioactive Material Analytical Laboratory
SCP	Site Characterization Plan
SLLW	solid low-level waste
SOP	standard operating procedure
SVOC	semivolatile organic compound
SWSA	solid waste storage area
TAL	Target Analyte List
TCL	Target Compound List
TCLP	toxicity characteristic leaching procedure
TLD	thermoluminescent dosimeter

TRU	transuranic
TSCA	Toxic Substances Control Act
VLA	very low activity
VOC	volatile organic compound
WAC	waste acceptance criteria
WAG	waste area grouping
WM	waste management

EXECUTIVE SUMMARY

Buildings 3506, the Waste Evaporator Facility, and 3515, the Fission Product Pilot Plant, at Oak Ridge National Laboratory (ORNL), are scheduled for decontamination and decommissioning (D&D). This Site Characterization Plan (SCP) presents the strategy and techniques to be used to characterize Buildings 3506/3515 for the purpose of planning D&D activities.

The elements of the site characterization for Buildings 3506/3515 are planning and preparation, field investigation, and characterization reporting. Other level of effort activities will include management and oversight, project controls, meetings, and progress reporting.

The objective of the site characterization is to determine the nature and extent of radioactive and hazardous materials and other industrial hazards in and around the buildings. This information will be used in subsequent planning to develop a detailed approach for final decommissioning of the facilities: (1) to evaluate decommissioning alternatives and design the most cost-effective D&D approach; (2) to determine the level and type of protection necessary for D&D workers; and (3) to estimate the types and volumes of wastes generated during D&D activities. The current D&D characterization scope includes the entire building, including the foundation and equipment or materials within the building. To estimate potential worker exposure from the soil during D&D, some subfoundation soil sample collection is planned.

Buildings 3506/3515 are located in the ORNL main plant area, to the west and east, respectively, of the South Tank Farm. Building 3506 was built in 1949 to house a liquid waste evaporator and was subsequently used for an incinerator experiment. Partial D&D was done prior to abandonment, and most equipment has been removed. Building 3515 was built in 1948 to house fission product separation equipment. In about 1960, all entrances were sealed with concrete block and mortar. Building 3515 is expected to be highly contaminated.

The following methods may be used to determine the nature and extent of loose and fixed surface contamination and to measure the radiation fields present in Buildings 3506/3515:

- smears,
- field gross alpha, beta, and gamma measurements,
- field gamma spectroscopy,
- thermoluminescent dosimeter strings,
- concrete core scanning and analysis,
- soil sampling,
- air grab samples,
- field photography, and
- physical measurements.

High radiation levels in Building 3515 may restrict access, and a tiered approach to characterization, based on radiation and contamination levels, is planned.

Data and information collected during field activities will be reviewed, and the necessary calculations and modeling will be performed to infer loose and fixed contamination levels; general area radiation exposure rates; relative isotopic distribution of contaminants; and general building conditions (industrial hazards, volume of material, and numbers and sizes of remaining equipment).

1. INTRODUCTION

Buildings 3506, the Waste Evaporator Facility, and 3515, the Fission Product Pilot Plant, at Oak Ridge National Laboratory (ORNL), are scheduled for decontamination and decommissioning (D&D). D&D traditionally involves four basic tasks: site characterization, environmental compliance, D&D planning and design, and D&D implementation. The first task, site characterization, provides information required to develop the subsequent tasks. This Site Characterization Plan (SCP) presents the strategy and techniques to be used to characterize Buildings 3506/3515.

1.1 OBJECTIVE

The objective of the site characterization is to determine the nature and extent of radioactive and hazardous materials and other industrial hazards in and around the buildings. This information will be used in subsequent planning to develop a detailed approach for dismantling and disposing of the facilities: (1) to evaluate and design the most cost-effective D&D approach; (2) to determine the level and type of protection necessary for D&D workers; and (3) to estimate the types and volumes of wastes generated during D&D activities and support decisions on waste disposal (e.g., waste forms and disposal locations).

Decommissioning alternatives generally include

- dismantling and disposing of the facility;
- entombing the facility;
- reconditioning the facility for reuse so that it is safe and operates within desired parameters; or
- leaving the facility "as is" or in reserve, with continued surveillance and maintenance, until final disposition can be determined.

The Department of Energy (DOE) is currently evaluating decommissioning alternatives for Buildings 3506 and 3515; a summary report based on existing characterization data is expected to be issued in early FY 1994.

1.2 D&D CHARACTERIZATION SCOPE

Buildings 3506/3515 are within the administrative boundary of ORNL's Gunit and Associated Tanks Operable Unit (OU) of Waste Area Grouping (WAG) 1. The OU remediation, which is subject to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations, is integrated with D&D of Buildings 3506/3515. Currently existing information about Buildings 3506/3515 satisfies the OU remedial investigation/feasibility study (RI/FS) data needs; new information to be collected during this characterization effort is not needed for the OU RI/FS, but will instead support D&D design.

The current D&D characterization (and future implementation) scope includes the entire building, plus the foundation and equipment or materials within the building. However, D&D implementation does not specifically include remediation of the soils underneath and surrounding the building, nor does it include remediation of ancillary external piping or drains leading to or from the building. Because Buildings 3506/3515 are within the Guniting and Associated Tanks OU, the soil and ancillary piping are currently considered elements of that OU and will be remediated in accordance with CERCLA requirements. Although remediation of Buildings 3506/3515 soils is not considered part of the D&D implementation, some subfoundation soil sampling and analyses are planned to estimate contaminant penetration and potential exposure to D&D workers. Field investigation of piping or drains will be limited to visual identification and cross-referencing to existing drawings.

The WAG 1 OUs, as currently proposed, are defined with flexible elements or boundaries; thus they can be optimized on the basis of new characterization data or alternatives evaluations. Similarly, the D&D work is defined with elements and boundaries that can be adjusted in the future on the basis of new D&D data or alternatives. The D&D and OU remediation teams will continue their interface to provide an optimum and efficient design for remediation of all OU elements including the D&D buildings.

It is possible that some areas within Building 3515 are so highly contaminated that environmental, safety, and health (ES&H) constraints will prevent full characterization during the initial field effort; in such a situation, characterization may need to proceed in stages. Additional characterization may require the use of robotics and/or early decontamination or removal of those sources significantly contributing to the radiation hazard. The current scope of work for site characterization does not stipulate phased characterization or entail the use of robotics.

It is also beyond the scope of work for this site characterization effort to investigate the contents of any equipment (e.g., containers or piping) whose only access is via destructive entry (e.g., cutting) or disassembly. No isolated containers or inoperable valves will be forced opened, and no waste samples will be collected from inside sealed equipment. However, if liquids or sludges are found external to the equipment, or if operable valves and drain lines are available, grab samples may be collected and analyzed.

It is beyond the scope of work to characterize the site with regard to asbestos. A separate investigation will be made by the Energy Systems Industrial Hygiene group to identify those building materials containing asbestos. If available when the report is prepared, the results of their investigation will be included in the Site Characterization Report.

1.3 REPORT ORGANIZATION

The remainder of this SCP is organized as follows.

- Section 2 summarizes currently available information and briefly discusses the site conceptual model based on that information.

- Section 3 specifies the data needs of the decision-maker, how the data will be used, and a summary of data quality objectives (DQOs) for the project, for the field investigation, and for the laboratory analyses. This section also lists plans, policies, and procedures to which project personnel will adhere.
- Section 4 describes the types of instruments and associated measurement techniques that may be used in the field to assess the nature and extent of contamination.
- Sections 5 and 6 delineate the technical approach for accessing the building, investigating site conditions, conducting radiological measurements, and collecting samples for Buildings 3506 and 3515, respectively. These sections also discuss the types and quantities of data that could be collected during the field effort, depending on the radiation hazards encountered and the technical approach for the smear and sample analysis.
- Section 7 discusses how the results of the field investigation and laboratory analyses are used to estimate contamination and radioactive sources.
- Section 8 discusses planned activity sequencing, relationships, and constraints and identifies key deliverables and intermediate milestones.
- Appendix A assesses the radiation exposure hazard, chemical hazards, and physical and industrial hazards.
- Appendix E lists contract-required detection limits (CRDLs) and contract-required quantitation limits (CRQLs) for Target Analyte List/Target Compound List (TAL/TCL) analytes.

2. INITIAL SITE EVALUATION

2.1 SITE DESCRIPTION: BUILDING 3506

Building 3506 is located in Bethel Valley in the main plant area, as shown in Fig. 2.1. It is on the west side of the South Tank Farm, near the intersection of Central Avenue and Third Street. ORNL grid coordinates are approximately N22,000 and E30,800. The facility was built in 1949 and was modified during its operational life; Figs. 2.2 and 2.3 are photographs of the exterior of the building as it appeared in June 1993.

Figure 2.4 is an architectural plan view and Fig. 2.5 is a section view, both reconstructed from ORNL drawings. The building consists of three main areas: the north cell, the south cell, and the east gallery. Dimensions are shown on Figs. 2.4 and 2.5. The concrete walls of the north cell are 2 ft thick, and those of the south cell are 3 ft thick. The wall between the cells was a modification, built of concrete block in 1959. The building had a second floor for access to the cells, but the second floor structures and interior stairs have been removed. The gallery floor is approximately 3 ft above grade, and design drawings show a crawlspace under the floor; there is a manhole for access to the crawlspace in the north end of the gallery floor. The cell area extends below grade approximately 6 ft, and the distance between the floor and the top of the roof is approximately 19 ft 4 in. The concrete roof is currently covered with ¼-in. steel deck plates.

There are two pits immediately adjacent to the building. The small pit on the west side is uncovered, and two pipes extend from the building into an unidentified piece of equipment (see Fig. 2.6). North of the building is a valve pit with three concrete covers ($\approx$ 3 ft wide by 13.5 ft long). Valve operators extend through the concrete covers, shown in Fig. 2.7.

Building 3506 housed the first liquid waste evaporator at ORNL (Horton 1984). Subsequently, an experimental radioactive waste incinerator was housed in the cell area. Drawings dated 1959 show equipment for rare earth separation installed in this facility. Expected isotopes are long-lived fission fragments, particularly cesium-137 and strontium-90, and possibly uranium and cobalt-60. In the 1980s, the east gallery was used as a dressing room for workers in the tank farm area.

This building was partially decontaminated and decommissioned before abandonment. Reportedly, all equipment has been removed from the gallery and cells; preliminary inspections of the gallery confirm this.

2.2 SITE DESCRIPTION: BUILDING 3515

Building 3515 is in Bethel Valley in the ORNL main plant area, as shown in Fig. 2.1. It is located on the east side of the South Tank Farm, near the intersection of Central Avenue and Fourth Street. ORNL grid coordinates are approximately N21,940 and E31,030. Figures 2.8 and 2.9 are photographs of the exterior of the building as it appeared in June 1993. The facility was built in 1948 and was modified during its operational life. All access to the interior of the building is sealed.

Fig. 2.1. D&D facilities in the Gunite and Associated Tanks OU area.

Fig. 2.2. Building 3506, northwest corner.

Fig. 2.3. Building 3506, southeast corner.

LEGEND

- BRICK OR CONCRETE BLOCK WALL
- POURED CONCRETE WALL

Fig. 2.4. Building 3506 floor plan.

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Fig. 2.5. Section of Building 3506.

Fig. 2.6. Pit on west side of Building 3506.

Fig. 2.7. Valve pits on north side of Building 3506.

Fig.2.8. Building 3515, northwest corner.

Fig. 2.9. Building 3515, southwest corner.

Figure 2.10 is an architectural plan view reconstructed from ORNL drawings and sketches. No detailed design drawings for this building were found, and the internal layout was estimated. The building consists of two areas, the north cell and the south cell. In 1988, stainless steel was installed on the roof to stop rainwater inleakage that caused contaminant migration.

Building 3515 housed a pilot system for fission product separation. Figures 2.11 and 2.12 are photographs of the interior of the north and south cells as they appeared prior to abandonment. The following history of the facility is taken from Horton (1984):

The Fission Product Pilot Plant facility, as now named, first existed in 1948 and was referred to as the ^{106}Ru tank arrangement. At that time, the facility consisted of a concrete pad with tanks surrounded by stacks of concrete blocks three rows deep. A tent once surrounded the pad. Several modifications around 1950-51 resulted in construction of a hot cell with 18-in.-thick walls and a 2-ft-thick concrete roof. Lean-to buildings, which were added on the east and south sides, were later removed down to the concrete pad. The remaining hot cell portion of the building now has all doors sealed with concrete block and mortar. Additional concrete block shielding 2 to 3 ft thick was added, bringing the total hot cell wall thickness in most areas up to around 3.5 to 4.5 ft.

The Fission Product Pilot Plant was used to extract radioisotopes of ruthenium, strontium, cesium, cerium, and other elements from liquid waste. The waste came from the ORNL operations and from the Canadian Chalk River cleanup operation.

The Fission Product Pilot Plant has not been used since the late 1950s. The concrete interior, particularly the concrete floor, was frequently soaked with contaminated waste and is very radioactive. When maintenance was required during facility operations, personnel entered the cells only after several weeks of decontamination by overflowing the piping and vessels with purge liquid followed by spraying down the equipment, walls, and floor for several weeks with ceiling-mounted sprays. Finally a few masonry blocks would be removed from the door to permit final spraying and decontamination using long-handled tools. A floor drain in the concrete floor exited under the lean-to room on the east side and turned southward to the waste tank. At times, the lean-to room had to be evacuated due to high radiation levels from the line. The line leaked outside the building and contaminated liquid sometimes bubbled up through the soil.

2.3 CONCEPTUAL MODEL

The conceptual model identifies potential sources for release of contaminants, release mechanisms, transport/exposure media, and exposure routes. Appendix A lists possible contaminants, the expected range of radiation fields, and other hazards.

Fig. 2.10. Building 3515 floor plan.

Fig. 3.11. Equipment in north cell of Building 3515 before abandonment.

Fig. 2-12 Equipment in south cell of Building 3515, before abandonment

Personnel exposure to contaminants at Buildings 3506/3515 is limited because the buildings and immediate area are secured against trespassers, and contaminants are generally contained within the facility. Occupational exposures may occur during characterization, decontamination, and dismantling of the building; safeguards will be stipulated and maintained during these efforts to keep these exposures to a practical minimum. Occupational exposure may occur within the facility or in the immediate vicinity, principally as a result of direct radiation, but also potentially from dermal contact and inhalation. Sources of direct radiation and dermal contact exposure include contaminated surfaces (e.g., walls, floors, equipment), soil or debris under and around the building, and spills or bulk contamination from leaking containers. Interior equipment surfaces or contents are also potential sources for direct gamma exposure.

Inhalation is a potentially significant exposure route because of the air's ability to act as a transport/exposure medium. The likely release mechanism for Buildings 3506/3515 is fugitive dust generation; volatilization will probably not be a principal contributor given the types and forms of contaminants expected. Potential dust sources are contaminated surfaces subject to dust generation, contaminated surface soil around and underneath the building, and bulk contaminants in particulate form. A relatively great potential for dust releases occurs during demolition of the structure and surface decontamination.

3. DATA NEEDS AND QUALITY

This section provides the general project, field, and laboratory DQOs for characterization of Buildings 3506/3515. These DQOs were developed by evaluating the needs of the decision-makers and determining how the data would be used. Also included is a brief identification of the types of potential data uncertainties.

3.1 DATA NEEDS

A discussion of available historical information on Buildings 3506/3515 is presented in Sect. 2; this information is insufficient for defining the design approach for D&D of the facility, but it does help indicate what and how much additional information is needed. Table 3.1 lists data needed to develop D&D procedures or specifications and to confirm the available site information.

This site is primarily contaminated with radionuclides, and the majority of the characterization effort will be aimed toward defining radiological conditions. Screening level characterization for other hazardous chemicals and conditions will be done, but to a lesser extent. Characterization will be sufficient for defining personal protection requirements, estimating waste volume, and planning decontamination. This pre-D&D characterization will not attempt to use statistical methods to define contaminants in such detail as would be necessary for a post-cleanup characterization.

RI/FS requirements impose no unique data needs on the facility D&D, and no additional data needs were identified for the SCP as a result of the OU remediation interface with D&D. As part of National Environmental Policy Act (NEPA) compliance, an environmental assessment will be written (by others) for the buildings and the adjacent tank farm; no unique data needs have yet been identified because of these requirements.

3.2 DATA USES AND CONSIDERATIONS

Specific uses of the data to be collected and categories of collection techniques are also listed in Table 3.1.

The engineering data collected during site characterization will be used (by others) as input for making D&D decisions on the implementation approach for the selected D&D alternative. These decisions will not be based solely on the data collected during site characterization (i.e., other non-site-characterization factors will also be folded into the decision-making process).

The preferred D&D alternative for Buildings 3506/3515 will be determined independent of the site characterization effort. However, the approach taken to implement the alternative, such as sequencing D&D actions or selecting D&D equipment and methods, will be influenced by site costs.

Table 3.1. Data needs, uses, and collection

Data Needs	Specific Uses of Data	Data Collection Methods
General condition of building (interior and exterior)	Assess structural integrity; identify access limitations; identify industrial hazards	Visual inspection and photography; historic knowledge
Equipment identification and location	Design sequence of D&D actions; specify D&D procedures and methods	Visual inspection and photography
Radiation (i.e., alpha, beta, and gamma) dose or exposure rates (building interior and exterior)	Identify radiation hazards and access limitations; specify D&D procedures and methods; estimate waste volumes	Radiation scans; screening level air monitoring
Amount of loose (removable) and fixed contamination on building equipment surfaces ^a	Evaluate effectiveness of pre-decontamination ^b ; predict airborne releases; identify access limitations	Analysis of smear samples and correlated radiation scans
Location of radiation sources and contamination (e.g., "hotspots")	Design sequence of D&D actions; specify D&D procedures and methods	Radiation scans; historic knowledge of process
Contaminant penetration into building walls and floor	Design sequence of D&D actions; specify D&D procedures and methods ^c	Scans and analyses of core samples from structural components
Contamination level in soils under and near the facility	Specify D&D procedures and methods; assess foundation removal and excavation hazard	Analysis of soil samples; historical soil sampling data
Isotope inventory	Determine waste management options	Field gamma spectroscopy; sample analyses

^aContamination that is loose or removable has been deposited (generally as dust) on the building or equipment surfaces and can be removed (in theory) by such techniques as wiping, washing, or scraping. Fixed contamination refers to materials into which contaminants have been leached or otherwise become a part of the material matrix (e.g., leaching into concrete).

^bPredecontamination of particularly "hot" areas should be considered as an alternative that may allow the use of nonremote methods and perhaps produce cost and/or schedule savings. Waste minimization may also be accomplished through predecontamination.

^cIf contaminant penetration is shallow, the design contractor may elect to minimize the waste sent to a low-level waste site by first removing and packaging for disposal only that layer of material from the walls and floor that is contaminated. The rest of the walls and floors may then be demolished and disposed of at a noncontaminated debris landfill.

characterization data. Other factors that could influence the approach include management policies, schedules, and interactions with other ORNL activities.

The detailed approach for D&D of Buildings 3506/3515 will also be affected significantly by ES&H considerations for the worker and waste management (WM) considerations for the building waste. The principal ES&H constraints are radiation exposure hazards, but they also include the buildings' structural integrity, access limitations, airborne releases, and industrial hazards. Data collected during site characterization will largely define these ES&H constraints. Other ES&H considerations not directly determined by the site characterization effort include regulatory ES&H limits, shielding or containment options, and available D&D resources (e.g., personnel, equipment, funding). An understanding of the ES&H considerations will allow the design contractor to specify, for example, those D&D areas that can be accessed directly by personnel and those areas, if any, requiring other options such as use of remote-controlled or robotic equipment. The principal WM considerations include waste generation, segregation, handling, packaging, transportation, and storage/disposal. The design contractor will use the isotope inventory and contaminant penetration information to be collected during site characterization for planning WM options. The future WM planning effort will also consider non-site-characterization factors such as regulatory definitions of waste types [e.g., Resource Conservation and Recovery Act (RCRA), radioactive, transuranic (TRU), mixed] and the waste acceptance criteria (WAC) of the respective storage or disposal sites.

3.2.1 ES&H Considerations

During characterization of Buildings 3506/3515, site data relevant to formal exposure assessments, toxicity assessments, and risk estimation need not be collected. (Note: Formal CERCLA risk assessments for the Gunit and Associated Tanks OU will be performed by the OU remediation contractor, using existing data, to address risk to the public from contaminant releases and transport.) However, risk from the standpoint of worker safety and health and potential public exposure during D&D activities will be addressed by the D&D design contractor. In this context, an evaluation of potential sources, release and transport mechanisms, and exposure routes for the worker will be conducted to the extent necessary to define protective D&D equipment, monitoring programs, and procedural requirements. Data will be collected during site characterization to support this type of dose assessment. The resulting D&D worker safety requirements will help to minimize contaminant exposure in accordance with DOE and Occupational Safety and Health Administration limits.

Standards associated with personnel radiation exposure and contamination control have been instituted to minimize potential risks of biological effects associated with radiation. D&D of Buildings 3506/3515 will be designed and conducted in accordance with radiological standards. Currently, worker dose limits are stipulated in DOE Order 5480.11. To maintain exposures well below these limits, administrative controls are established at levels below those limits. Specific limits/controls have been instituted for exposures to the whole body, to body extremities, to skin and other organs, to the lens of the eye, and to an embryo or fetus (DOE 1992). The whole-body limits, based on the sum of internal and external exposure, are described below to illustrate the regulatory limits and administrative controls.

- The DOE radiation limit during routine conditions is 5 rem/year.
- The DOE administrative control level during routine conditions is 2 rem/year.
- The ORNL administrative control level during routine conditions is 1 rem/year. ORNL also has a daily and weekly administrative control limit of 20 mrem/day and 100 mrem/week. Both of these limits may be exceeded with the proper signature on a Hazardous Work Permit (HWP). During these activities, it is expected that the daily and weekly administrative limits will be exceeded as planned special exposures (see Appendix A). However, the yearly limit will not be exceeded.

Radiological standards exist not only for personnel radiation exposure but also for contamination control (DOE Order 5480.11). Control of contamination is achieved through use of engineering controls and worker performance. Specific standards, generally in the form of monitoring, decontamination, and posting (e.g., signs and labels), exist for personnel contamination control, surface contamination control, and airborne radioactivity control. The surface contamination control standards provide limits (in units of dpm/100 cm²) for both removable and total (removable plus fixed) surface contamination that can be measured using swipes and/or direct scan surveys. The surface is considered contaminated if either removable or total radioactivity is detected above those limits.

3.2.2 WM Considerations

Solid and liquid wastes at ORNL are divided into four general categories: radioactive, hazardous, mixed, and sanitary. The waste categories can be further broken down into subcategories that have been defined in waste management plans and for which some protocols and WAC are available (Energy Systems 1993a,b; Gilpin 1992). If a final waste form resulting from D&D of Buildings 3506/3515 matches the definition and WAC of an ORNL waste subcategory, then disposal or storage of the waste can proceed according to the WM protocols established for that subcategory. Estimates of types and volumes of waste will be made during site characterization (see Table 3.1).

The principal wastes expected to be generated during D&D are radioactive—specifically, solid low-level wastes (SLLW) and liquid low-level wastes (LLLW). Any freestanding radioactive liquid waste will be pumped out by Energy Systems prior to characterization. SLLW is defined as waste containing beta-gamma activity and/or alpha activity (in concentrations $< 1 \text{ g/ft}^3$ or $< 1 \text{ g total}$ and TRU radionuclide specific activity $< 100 \text{ nCi/g}$) and is not classified as high-level waste, TRU waste, or spent fuel. The SLLW category is divided into various subcategories; those subcategories with potential application to Buildings 3506/3515 D&D are defined below (Energy Systems 1993a).

- Contact-Handled (CH) SLLW—Packaged waste with an unshielded container surface radiation dose equivalent rate of $\leq 2 \text{ mSv/h}$ (200 mrem/h). CH waste is divided into two groups: compactible (e.g., plastic bags and sheets, paper, cardboard, cloth, rubber gloves and shoe coverings, plastic bottles) and noncompactible (e.g., wood, scrap metal, glass bottles, metal tools, equipment).

- **Remote-Handled (RH) SLLW**—Packaged waste with an unshielded container surface radiation dose equivalent rate of > 2 mSv/h (200 mrem/h). RH waste is divided into two groups: (1) 2 mSv/h (200 mrem/h) to 10 mSv/h (1 rem/h) and (2) > 10 mSv/h (1 rem/h). RH SLLW > 10 mSv/h (1 rem/h) will be placed in retrievable storage.
- **Very-Low-Activity (VLA) Waste**—Waste that contains no measurable contamination by radiation survey but judged by ORNL Radiation Protection because of its past history and inaccessible areas to be possibly contaminated in excess of defined free release limits.
- **Asbestos Waste**—Any waste that contains commercial asbestos or asbestos material that is radioactively contaminated.

These types of SLLW, assuming that all the WAC are satisfied, are currently disposed of at ORNL's Solid Waste Storage Area (SWSA) 6 or Interim Waste Management Facility.

Another radioactive waste, TRU, is defined as waste contaminated with alpha-emitting transuranic radionuclides (atomic number > 92) with half-lives > 20 years and specific activities > 100 nCi/g at the time of assay. Additional radioisotopes managed as TRU waste at ORNL include californium-252, curium-244, and uranium-233. Most of the existing solid TRU waste storage facilities at ORNL are located in the north area of SWSA 5; the wastes are stored there pending development of an approved strategy for permanent disposal.

Other wastes that may be discovered during site characterization, but probably in smaller amounts, are nonradioactive hazardous waste and mixed waste. The primary regulatory driver for ORNL hazardous WM operations is RCRA; the secondary driver is the Toxic Substances Control Act (TSCA). "Hazardous" compounds/substances are those that are listed in Subpart D of 40 CFR 261, and/or exhibit any of the characteristics of a hazardous waste as defined in Subpart C of 40 CFR 261 and 40 CFR 268, or fail the toxicity characteristic leaching procedure (TCLP). If a waste is determined to be a hazardous waste, it must be handled in strict accordance with RCRA. The State of Tennessee, under the auspices of the Environmental Protection Agency (EPA), has implemented hazardous waste laws essentially equivalent to those of RCRA (Gilpin 1992). TSCA waste includes those compounds and substances contaminated with polychlorinated biphenyls (PCBs), as described in 40 CFR 761. Asbestos and beryllium are also regulated under TSCA. Several ORNL facilities are used for the short-term storage of hazardous waste.

Mixed waste is hazardous waste found to contain radioactive contamination. Examples include cleaning fluids or oils found in a radioactive environment and surface-contaminated lead. No on-site treatment of solid mixed wastes is currently available, and storage capacity at the Oak Ridge Reservation is limited.

If some of the construction debris (including concrete, asphalt, and asbestos) resulting from Buildings 3506/3515 D&D is nonradioactive and nonhazardous, it may be disposed of at the Sanitary Landfill II at the Y-12 Plant, or at an equivalent facility available at the time D&D is performed.

3.3 DATA UNCERTAINTIES

Various limitations on data collection (e.g., no sampling of equipment contents and restricted occupational dose) inherently produce data uncertainties. Other examples of uncertainty for site characterization include the following.

- Tile, concrete, or paint layers may cover previous spills on the floor and wall surfaces. These cover layers may interfere with surface characterization of alpha- or low-energy beta-emitting contaminants, thus causing under-estimation of contamination.
- Some areas, such as joints between walls or between walls and the floor, may be highly contaminated. These same areas are more difficult to survey and sample than the wall or floor surfaces.
- Smears will be taken of external equipment surfaces, but some equipment surfaces are irregular and may be partially or completely inaccessible.

3.4 DATA QUALITY OBJECTIVES

The DQO process is a planning tool developed by EPA to help decision-makers and data collectors to generate quality (i.e., adequate and usable) characterization data. EPA has provided guidance (EPA 1986, 1991a) for effectively applying the DQO process, and the process has actually been applied to remedial investigations at CERCLA sites. However, formal application of DQOs to D&D is new. DOE is currently reevaluating the EPA guidance with the specific objective of integrating the DQO process into D&D efforts and will probably issue its draft recommendations for DQO integration at the end of FY 1993.

3.4.1 General DQOs

Buildings 3506/3515 characterization data must be of sufficient type and quality to support subsequent D&D engineering; specifically, to (1) evaluate and design the most cost-effective D&D approach; (2) determine the level and type of protection necessary for D&D workers; and (3) estimate the waste categories (e.g., TRU, VLA, CH SLLW, RH SLLW, mixed, hazardous) and volumes of wastes to be generated from D&D and make planning decisions concerning waste disposal.

The proposed measuring and sampling scheme for Buildings 3506/3515 is "biased" (nonrandom) rather than "unbiased" (random or gridded). Unbiased measuring and sampling is used in some situations to predict overall site properties or to provide estimates that are representative of the population at large. For this site characterization, a biased scheme will be used to increase the chance of obtaining measurements and samples from the most heavily contaminated areas. With regard to radiological measurements and samples, direct reading instruments will survey and identify "hotspots" for additional characterization. With regard to nonradiological samples, sampling

locations will be selected, using engineering judgment, from areas that are probably contaminated (e.g., discolored areas, drain or spill areas, low spots, visible residue). Biased measurements and samples will generally represent higher contamination than might exist overall at the site.

3.4.2 Field Radiological Survey DQOs

To ensure that the data collected during the characterization survey are of known and acceptable quality, the data will be validated through an evaluation for precision, accuracy, representativeness, completeness, and comparability (PARCC). The validation will be an ongoing effort during the course of the characterization. A brief description of how each component will be evaluated is given below.

Precision

Precision is a measure of the mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is evaluated through the use of duplicate or replicate measures. Precision will be determined using the concept of "relative percent difference" (RPD).

During the course of the characterization, the measurements from approximately 10% of the locations surveyed will be randomly selected for remeasurement and the RPD will be determined. (Note: One remeasurement will occur after each sequence of 10 measurements.) If the RPD falls outside a control limit of 20%, the instrument will be removed from service and all data collected since the last acceptable RPD will be reviewed. The entire data set, since the last acceptable RPD, will be declared unusable if the point at which instrument deviations began can not be determined. Precision will not be determined for smears because smears are collected from each assigned area only once.

Accuracy

Accuracy is the degree of agreement between the observed (measurement) value and the true value. Each instrument will be calibrated, and changes in accuracy will be monitored by tracking the daily source checks for an instrument in use in a fixed geometry. Project Procedure (PP) 1715, "Radiological Quality Control Procedure," outline the techniques used to provide quality data for radiological analyses and counting at the Close Support Laboratory (CSL).

During the characterization survey, the field survey instruments will be source-checked at the beginning and end of each day, when in use. If the source check falls outside a 10% control limit, the instrument will be removed from service and data collected since the last acceptable source check will be reviewed. The entire data set will be declared unusable if the point at which instrument deviations began cannot be determined.

The minimum detectable activity for each counting instrument will be calculated and reported as part of the data analysis.

Representativeness

Representativeness expresses the degree to which data represent the contaminants present in the area of interest. Therefore, representativeness is dependent on appropriate measurement and sampling techniques for the matrix and contaminant and on measurement and sampling locations that are typical of the area being surveyed.

Measurement and sampling techniques and the strategy for selecting measurement and sampling locations for the characterization survey are described in Sects. 4 through 6. This investigation will be conducted using biased sampling so that radiological exposure is minimized and conservative assumptions go into D&D planning.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system (through both in situ measurements and sample analyses) compared with the amount that was specified by the plan. The validity of the data obtained is based on whether the measured results satisfy field and laboratory protocols, mathematical data reduction techniques, and the other requirements described herein. For each data type to be obtained (e.g., direct alpha, direct beta/gamma, removable activity, dose rate) the data set will be considered complete if the actual number of measurements is less than the planned number of measurements due to access or as low as reasonably achievable (ALARA) limitations encountered during field efforts.

Comparability

Comparability expresses the confidence with which one data set may be compared with another. This includes two elements of the survey process: the measurement instrument and the technique by which measurements and samples are obtained.

Comparability of data collected with different measurement instruments is ensured through achievement of precision and accuracy. Comparability of survey technique is accomplished by adhering to field work guides (FWGs) and procedures and by documenting this adherence in field logs, ES&H notebooks, and sample results. This will be reviewed during periodic audits of measurement records.

Data review

Survey data will be reviewed by a radiation measurement specialist and will not be released for final use until the quality and usability of the data have been determined. The data will be typically reviewed as a case, where a case is a group of data of a similar nature (e.g., radiological data as opposed to chemical data) obtained over a specific period of time from the same general area (e.g., a particular room in a given building). The data review process will incorporate the following elements:

- completeness of the data and appropriate supporting PARCC documentation;
- evaluation of data based on PARCC documentation;
- identification of suspect, reject, and usable data; and
- elimination of previously rejected data that have been replaced with valid data.

Data interpretation

Measurement data will be converted to units of dpm/100 cm² (surface activity), mR/h (exposure rate), pCi/L (liquid concentration), or pCi/g (soil concentration). Detector backgrounds are subtracted from measured readings, and resultant values are corrected for efficiency and geometric factors associated with the instrumentation to complete the conversion of measured values to units suitable for comparison to the guidelines.

- **Background**—The background for each instrument will be determined and tracked as part of the routine instrument quality control checks. This background will be subtracted from measured values.
- **Efficiency**—Standards traceable to the National Institute of Standards and Technology will be used to determine the efficiency of each instrument.
- **Geometry Correction**—A geometry correction factor will be used to convert the measurement results to dpm/100 cm². This factor will be primarily the ratio of 100 cm² to the area subtended by the face of the detector, corrected for distance.

3.4.3 Sample Collection DQOs

The DQOs associated with the collection of miscellaneous samples, concrete cores, soil samples, and grab air samples from Buildings 3506/3515 are given below.

Documentation

Samples obtained during the characterization of Buildings 3506/3515 will be collected in a manner that documents sample type, sample location, date of sampling, and interval (where applicable). This information will be maintained in field logbooks. Collection of samples and documentation of these activities will be in accordance with all pertinent ORNL RI/FS project procedures (e.g., PP 1303: "Field Quality Control") and plans (see Sect. 3.5). Proper documentation in the field and during sample collection will be used to establish the fact that protocols have been followed and sample identification and integrity have been maintained.

Precision

Precision in sampling is normally measured by using field replicates (samples that have been divided into two or more portions). The recommended frequency of collection is generally 1 per 20 regular samples collected. Collection of field replicates for Buildings 3506/3515 will depend on the

sample radioactivity, the sample quantity or availability, and the appropriateness of dividing the sample. It is anticipated that the concrete cores and grab samples will not be divided in the field; field replicates of the soil will be obtained if exposure levels permit. RPD limits for field replicate soil samples will be 35%. Detects for field replicate analyses will be evaluated only if the detect value is at least five times the stated detection limit.

Accuracy

Accuracy is difficult to measure for field sampling efforts. Errors can arise from sampling methodologies, contamination in the field, errors in sample preservation and handling, interferences from the sample matrix, and errors in sample preparation and analysis. The use of standard procedures for container and sampling equipment cleaning and sample collection, standardized training and performance criteria for instrument users, uniform sample handling techniques, and blanks to detect contamination can reduce the sources and impacts of the various errors listed above.

Representativeness

Sample representativeness will be ensured by the use of specified procedures for sample preservation, transport, and storage. Various sampling techniques, including biased sampling (see Sect. 3.4.1) and compositing, will be used to ensure that samples collected are representative of the contamination present. During sampling, various field blanks (e.g., trip blanks, equipment rinsates) will be collected to ensure that false positive results are not introduced as a result of the sampling techniques or environmental factors.

Completeness

The quality assurance (QA) objective for this project is that sample breakage or loss be minimized; the "completeness" of sample collection (number planned versus number collected for which valid data can be obtained) should be as near 100% as possible.

Comparability

Comparability is increased by the use of narrowly defined sampling methodologies; use of standard sampling devices; training of personnel; and surveying, mapping, and marking of sampling points.

3.4.4 Laboratory Analysis DQOs

The DQOs associated with the analysis of samples obtained from Buildings 3506/3515 are given below.

Documentation

Documentation requirements for samples requiring offsite analysis will be specified on the Request for Analysis. This will be accomplished by referencing a quality control (QC) level for the particular sample. (Note: The "QC level" discussed in the subsection refers to reporting requirements for analytical laboratory services and is not to be confused with EPA analytical support levels.) The QC level requested will define the minimum amount of QC to be performed and reported with the analysis and the amount of supporting documentation that will accompany the hard-copy data deliverable. The QC levels anticipated for this sampling activity are as stated in the Technical Specification for Analytical Laboratory Services (Bechtel 1993):

QC Level III QC protocols, including instrument calibration, are as defined by the US EPA [Contract Laboratory Program] CLP for TCL/TAL samples for which CLP protocols are specified. For non-TCL/TAL analyses, which are not covered by the CLP Statements of Work, the QC program employed must meet the intent of the CLP. As a minimum, 20% QC samples for each analytical batch is required. (Note: The phrase "20% QC samples" should be interpreted as 1 set of 4 QC samples for every 20 samples, with each set generally consisting of a blank, a spike, a duplicate or spike duplicate, and laboratory control sample.) QC data, including raw data, are reported in a CLP, or "CLP-like," data package.

The specific documentation requirements for radiological data packages are included in Attachment B of the above-referenced technical specification.

Data sources

Samples collected at Buildings 3506/3515 will be analyzed by using off-site analytical support laboratories and the CSL. Samples with radiological activity that exceeds applicable Department of Transportation limits (49 CFR 172-178) for transport will be analyzed by the ORNL Radiological Materials Analytical Laboratory (RMAL).

Precision

Precision for this sample collection effort will be assessed by evaluating laboratory duplicate analyses. RPD limits for analytical precision will be defined by the analytical method selected.

Accuracy

Accuracy will be evaluated by the results of matrix spike analyses. Spike recovery limits will be defined by the analytical method selected. In addition to matrix spikes, method performance will be evaluated by the use of laboratory control samples.

Representativeness

Sample representativeness will be ensured by the use of proper sample preservation techniques and adherence to specified analytical holding times. During the analytical measurement process, method blanks will be analyzed to ensure that contaminants were not introduced by conditions occurring at the analytical laboratory facility. Efforts will be made by the laboratory to adequately homogenize (e.g., invert a liquid sample, mix a soil sample, or crush a concrete sample) the sample before taking a sample aliquot.

Completeness

The completeness goal for this project will be valid analytical results for 95% of the analyses requested.

Comparability

The analytical methods requested for samples requiring off-site chemical analysis will be based on EPA CLP methods. Radiological samples will be analyzed using a combination of EPA-approved radiological methods and laboratory-specific standard operating procedures (SOPs). All laboratory-specific SOPs have been reviewed to ensure comparability between the various laboratories.

Data review

Data submitted by off-site analytical laboratories will be reviewed in accordance with PP 1503.1, "Receipt, Review, and Assessment of Analytical Data Quality." The data obtained from off-site analyses will not be maintained in the ORNL RI/FS project electronic data base.

Data validation

Chemical data will be reviewed in accordance with EPA CLP data validation procedures for organic and inorganic data (EPA 1988a, 1990). Non-CLP analyses will be reviewed against data validation procedures designed to meet the format and intent of the CLP program (specifically, PP 1503.2, "Validation of Radiological Data").

3.5 PLANS, PROCEDURES, AND PERMITS

The current revision of the following approved program plans will be used for this task.

- *Environmental, Safety, and Health Plan for the Remedial Investigation/Feasibility Study at Oak Ridge National Laboratory, Oak Ridge, Tennessee*
This document outlines the ES&H concepts and methodologies to be followed during characterization of Buildings 3506/3515 to protect the health and safety of employees, the public, and the environment. The ES&H Plan acts as a management extension for ORNL and

Energy Systems to direct and control implementation of the project ES&H program. Plan subsections establish the program philosophy, requirements, QA measures, and methods for applying the ES&H program to the site.

- *Quality Assurance Plan for the Remedial Investigation/Feasibility Study at Oak Ridge National Laboratory, Oak Ridge, Tennessee*

The QA Plan specifies those controls and activities necessary to meet the technical and quality standards of Bechtel, Energy Systems, and ORNL. These controls and activities are designed to ensure that all D&D characterization activities are of known and defensible quality and comply with appropriate safety and health provisions. The QA Plan also establishes the management approach, organization, interfaces, and verification/overview controls; and specifies the applicable procedures necessary to ensure quality. The project QA Plan complies with ANSI/ASME NQA-1 and EPA QAMS-005/80 requirements.

- *Waste Management Plan for the Oak Ridge National Laboratory Remedial Investigation/Feasibility Study*

The WM Plan establishes clear lines of responsibility and authority, documentation requirements, and operational guidance for waste materials generated as a result of field investigation activities. This plan establishes those standards, criteria, waste handling and packaging requirements, and project interfaces necessary to ensure proper collection, identification, segregation, classification, packaging, and certification of waste materials.

- *Close Support Laboratory Quality Assurance Plan for the Remedial Investigation/Feasibility Study at Oak Ridge National Laboratory*

This plan describes the tools and mechanisms needed to meet the program goals for the CSL. It specifies the approach for implementing analytical and radiological protocols and procedures for the documentation, handling, control, and analysis of samples; and establishes the levels of authority and responsibilities for laboratory operation. Specific QC methods used by the CSL for individual analyses are described in the project procedures.

- *Project Management Plan for the Oak Ridge National Laboratory Remedial Investigation/Feasibility Study*

The Project Management Plan is an overview document that establishes management and technical objectives, technical approach to the work, critical support activities, responsible organizations and interfaces, and project management systems to be applied for cost and schedule control and monitoring.

These documents are written for the ORNL RI/FS Project and apply to D&D characterization activities.

Similarly, project procedures written for the ORNL RI/FS Project are also directly applicable to the D&D characterization effort. Each procedure is identified with a number, a revision, and an issue date; it is then grouped with other procedures in eight "series" with common themes. Examples of procedures that will be followed in the D&D characterization effort are shown in Table 3.2. Project procedures are revised as needed, and the current revision applies.

Prior to initiation of field measurements and sampling, FWGs will be issued and the necessary characterization activity permits will be obtained. The FWGs will detail where and how building characterization and sampling will occur. Permits to be obtained will include HWP, in accordance with PP 1235; and excavation/penetration permits (E/PPs), in accordance with PP 1620. HWPs are issued to indicate safety and health measures and task-specific procedures for potentially hazardous work operations; E/PPs are issued to address safety concerns with regard to entering into or passing through a surface such as a roof, floor slab, wall, or the ground by means of drilling, cutting, boring, digging, and probing. An E/PP will be in place before concrete drilling and soil sampling are performed at the site.

The QA Department will review applicable D&D documents for inclusion of quality requirements and will plan, schedule, perform, and report audits and surveillances as required by the project QA program requirements. Deficiencies will be documented, and follow-up will be accomplished as required.

As part of the QA process, a Quality Assurance Assessment (QAA) and Quality Assurance Action Plan (QAAP) will be developed, in accordance with PP 1308. The QAA is a qualitative, formal evaluation of the elements of a D&D project task to identify potential quality problems and assess the associated risks. The assessment is based on an evaluation of the consequences of the potential quality problem and the probability of its occurrence. The QAAP defines the actions and responsibilities that are necessary to prevent or mitigate the consequences of potentially significant quality problems identified in the QAA.

Project training (see PP 1120) includes training of CSL technicians, as specified in the CSL QA Plan; "on-the-job" and equipment training, which is conducted by the appropriate discipline manager or designee; and ES&H training, which is provided in accordance with PP 1210. The purpose of ES&H instruction and training is to inform workers of potential safety and health hazards and to comply with applicable state and federal regulations or orders. All workers assigned to enter controlled areas will receive a minimum of 40 hours of classroom training, and personnel who supervise field activities will receive an additional 8 hours of instruction. A refresher course of at least 8 hours covering this material is required annually. Included in the training are general descriptions of site history, the scope of work, hazardous materials and work situations that may be encountered, and protective measures that workers should use for their own safety. Weekly toolbox safety meetings will also be conducted during field operations.

Table 3.2. Examples of project procedures for D&D characterization

Series No.	Series Title	PP No.	PP Subject
1100	Administration	1105	Project Procurement Procedures
		1107	Project Engineering Procedures
		1110.1	Field Photography and Control
		1110.2	Communications Documents
		1110.3	Distribution of Controlled Documents
		1110.4	Project Master Distribution Schedule
		1110.5	Processing of Project Technical/Design Documents
		1110.6	Supplier Documents
		1110.7	Microfilming
		1110.8	Records Retention and Turnover
		1110.9	Project Signature Control
		1113	Preparation of Project Plans and Reports
		1114	Preparation of Project Procedures
		1115	Internal Review of Project Documents
		1120	Administration of RI/FS Training
		1132	Preparation of Project Field Work Guides
1200	Environmental, Safety, and Health	1210	ES&H Training
		1230	Personal Protective Equipment
		1235	Hazardous Work Permits
		1245	Emergency Response
		1250	Equipment Decontamination
		1255	Work Area and Environmental Monitoring
		1260	Hazardous Materials Transportation
		1270	Industrial Hygiene Practice
		1280	Health Physics Practices
		1285	Calibration and Maintenance of ES&H Instruments
1300	Quality Assurance	1302	QC Surveillance Inspection Program
		1303	Field Quality Control
		1304	Laboratory Quality Control
		1305	Nonconformances
		1308	Quality Assurance Assessments
		1309	Quality Assurance Action Plan
		1313	Quality Assurance Procedures
1400	Waste Management	1401	Waste Categorization
		1402	Waste Handling
		1403	Waste Transportation and Storage
		1404	Waste Management Training
		1405	Waste Management Records
		1406	Operation of Hazardous Waste Accumulation Areas

Table 3.2 (continued)

Series No.	Series Title	PP No.	PP Subject
1500	Data Base Management	1503.1	Receipt, Review, and Assessment of Analytical Data Quality
		1503.2	Data Review for Radiological Data
		1503.3	Wet Chemistry Data Validation Procedures
1600	Field Operations	1603	Sample Information Management System
		1605	Sample Archiving
		1620	Obtaining an Excavation/Penetration Permit
		1625	Sample Documentation to Support Data Assessment
		1631	Logbook Protocols
		1632	Sample Containers and Preservation
		1634	Sampling Compositing and Duplicate Techniques
		1636	Use and Calibration of Field Instruments
1700	Close Support Laboratory	1650	Decontamination Program
		1710	Sample Preparation for Radiochemical Analyses
		1715	Radiological Quality Control Procedure
		1726	Transfer of CSL Data into Project Records
1800	Project Controls	1727	Reporting CSL Analytical Data
		1801	Baseline Management
		1802	Trend Program

4. INSTRUMENTATION AND METHODOLOGY

The following equipment and methods may be used to determine the nature and extent of loose and fixed surface contamination and to measure the radiation fields present in Buildings 3506/3515:

- smears,
- field gross alpha measurements,
- field gross mixed beta/gamma measurements,
- field gross gamma measurements (directional and omnidirectional),
- field gamma spectroscopy,
- thermoluminescent dosimeter (TLD) strings,
- concrete core scanning and analysis,
- laboratory analysis,
- soil sample scanning and analysis,
- air grab samples,
- field video or photography, and
- physical measurements.

Table 4.1 summarizes these methods, and the following sections provide details.

All field characterization equipment will be operated in compliance with appropriate existing project procedures and/or the instrument manufacturer's operating manual. Portable field survey instruments will be operated using PP 1285 and/or the manufacturer's operating manual. Operation of CSL equipment is in accordance with the 1700 series procedures and/or the manufacturer's instrument operating manual. Off-site and ORNL analytical laboratories follow SOPs and methods (e.g., American National Standards Institute, EPA, or equivalent) for laboratory instrument operation and sample preparation and analysis, respectively. All equipment mentioned here may be substituted with equivalent systems.

4.1 SMEARS

Smears are used to determine the nature and extent of loose surface contamination. Smears are obtained by rubbing an approximately 5-cm-diameter swatch of paper in a serpentine fashion over an allegedly contaminated surface area of approximately 10 by 10 cm (DOE 1983). Smear locations will be selected in the field, taking into account ALARA considerations and physical access conditions, and each smear will be numbered and its location noted. Correlation of analytical results with smear locations provides a spatial distribution of loose surface contamination levels.

Generally, each smear will be analyzed in the field for gross beta/gamma activity. If the smear activity level is > 5 mR/h (closed window) as determined by field beta/gamma survey, then field

**Table 4.1. General description of field characterization
for Buildings 3506/3515**

Section	Method	Procedures/Equipment	Purpose	Data Form
4.1	Smears	5-cm-diameter paper rubbed over a 10-cm by 10-cm area	Analyze loose surface contamination	Activity per 100 cm ²
4.2	Field gross alpha measurement	Alpha scintillation probe	Characterize alpha-emitting surface contamination	(1) Count rate (2) Integrated counts for a period of time
4.3	Field gross mixed beta/gamma measurement	Beta/gamma detectors	Characterize beta- and gamma-emitting contamination	(1) Exposure rate (2) Integrated exposure for a period of time (3) Counts per unit time
4.4	Field gross gamma measurement	Omnidirectional and directional (collimated) gamma detectors	Characterize gamma contamination and infer source locations	(1) Exposure rate (2) Integrated dose for a period of time (3) Counts per unit time
4.5	Field gamma spectroscopy	Germanium or sodium iodide detectors	Determine isotopic distribution of building contaminants	Relative isotopic distribution
4.6	TLD string	TLDs spaced at predetermined intervals in a radiation field	Characterize beta and gamma fields	Dose for a period of time

Table 4.1 (continued)

Section	Method	Procedures/Equipment	Purpose	Data Form
4.7	Concrete core sample/scan	(1) Slit scanning using a gamma spectroscopy system, (2) slit scanning using a gross gamma measurement, (3) scanning using a film sheet, (4) lab analysis	Determine the penetration of gamma-emitting contaminants into the concrete floor and walls	Exposure rate spectrum count rate; contaminant concentrations
4.8	Soil sample/scan	(1) Hand auger/Shelby tube or spilt spoon, (2) slit scanning using gamma spectroscopy, (3) slit scanning using gross gamma, (4) lab analysis	Determine spatial distribution of contaminants, top to bottom; identify contaminant penetration through foundation	Exposure rates, count rates, and spectrum; contaminant concentrations
4.9	Field video or photography	Cameras	Record situations and conditions	Photography or videotape
4.10	Physical measurements	Measuring tape	Record dimensions/distances	Logbook
4.11	Grab air samples	Tedlar bag	Air quality	Contaminant concentrations

gross alpha, beta, and gamma measurements will be performed and the smear may be sent to the ORNL RMAL or a low-background field station for further analysis (i.e., gamma spectroscopy). Figure 4.1 shows a typical field arrangement. If the smear activity level is < 5 mR/h, the smear will be sent to the CSL for analysis. The limit of 5 mR/h is not an administrative limit, but an approximate CSL operating limit; this limit may change depending on recommendations from CSL personnel.

A portable smear counting system may be deployed in the field to measure the gross alpha and beta/gamma activity of smears with exposure rates > 5 mR/h. This system may employ a Ludlum Model 43-10 probe [a windowless ZnS(Ag) scintillation probe] or equivalent for alpha counting and a Ludlum Model 44-40 probe [a shielded, thin-window, 1.7-mg/cm^2 Geiger Mueller (GM) tube detector] (Ludlum 1992) for beta/gamma counting (see Fig. 4.2). (Detection fundamentals of these probes are discussed in Sects. 4.2 and 4.3). To collect and record the data, a Ludlum Model 2000 scaler (see Fig. 4.2) may be used to process the signals produced by the probe.

Field measurement instruments will be appropriately selected for each type of gross measurement; descriptions of these instruments are presented in more detail in Sects. 4.2 through 4.5. To maintain the repeatability of field measurements, a measurement geometry template (spacer) will be devised and used for each type of radiation field measurement (see Fig. 4.3). For alpha activity measurements, this height (the distance between the alpha probe's active surface and the smear) will not be more than 1 cm, depending on the probe type. For measuring mixed beta/gamma and gamma radiation fields, a spacer of 10-cm height may be employed. These field measurements will be performed away from the general contaminated area radiation fields and in a low-radiation background setting.

4.2 FIELD GROSS ALPHA MEASUREMENTS

An alpha scintillation probe such as Eberline Model AC-3 [a ZnS(Ag) powder embedded onto a tape with a thin (0.50 mg/cm^2) aluminized Mylar window (Eberline 1991) (see Fig. 4.4)] may be used to measure surface alpha activities in the field. Measurement results exceeding background values generally indicate the presence of uranium and transuranic isotopes. The detection mechanism of this probe is based on the interaction of ionizing radiation with the scintillator material, which leaves the material in an excited state. In turn, the scintillator material de-excites and releases energy in the form of light photons in the visible band of the spectrum. These light signals are detected and transformed into an electronic signal by a photomultiplier tube.

These measurements provide information on surface activity (i.e., fixed and loose contaminants on the surface) but generally cannot quantify fixed contamination below the surface. This is due to the short range of alpha particles in material (on the order of 2 to 3 cm in air for an alpha particle with energy of 4.5 MeV) (Cember 1983). The range of alpha particles in media is dependent on the alpha energy and the density of the interacting media (Knoll 1989). During field measurements, therefore, the active surface of the alpha probe will be placed as close to the contaminated surfaces as possible without contaminating the probe. To achieve this and to provide consistency of

Fig. 4.1. Schematic diagram of gamma spectroscopy of smears reading >5 mR/h.

(A) LUDLUM MODEL 43-10

ALPHA SAMPLE COUNTER

(B) LUDLUM MODEL 44-40

**SHIELDED GM PANCAKE
DETECTOR**

(C) LUDLUM MODEL 2000

SCALER

Fig. 4.2. Typical field detectors and data collection/recording instruments for counting smears with >5 mR/h.

Fig. 4.3. Typical spacer arrangement.

AC-3 scint. with
optimal track pattern

(A) EBERLINE MODEL AC-3

(B) EBERLINE MODELS RO-2 AND RO-2A

Fig. 4.4. Typical (A) alpha scintillation detector and (B) ionization chamber detection system.

measurement locations, an appropriate spacer will be attached to the alpha probe face (see Fig. 4.2). Measurements will be performed systematically at locations that will be selected in the field, taking into account ALARA considerations and physical access conditions.

To collect and record the data, an Eberline ASP-1 or Eberline ESP-2 (see Fig. 4.5) or similar instrument may be used to process the signals produced by the scintillator probe photomultiplier tube. Eberline ASP-1 is an analog device that can function either as a ratemeter (output exposure or counts per unit time) or integrator (output total exposure or count for a period of time set manually using a reset button). Eberline ESP-2 is a data logging microcomputer-based survey instrument that stores survey readings for later output to a printer or personal computer via an RS-232C serial interface port. This unit also can be operated either as a ratemeter or a scaler (integrates counts or exposure for a preset period of time automatically) (Eberline 1991).

The detection system selected (consisting of the probe and data collection unit) will be calibrated appropriately prior to field measurements. Daily response checks employing a check source will be performed prior to use in the field. In addition, the instrument response to background radiation will be recorded before and after daily activities (DOE 1983).

4.3 FIELD GROSS MIXED BETA/GAMMA MEASUREMENT

An Eberline HP-270 probe may be used to estimate radiological exposure levels due to mixed beta/gamma fields generated by contaminants present in the general area (Fig. 4.6). The HP-270 is an energy-compensated GM tube with a 30-mg/cm²-thick stainless steel wall, housed inside 1/16-in. ABS plastic (Eberline 1991). In addition, this probe has a sliding window in its plastic housing that allows for exposing the bare GM tube to mixed fields. The plastic housing and the stainless steel wall together are sufficiently thick to stop strontium-90/yttrium-90 betas from entering the GM tube's active area. However, with the plastic window open, the stainless steel wall is thin enough to allow the strontium-90/yttrium-90 betas to enter the GM tube's active volume. Using this probe in mixed beta/gamma fields allows the surveyor to estimate the contribution of beta exposure fields to the total mixed exposure fields. This is achieved by performing two measurements—one with open window and one with closed window—at a single location.

The detection mechanism of this probe is based on gas-filled detectors. These detectors are generally constructed by filling an electrically conducting receptacle (often cylindrical) with an appropriate counting gas and inserting a collecting electrode (usually a wire along the axis of the cylinder) that is electrically insulated from the receptacle. Interaction of ionizing radiation with the gas in the tube forms ion pairs. If a positive voltage is applied across the gas between the center electrode and the outside receptacle, the ion pairs generated in the gas can move to the electrode under Coulomb force and produce an electrical signal (Knoll 1989, Gollnick 1988). These signals can then be processed to provide information about the radiation field.

To collect and record the data, an Eberline ASP-1 or Eberline ESP-2 (see Fig. 4.5) may be used to process the signals produced by the probe, as described in Sect. 4.2.

(A) EBERLINE MODEL ASP-1

(B) EBERLINE MODEL ESP-2

Fig. 4.5. Typical field data collection/recording instruments.

(A) EBERLINE MODEL HP-270

(B) EBERLINE MODEL HP-290

(C) EBERLINE MODEL HP-220A

Fig. 4.6. Typical detectors used for direct field gross measurements (A) mixed beta/gamma, (B) gamma omnidirectional, and (C) gamma directional.

The energy compensation feature of the Eberline HP-270 probe provides reliable measurements of the radiation exposure fields from natural background levels to few hundred mR/h. If mixed fields greater than several hundred mR/h are encountered, an Eberline RO-2 or RO-2A (see Fig. 4.4) or similar instrument may be used.

The Eberline RO-2 and RO-2A are portable air ionization chamber instruments sensitive to beta and gamma fields. The instruments differ in the range of radiation fields in which they may be operated; RO-2 is usually used in a field ranging from several mR/h to several thousand mR/h (approximately 5 to 5000 mR/h), and RO-2A is usually used in a field ranging from tens of mR/h to tens of R/h (approximately 50 mR/h to 50 R/h) (Eberline 1991).

The ionization chamber in these instruments has 200-mg/cm²-thick phenolic walls inside a 0.13-cm-thick aluminum casing. At the bottom of the instrument, a thin Mylar window (7 mg/cm² thick, enough to allow the strontium-90/yttrium-90 betas to pass through) covered with a sliding beta shield (400-mg/cm²-thick phenolic material) prevents strontium-90/yttrium-90 beta particles from entering the active volume of the chamber. These instruments can be used to measure mixed fields and estimate the contribution of beta fields to the mixed fields. This is achieved by performing two measurements at a single location—once with the window open and once with the window closed. The detection mechanism of these probes is based on gas-filled detectors, described earlier in this section.

To maintain the repeatability of field measurements, a measurement geometry template (spacer) will be devised and used for each type of radiation measurement system (see Fig. 4.3). Measurement locations will be selected in the field, taking into account ALARA considerations and physical access conditions.

The system selected (probe and data collection unit) will be calibrated appropriately before field measurements are taken. Daily response checks will be performed with a standard beta/gamma source prior to use in the field, and the instrument response to background radiation will be recorded daily before and after field activities.

4.4 FIELD GROSS GAMMA MEASUREMENTS

Two different measurement methods will be used to estimate the radiological exposure levels due to gamma fields generated by contaminants present on and within building surfaces and indoor equipment. The first method uses an omnidirectional probe such as the Eberline HP-290 (see Fig. 4.6), which is an energy-compensated GM tube with a 90-mg/cm²-thick stainless steel wall covered by approximately 0.32 cm of ABS plastic. The combined thickness of steel and plastic makes the probe insensitive to strontium-90/yttrium-90 betas and responsive only to gamma fields. The energy compensation feature of this probe permits reliable exposure rate measurements from 0.1 mR/h to 10 R/h (Eberline 1991).

The second system is a modified Eberline HP-220A directional probe (see Fig. 4.6) with a collimator attached to its front face probe (see Fig. 4.7). The collimator is a right-circular cylindrical piece of tungsten approximately 7.6 cm in diameter and 2.9 cm in height, with a 90° internal conical cut from the center of the cylinder base to the edge of the top surface. The HP-220A probe employs a small halogen-quenched GM tube for detection of relatively high gamma fields. The GM tube assembly is housed inside a stainless steel casing within a hemispherical tungsten alloy shield. The directional probe system in turn is within an approximately 0.6-cm-thick Plexiglas enclosure that reduces beta field interference with gamma readings (Cember 1983). [Beta interference is produced by interaction of beta particles with high-atomic-number materials (e.g., tungsten) used for the back shield and collimator in this system; the interference results in bremsstrahlung radiation (Turner 1986), to which the probe is sensitive.]

Use of this directional gamma detection system enables the operator to obtain directional (front face) information without the interference of gamma fields from other directions. This probe can also be used to monitor the gamma fields generated by a specific object without interference from objects outside of the detector solid angle. The front-to-back ratio is approximately 10 for cobalt-60 and 20 for cesium-137. Because of the tungsten collimator geometry, exposure rate measurements from a uniformly contaminated surface can be performed at any distance from the surface with approximately the same results. For comparability of measurement results from omnidirectional and directional probes, the omnidirectional probe is also placed in an approximately 0.6-cm-thick Plexiglas enclosure. The detection mechanism of these probes is based on gas-filled detectors, as described in Sect. 4.3.

To maintain the repeatability of field measurements, a measurement geometry template (spacer) will be devised and used for each type of system (see Fig. 4.2). Also, measurements will be performed systematically at locations that will be selected in the field taking into account ALARA considerations and physical access conditions. The directional probe may be used at each measurement location to make hexadirectional measurements (Fig. 4.7) if an appropriate geometry exists and no restriction is imposed by conditions in the building. Individual measurements may be taken from the center of the room or up and down the four walls using the template.

To collect and record the data, an Eberline ASP-1 or Eberline ESP-2 (see Fig. 4.5) may be used to process the signals generated by these probes, as described in Sect. 4.2.

The selected detection system, probe, and data collection unit will be calibrated appropriately before field measurements are taken. Daily response checks with a standard gamma source will be performed prior to use in the field, and the instrument response to background radiation will be recorded before and after daily activities.

4.5 FIELD GAMMA SPECTROSCOPY

A series of direct gamma spectroscopy measurements (i.e., counting for one or more of the rare earth isotopes) may be performed within the building to determine the relative isotopic distribution

Fig. 4.7. Modified HP-220A used as directional detector with tungsten collimator.

of contaminants. These measurements estimate the contribution of each isotope to the total radiological exposure levels in the area. The principle of this method is that specific energy peaks which correspond to specific radioisotopes on a gamma spectrum would be detected and can be used to estimate the amount of activity of this radioisotope because the strength of the signal is proportional to the activity of the radioisotope (Knoll 1989; Tsoulfanidis 1983).

Before these measurements are performed in the field, the following must be considered: accuracy is limited by knowledge of the source location and distribution and by the accuracy of the analytical model; and geometry correction is required (determined by the detector field of view, components and materials in the field of view, distances, source volumes, etc.). In situations such as this, it may be difficult to estimate a value for the quantity of a single isotope; however, ranges of values can be established through modeling using the results of this method.

4.5.1 Germanium Detection System

A high-purity germanium (HPGe) detector uses a solid-state diode built of a fairly large piece of germanium crystal (Fig. 4.8). The diode is made large enough to totally absorb a fraction of the gamma rays that enter the crystal volume (5 to 100 cm³). The semiconductor junction must also span the sensitive volume of the crystal. This is accomplished with an intrinsic region between the n and p regions (an n.i.p junction). When voltage is applied to the diode, an electric field is created in the crystal. Free carriers created in this region by the passage of ionizing radiation will be swept out and collected as a signal for detection (Knoll 1989).

A germanium spectroscopy system is usually chosen for gamma detection because

- the linear coefficient for gamma absorption is high, so only a small crystal is needed;
- the charge collection time is small, which enables the detection system to count faster;
- the photoelectric cross section is high; and
- the germanium detector has better energy resolution due to a comparatively smaller crystal and less trapping.

Germanium crystals used for detecting gamma energies above 1 MeV are usually in a cylindrical coaxial configuration. This helps to reduce the crystal thickness between the electrodes by a factor of 2 without compromising crystal volume (Tait 1980).

The advantages of the germanium detector are high sensitivity and good resolution. Two difficulties are associated with these detectors: much shielding is required to filter out the low-energy gammas from background to keep the count rate manageable, and the detector must be maintained (using liquid nitrogen) at a temperature of 80°K when in operation. The low temperature prevents the junction dopants from migrating under the electric force of the bias voltage and maintains an adequately low leakage current.

Figure 4.9 shows a typical logic diagram of a low to moderate count rate gamma spectroscopy system.

(A) NaI(Tl) SCINTILLATION DETECTOR

(B) PORTABLE, SOLID-STATE HPGe GAMMA RAY SPECTROMETER GAMMA GAUGE

Fig. 4.8. Typical NaI(Tl) and HPGe gamma detectors.

Fig. 4.9. Schematic diagram of typical gamma spectroscopy system.

A germanium system can be used for high count rate measurements with some loss in energy resolution and more complicated electronics. Some of the major problems are high dead time and pulse pile-up due to high count rate measurements. Figure 4.10 shows a typical logic diagram of a high count rate germanium system with a pulse pile-up rejection mechanism in place.

4.5.2 Sodium Iodide Detection System

The sodium iodide [NaI(Tl)] detector uses a scintillator crystal (see Fig. 4.8) that interacts with photons (i.e., a gamma ray) and produces light pulses that are detected, amplified, and changed to an electronic signal by a photomultiplier tube. The energy resolution of this detector is much lower than that of a germanium detector; therefore, the photon energies of a mixed source, in combination with a partial energy loss in the crystal, form a continuous spectrum. Peaks corresponding to high-strength gamma energy, such as those from cobalt-60, cesium-137/barium-137m, and cesium-134 may stand out of the spectra continuum. This detector has the same problem as the germanium detector in radiation fields with intense, low-energy photon background. An appropriate amount of shielding and a smaller detector size are necessary for successful collection of a gamma ray spectrum of concern; this configuration reduces dead time and pulse pile-up (Knoll 1989).

In general, sodium iodide detectors are more efficient for a gamma energy line (peak) than the germanium detectors, and they do not require cooling by liquid nitrogen. The energy resolution of these detectors, however, is not as good as germanium detectors. Both systems use the same electronic equipment and circuitry (see Fig. 4.9).

To collect and record the data [both HPGe and NaI(Tl)], the signals generated by the detectors are processed and analyzed using a preamplifier such as EG&G 137 for HPGe or EG&G ORTEC 113 for NaI(Tl); a spectroscopy amplifier such as EG&G ORTEC 673/575A/572; a high-voltage bias power supply such as EG&G ORTEC 459/556/556H; a preamplifier power supply such as EG&G ORTEC 114; and a multichannel analyzer (MCA) such as the Davidson portable. In some MCA models (e.g., portable Davidson), all of these modules are provided for the user as individual ports (see Fig. 4.11). This feature makes the system more compact and portable for field measurements and still provides adequate results.

Spectroscopy measurements may be performed of the hotspots found during directional measurements. To maintain the repeatability of field measurements, a measurement geometry template (spacer) will be devised and used for each type of spectroscopy system during the field measurement.

The selected spectroscopy system will be calibrated appropriately prior to field measurements, and daily response checks will be performed with a standard gamma source prior to use in the field. In addition, the instrument response to background will be recorded daily before and after field activities.

Fig. 4.10. Schematic diagram of HPGe gamma detection system with pulse pile-up rejection.

Fig. 4.11. Typical portable Davidson 2056-B multichannel analyzer.

4.6 TLD STRING

TLDs, which are sensitive to ionizing radiation (e.g., beta, gamma, and neutron) may be used to estimate the general radiological exposure fields in the building. Dosimeters are generally made of a few compartments holding TLD chips; each compartment is covered with a layer of shielding material. Different shielding materials are used so that the dosimeter will be sensitive to different types of radiation, which permits estimates of the shallow dose equivalent (skin dose) and the deep dose equivalent (whole-body dose) and predictions about the average energy of the photon field to which the dosimeter is being exposed (Gollnick 1988; Knoll 1989).

TLDs are generally made of inorganic phosphor crystals. When these crystals interact with ionizing radiation, the energy from the ionizing radiation is transferred to electrons of the phosphor atom. These electrons detach from the atoms and move around somewhat freely inside the phosphor crystals; many of them eventually become trapped at a luminescence center, usually an impurity atom added to the phosphor during manufacturing. The impurities are carefully chosen to produce relatively stable electron traps of desired energy. When the exposed TLD is heated, the thermal energy causes the electrons to escape from the traps and return to their ground state. This transformation (dropping from higher to lower energy state) generates a light photon in the visible band that can be detected and transformed into electronic signals by a photomultiplier tube. These signals are then processed by a TLD reader to estimate the level of the radiological exposure fields (Knoll 1989).

TLDs can be attached in string fashion along the length of a material that holds a fixed geometry at a predetermined spacing (e.g., 30 cm/1 ft apart, Fig. 4.12) for passive determination of the radiation fields. These strings may be hung from the ceiling, along a wall, or across equipment to determine the exposure fields. These strings can be made directional, but directional strings are more costly, more time-consuming, and harder to deploy.

To maintain repeatability of measurements, a measurement geometry template (spacer) will be devised to position the TLD string correctly and to keep TLDs from moving and spinning on the string. Measurements will be performed systematically at locations that will be selected in the field, taking into account ALARA considerations and physical access conditions.

The TLD strings will be calibrated appropriately prior to field measurements. All TLDs used for these measurements will be provided, calibrated, and analyzed by ORNL.

4.7 CONCRETE CORE SCANNING AND ANALYSIS

During this investigation, 4-in.-diameter concrete cores will be taken (with a diamond-bit core drill) from the inside walls and floor to examine the extent of contaminant penetration. Concrete core samples will be handled in accordance with appropriate 1600 series RIFS project procedures

Fig. 4.12. Typical TLD string arrangement.

("Field Operations"). The coring machine will be operated in accordance with the manufacturer's operating manual. All holes bored during coring activities will be filled with grout after the soil sampling activities described in Sect. 4.8 are completed. One or more of the measurement methods described in Sects. 4.7.1 through 4.7.3 may be used for determining the spatial distribution of contamination in the cores.

To maintain the repeatability of field measurements, the measurement geometry will be kept the same throughout these activities (see Fig. 4.13). The measurements and sampling will be performed systematically, taking into account ALARA considerations and physical access conditions.

The selected measurement system will be calibrated appropriately prior to field measurements. Daily response checks will be performed prior to use in the field employing a standard source as applicable, and the instrument response to background will be recorded daily before and after field activities.

4.7.1 Gamma Spectroscopy

To scan concrete cores, a slit will be provided in the shielding of a gamma spectroscopy system so that the detector is exposed to only a small portion of the core. The shielding minimizes the influence of the gamma field created by the portion of the concrete core outside the detector view. A positioning system will be designed and deployed in front of the shielded detection system opening to move the concrete core in equal increments from one end to the other and to position each increment, in sequence, in front of the opening. A gamma spectroscopy measurement would be performed on each incremental portion of the core length. The core may be rotated about its axis with a low-rpm motor while being measured to reduce the effects of nonuniformity of the exposure fields in radial directions. Use of this system will provide both isotopic distribution and an estimate of the average activity of the contaminants.

4.7.2 Gross Gamma

This system would be the same as that described in Sect. 4.7.1, with the exception of the detection system. Here, instead of a spectroscopy system, the directional gross gamma measurement system will be employed to perform the measurements.

4.7.3 Film Sheet

A third method is to wrap the cores with radiographic film sheets that are sensitive to radiation fields created by the concrete core contaminants. After exposure for a certain period of time in a low-background area, the exposed films are developed to obtain the desired information regarding exposure rates created by the core.

4.7.4 Core Analysis

Concrete cores will be analyzed for both radiological and chemical contaminants at the CSL, the off-site laboratory, and/or the ORNL RMAL. CSL analyses will be performed for concrete cores with contact exposure levels of ≤ 5 mR/h beta/gamma as determined by field instruments and will be limited to those required for shipping to the off-site laboratory. Concrete cores with contact

Fig. 4.13. Schematic diagram of gamma spectroscopy of slit scanning of cores.

**Table 4.2. Radiological and chemical analyses
of soil and concrete samples**

Radiological	Chemical
Gross alpha	TAL inorganics
Gross beta	TCL volatile organic compounds (VOCs)
Gamma spectroscopy	TCL semivolatile organic compounds (SVOCs)
Total radioactive strontium	TCL Pesticides/PCBs
Plutonium (isotopic)	QC package for TAL/TCL constituents
Thorium (isotopic)	
Uranium (isotopic)	

exposure levels >5 mR/h beta/gamma determined by field instruments will be sent to the ORNL RMAL for analysis. Radiological and chemical (RCRA screening) analyses that will be performed by the off-site and ORNL laboratories are listed in Table 4.2.

4.8 SOIL SAMPLES

Soil underlying the concrete floors may be accessed through the 4-in. holes created by concrete core sampling activities. A 2-in.-diameter Shelby tube or hand auger may be used to collect composite soil samples from these locations to a maximum depth of 5 ft. Sample collection and handling will be in accordance with appropriate 1600 series RI/FS project procedures. These samples will be only for screening of soil contaminants. If Shelby tube core samples are obtained, a slit scan by a gross gamma measurement system such as the one discussed in Sect. 4.7.2 will be performed on the samples to characterize the radiation exposure levels as a function of depth.

Soil samples will be analyzed for both radiological and chemical contaminants by the CSL, off-site laboratory, or the ORNL RMAL. CSL analyses will be performed for soil samples with contact exposure ≤ 5 mR/h beta/gamma as determined by field instruments and will be limited to those required for shipping to the off-site laboratory. Soil samples with contact exposure levels of >5 mR/h beta/gamma as determined by field instruments will be sent to the ORNL RMAL for analysis. Radiological and chemical (RCRA screening) analyses to be performed are listed in Table 4.2.

4.9 FIELD VIDEO OR PHOTOGRAPHY

The condition of the building's exterior and interior will be recorded systematically by still photography or videotape. Attempts will be made to have a standard scale present at all times when a photograph or videotape is being made. All the specifics concerning the situations being photographed or videotaped will be recorded for use in estimating volume of the material or the structural integrity of the building and its components for industrial hazard evaluation. These activities will be performed systematically, taking into account ALARA considerations and physical access conditions.

4.10 PHYSICAL MEASUREMENTS

The physical dimensions of the building and components will be measured and recorded, as will distances between pieces of major equipment with respect to each other and the interior walls. These activities will be performed systematically, taking into account ALARA considerations and physical access conditions.

4.11 GRAB AIR SAMPLES

A grab sample system will be used to assess the ambient air upon initial access to the building. This system will consist of a Mylar bag, aluminized from the inside and attached to a diaphragm pump. All air-filled sample bags will be analyzed at the CSL. Samples will be analyzed for air

quality parameters (double-bonded and aromatic VOCs, chlorinated hydrocarbons). The air sampling will be performed systematically, taking into account ALARA considerations and physical access conditions. (Note: During the initial entry, ES&H personnel will also take low- and high-volume air samples for the purpose of assessing radiological hazards in the air.) This information will be used to specify respiratory equipment and personnel protection requirements for subsequent entries.

5. FIELD INVESTIGATION: BUILDING 3506

Characterization of Building 3506 will begin in the east gallery and proceed to the cells. However, the sequence of measurement or sample locations may be varied in the field to take advantage of available personnel and material resources. Samples and measurements will also be taken outside the building from the pit on the west side and the valve pit on the north side.

The steps in characterization of a room or cell are:

- (1) Access the room or cell.
- (2) Conduct an initial site ES&H survey.
- (3) Conduct inspections and photography.
- (4) Conduct radiological measurements and smear sampling.
- (5) Collect miscellaneous grab samples.
- (6) Collect concrete core samples.
- (7) Collect subfloor soil samples.

These steps use the methods described in Sect. 4. The following sections describe these steps as they apply to Building 3506.

5.1 ACCESS

5.1.1 East Gallery

Access to the east gallery of Building 3506 is via the two doors on the north side of the building; no special preparations are required. Design drawings show a crawlspace under the gallery, and access to the crawlspace will be via the existing manway in the gallery floor.

5.1.2 North and South Cells

Access to the north and south cells will be via the roof, currently covered by three large 1/4-in. steel deck plates. Design drawings indicate that there are concrete shield plugs and at least one hatch in the roof under these plates. The available drawings do not, however, show the layout of the shield plugs/hatches in the roof (under the steel deck plate). The deck plates and, possibly, one or more concrete shield plugs will be removed by Energy Systems to allow access to these cells. If a hatch and ladder are available, they will be used for access. If a ladder is not in place or a shield plug must be removed, a portable ladder conforming to 29 CFR 1910.25 or 1910.26 and PP 1275.4, "Ladders," will be used.

Because of the restricted nature of the access to these cells, this is expected to be defined as a confined space entry and will be controlled per 29 CFR 1910.146 and PP 1275.8, "Confined Space Entry and Work."

5.1.3 Alternative Access to Cells

Should removal of the roof plates and plugs not be practicable because of safety and administrative constraints, alternative access to the north and south cells of Building 3506 will be necessary. Access via existing penetrations in the east wall (from the gallery) or core drilling through the roof or east wall will allow use of long-handled tools for limited radiological surveys and very limited sample collection.

5.1.4 Water in the North and South Cells

Previous surveys (Simpson 1984) and discussions with ORNL personnel indicate the presence of up to 3 ft of water in the north and south cells of Building 3506 as a result of inleakage of rainwater. This water will be pumped out by Energy Systems before characterization activities begin. If this water is sampled by Energy Systems for WM purposes, the sample results will be an additional piece of information that may be used to evaluate the radiological characteristics of the cells.

5.2 INITIAL ES&H SITE SURVEY

Before the cell is entered, the outside of the building will be surveyed to determine radiological conditions and possible industrial hazards. Survey results will be recorded in a field logbook.

The first entry into a room or cell will be by ES&H personnel to determine or verify health and safety assumptions as reflected in the HWP. The initial entry will be primarily for monitoring as defined in PP 1220, "Initial Site Survey." The general radiological and industrial hygiene information gathered during this survey may be used in the field to modify characterization activities.

5.2.1 East Gallery

The east gallery currently has very low levels of radiation and contamination, and the initial site survey was done as part of the planning process. The crawlspace under the cell will be accessed from the gallery by removing the manway cover and through core hole(s) in the floor, but personnel entry into the crawlspace is not planned.

5.2.2 North and South Cells

The initial survey of the north and south cells will first be done from outside the cells with a teletector gamma survey meter and by lowering atmosphere monitors into the cell. ES&H personnel will then enter the cell under confined space entry protocols and with appropriate respiratory protection and complete the initial survey.

5.3 INSPECTIONS AND PHOTOGRAPHY

Following the initial survey, inspections and photography will take place. The inspection will be done by the Team Leader and observations will be noted in the field logbook. If they exist, the Team Leader will note the following conditions:

- structural defects such as cracks, gaps, or sags;
- presence of pipes or conduits leading out of the building below grade;
- identification and construction of equipment;
- evidence of structural or equipment damage or deterioration;
- presence of standing water;
- evidence of past spills or leaks;
- variations in the materials of construction; and
- any other unusual conditions.

The Team Leader will measure and record the gross dimensions of the cell or room, the access points, and any large equipment.

A structural engineer will perform a site inspection at this time. Details of this inspection will be recorded in the logbook, and these observations, along with field photographs, will be used for a structural evaluation of the building. The engineer will follow guidelines found in ACI 210.2R-68, "Guide for Making a Condition Survey of Concrete in Service," and in ANSI/ASCE 11-90, "Guidelines for Structural Condition Assessment of Existing Buildings."

Photography will be done with a standard 35mm camera with flash. The cell or room will be methodically photographed, with close-ups of remaining equipment, access points, damaged or deteriorated areas, and structural details. Photographs will show a ruler or other reference object. All photography will be in accordance with PP 1110.1, "Field Photography and Control," which requires photograph descriptions to be maintained in a logbook. There are no special inspection or photography requirements for the various rooms or cells.

5.4 RADIOLOGICAL MEASUREMENTS

Two types of field radiological measurements will be done—general area and location-specific. General area field radiological measurements will consist of gross gamma (directional and omnidirectional), field gamma spectroscopy, and TLD string measurements. General area radiological measurements will be used to model radiation sources in the cell or room and to plan worker radiological exposures during D&D activities. Location-specific measurements will consist of gross alpha, gross mixed beta/gamma, and gross gamma (directional and omnidirectional) as well as smear sampling. Location-specific radiological measurements will be used to model contamination and to plan decontamination activities. These measurements will be done according to the methodologies discussed in Sect. 4.

5.4.1 General Area Measurements

In each cell or room, the Task Technical Lead will select the appropriate general area radiological measurements based on inspection observations, photographs, and ES&H surveys. As a minimum, a hexadirectional gross gamma measurement will be done in the center of the room; if dose rates allow, one field gamma spectroscopy measurement will also be done. If dose rates exceed 100 mrem/h, at least one TLD string measurement will be used to determine a vertical dose profile in the cell or room.

5.4.2 Location-Specific Measurements

In each cell or room, the Task Technical Lead will select up to 30 locations for measurement based on inspection observations, photographs, and ES&H surveys. These locations will be distributed among the walls, floor, ceiling, and equipment, but will be biased based on radiological survey results and other observations. Fewer than 30 locations may be selected if the general area dose rate in the cell or room is high enough to cause ALARA concerns. Up to 10 additional measurements may be taken from miscellaneous surfaces (e.g., building exterior, pits, equipment).

At each selected location the following tasks will be done in order.

- (1) Using a template, a 10 cm × 10 cm square will be drawn and numbered. The location numbers will be sequential with the format 06-xx-yy, where:

06 = Bldg. 3506

xx = NC, SC, or EG (north cell, south cell, or east gallery, respectively)

yy = a sequential number from 01 to 30.

- (2) Gross alpha measurement per Sect. 4.
- (3) Gross beta/gamma mixed measurement per Sect. 4.
- (4) Gross gamma measurement per Sect. 4.
- (5) Smear inside the 100-cm² box per Sect. 4.
- (6) Photograph the location.

If initial surveys show that particular items of equipment are highly radioactive, location-specific directional gamma and gamma spectroscopy measurements will be done to characterize that equipment. These equipment measurements will be at the discretion of the Task Technical Lead and within access and ALARA constraints.

5.5 CONCRETE CORE SAMPLES

Concrete core samples will be collected to determine the depth of penetration of contaminants. They will also be inspected for signs of gross structural deterioration, and they will be analyzed for hazardous and radioactive constituents. Core samples will be collected using a diamond bit core drill as described in Sect. 4.

Two core samples will be collected in each room—one from the floor and one from a wall. Locations will be selected and marked by the Team Leader and photographed before and after drilling. Concrete cores will be approximately 3.5 in. in diameter and extend the full depth of the concrete if possible. Because no as-built foundation drawings are available, the thickness of the concrete floor is unknown. The concrete floor thickness, as estimated from the length of the extracted cores, will be reported in the field logbook. Additional core samples may be collected depending on initial site survey observations, access restrictions, and ALARA considerations. Core locations will be selected based on initial survey results; criteria considered will include dose rates, hotspots, presence/absence of coatings, cracks in concrete, and access.

5.6 SUBFLOOR SOIL SAMPLES

Subfloor soil samples will be collected to indicate the release of contaminants from the structure and to plan D&D activities. Soil samples will be collected through the floor coreholes drilled per Sect. 5.5. Soil samples will be collected using either a 2-in. Shelby tube sampler or a 2-in. hand auger; Shelby tubes may be difficult to use because of the hard-packed clay in the area and the likelihood of rocks and construction debris under the foundation of the building. Soil bores may penetrate a maximum of 5 ft into the subsoil, and each location will yield one composite soil sample. One soil sample will be collected from each of the two cells. One to three soil samples will be collected from beneath the gallery, depending on access to the crawlspace and the success of Shelby tube sampling through the corehole in the floor.

5.7 PITS EXTERNAL TO BUILDING 3506

5.7.1 West Side Pit

The west side pit adjacent to Building 3506 is open to the elements and holds standing water after rainfall. ES&H personnel will conduct radiological surveys and smear sampling in this pit. If present, one water sample and one sludge sample will be taken from this pit.

5.7.2 North Side Valve Pit

The north side valve pit adjacent to Building 3506 is covered with concrete slabs and may not be accessible without disassembly of valve operators. The initial inspection will determine whether

access to this pit is practicable; if so, ES&H personnel will conduct radiological surveys and smear sampling. If present, one water sample and one sludge sample will be taken.

5.8 MISCELLANEOUS SAMPLES

Miscellaneous ("opportunity") samples will be selected by the Team Leader based on the inspection and ES&H survey. They may consist of extra core samples, liquids, sludges, structural materials, paint scrapings, concrete chips, or any other material that may be hazardous and/or radioactive. Samples will not be taken from equipment that can only be accessed via destructive entry or disassembly. Grab samples may be collected from pipes and vessels if operable valves and/or drain lines are available from which samples may be drawn. Up to 12 miscellaneous samples may be taken, distributed among the 3 inside areas and the pits outside of Building 3506.

5.9 ALTERNATIVE ACCESS MEASUREMENT STRATEGY

Access through the existing 10-in.-diameter wall penetration using poles to deploy instruments will allow general area and directional gamma measurements, photography, field gamma spectroscopy, and collection of a limited number of smear samples from the south cell. TLDs may also be deployed to determine horizontal and vertical dose profiles. Similar access to the north cell will require core drilling an 8- to 10-in. hole in the east wall from the gallery. Except for smears and the wall core itself, sample collection is not practicable in this case.

Access through an 8- to 10-in.-diameter corehole in the roof will allow general area and directional gamma measurements, photography, field gamma spectroscopy, vertical TLD string deployment, and limited smear sampling. In addition, a core sample from the floor may be collected, subject to some modifications and additional engineering to the core drill. This type of core sample collection has previously been done successfully through the use of a drill extension rod in a guide tube with centralizers.

Because of previous decontamination and the low hazard represented by these cells, aggressive efforts at sample collection are probably not warranted, and access by roof coring is not recommended.

5.10 SMEAR AND SAMPLE ANALYSES

Analyses will be performed in the field and in various laboratories for smears and samples collected during the field investigation. The laboratories include the CSL, the off-site analytical laboratory, and the ORNL RMAL. The proposed distribution of smears and samples is shown in Table 5.1. Adjustments to either the number of smears/samples and analysis locations may be made at the time of sampling.

Table 5.1. Building 3506 sample analysis

Sample type	Planned Analysis Locations			
	Field (radiological screening)	CSL (radiological screening)	Off-site laboratory (radiological and chemical analyses)	ORNL ^a (radiological and chemical analyses)
Smears ^b	-	Up to 100	-	-
Miscellaneous grab samples	-	-	Up to 12	-
Concrete cores ^c	-	6	6	-
Soil samples ^d	-	Up to 5	Up to 5	-
Grab air and air monitoring samples	-	10	-	-
TLDs	-	-	-	As needed

^aSamples unacceptable for shipment to the off-site laboratory will be submitted to the ORNL RMAL for analyses.

^bSmears unacceptable to the CSL will be screened in the field.

^cConcrete cores will first be slit-scanned (see Sect. 4.7.3) at the CSL and then shipped to the off-site or ORNL RMAL for further characterization.

^dIf the subfloor soils are extracted as a core by a Shelby tube rather than as bulk particulates by a hand auger, the soil core will be slit-scanned (see Sect. 4.7.3) prior to shipment to the off-site lab or ORNL RMAL for further characterization.

Note: One set of 4 QC samples will be required for every 20 samples.

5.10.1 Field Screening

Radiological screening will be performed in the field for those smears with gross gamma activity exceeding the allowable operating limit for smear submittal to the CSL (approximately 5 mR/h). The radiological screening, as permitted by ALARA and contamination control constraints, will include

- gross alpha,
- gross beta,
- gross gamma, and
- gamma spectroscopy.

A field measurement location will be set up to perform slit scanning of core samples (see Sect. 4.7.3). High-activity smears will also be analyzed at this location.

5.10.2 CSL Screening

The CSL will be used to (1) analyze smears (see Sect. 4.1), (2) analyze grab air and air monitoring samples ((see Sect. 4.12), and (3) screen samples prior to shipment to the off-site laboratory. The PP 1260 series provides guidance on the mechanics of transporting radioactive materials from locations at ORNL to an off-site laboratory.

The smears (maximum of 100) will be submitted to the CSL for the following radiological analyses:

- gross alpha,
- gross beta,
- gross gamma,
- gamma spectroscopy, and
- total radioactive strontium.

Those smears with gross gamma activities that exceed the CSL allowed analytical limit will be screened in the field.

5.10.3 Off-Site Laboratory Analyses

Off-site laboratory analyses are often performed when the field or CSL screening measurements cannot provide the type or sensitivity of analyses required. An off-site laboratory may also be needed if the radiation background or presence of analytes in the field interferes with field or CSL screening and a lower background or noncontaminated analytical environment is needed.

Samples to be submitted to the off-site laboratory include up to 12 miscellaneous grab samples, 6 concrete cores, and up to 5 soil samples. Analytical methods for these samples are summarized in Table 5.2.

Radiological analyses (EPA analytical support level V) proposed for the off-site laboratory are

- gross alpha,
- gross beta,
- gamma spectroscopy,
- total radioactive strontium,
- plutonium isotopics (Pu-238, Pu-239/-240),
- thorium isotopics (Th-228, Th-230, Th-232), and
- uranium isotopics (U-232, U-233, U-235, U-234/-238).

The proposed radiological analyses were selected on the basis of review of the building's history and on soil bore sample results (see ORNL 1992) obtained during the WAG 1 remedial investigation for an area near Building 3506.

Chemical analyses (EPA analytical support level IV) proposed for the off-site laboratory are

- TAL inorganics,
- TCL VOCs,
- TCL SVOCs, and
- TCL pesticides/PCBs.

Chemical analyses will follow EPA's Statements of Work for Organic and Inorganic Analyses (EPA 1991b,c). The chemical analysis detection limits (shown in Appendix B) will not be attainable for samples that require dilution prior to analysis.

5.10.4 ORNL Laboratory Analyses

Analyses similar to those performed at the off-site laboratory will be performed at the ORNL RMAL for those samples that exceed the radioactivity levels permitted for off-site shipment. In addition, ORNL will analyze TLDs, if any, in its dosimetry laboratory.

Table 5.2. Analytical methods

Parameter	Analytical Technique	Method Number ^a	Detection Limit ^b (solids, liquids)
Gross alpha	Gas flow proportional counting	USEPA 900.0	1 pCi/g, 1 pCi/L
Gross beta	Gas flow proportional counting	USEPA 900.0	2 pCi/g, 4 pCi/L
Gamma spectroscopy	Gamma spectroscopy	USEPA 600/901.1	0.2 pCi/g Cs-137, 20 pCi/L Cs-137
Total radioactive strontium	Radiochemical separation followed by gas flow proportional counting	USEPA 600/905	0.5 pCi/g, 5 pCi/L
Plutonium isotopics (Pu-238, Pu-239/-240)	Radiochemical separation followed by alpha spectroscopy	EML Pu-02	0.6 pCi/g, 1 pCi/L
Thorium isotopics (Th-228, Th-230, Th-232)	Radiochemical separation followed by alpha spectroscopy	LANL ER200	0.6 pCi/g, 1 pCi/L
Uranium isotopics (U-232, U-233/-234, U-235, U-238)	Radiochemical separation followed by alpha spectroscopy	EML U-02	0.6 pCi/g, 1 pCi/L
TAL inorganics		USEPA CLP SOW for inorganics	See App. B
• Mercury	Cold vapor atomic absorption		
• Cyanide	Automated method		
• Arsenic, lead, selenium, thallium	Graphite furnace atomic absorption		
• Other TAL metals	Inductively coupled plasma atomic emission spectroscopy		
TCL VOCs	Gas chromatograph/mass spectrometer	USEPA CLP SOW / 624-M(1)	See App. B
TCL SVOCs	Gas chromatograph/mass spectrometer	USEPA CLP SOW / 625-M(1)	See App. B
TCL pesticides/PCBs	Gas chromatograph/mass spectrometer	USEPA CLP SOW / 608-M(1)	See App. B

^a Abbreviations are: EML-Environmental Measurements Laboratory; LANL-Los Alamos National Laboratory; CLP-Contract Laboratory Program; and SOW-Statement of Work. Sources of information for methods are Bechtel (1993), EPA (1988b), EPA (1991b), EPA (1991c), DOE/EML (1992), and LANL (1986).

^b Detection limits for radiological parameters are extracted from Bechtel (1993) and are expressed as "detection limit goals." Appendix B lists the CRDLs for metals from EPA (1991c) and the CRQLs for VOCs, SVOCs, and pesticides/PCBs from EPA (1991b).

6. FIELD INVESTIGATION: BUILDING 3515

The field investigation of Building 3515 will follow a tiered approach. Because radiation and contamination levels are unknown, and expected to be high, this plan will describe three tiers of characterization based on ALARA principles. The investigation will proceed in steps, and field measurements of radiation and contamination will be used to determine subsequent activities.

Characterization of Building 3515 will begin in the north cell, which is expected to be less contaminated, and then proceed to the south cell.

The steps in site characterization of a cell are:

- (1) Access a cell.
- (2) Conduct an initial ES&H site survey.
- (3) Conduct inspections and photography.
- (4) Conduct radiological measurements and smear sampling.
- (5) Collect miscellaneous grab samples.
- (6) Collect concrete core samples.
- (7) Collect subfloor soil samples.

These steps use the methods described in Sect. 4. The following sections describe these steps as they apply to Building 3515.

6.1 ACCESS

Access to the two cells of Building 3515 is via the doors on the west side of the building, which are currently sealed with concrete block. Access will be in the following sequence.

- (1) A containment structure (tent) will be erected against the side of the building to enclose the doorway. Inside the tent, an anteroom enclosing the doorway will be built of lumber and plastic sheeting; this will provide two barriers for contamination control. A HEPA-filtered blower will take suction inside the anteroom and discharge outside the tent; this will set up an inflow of air from the surroundings to the tent, and from the tent to the anteroom, ensuring containment of any loose contamination.
- (2) Using hand tools, several concrete blocks will be removed from the doorway to allow access for a teletector and air monitoring equipment. The minimum number of blocks necessary will be removed; one to four should be sufficient.
- (3) Teletector radiation readings will be taken, and the general area gamma radiation level will become the decision point for the three-tiered investigation.

Tier 1:	< 100 mrem/h	manned entry, full characterization
Tier 2:	100-500 mrem/h	manned entry, limited characterization
Tier 3:	> 500 mrem/h	limited remote characterization

- (4) Smear samples will be taken by extending a pole through the opening and smearing accessible surfaces. Smearable contamination in excess of 500 mrad/100 cm² will also require a Tier 3 investigation.

If radiation and contamination levels allow a Tier 1 or Tier 2 investigation, the remainder of the concrete blocks will be removed from the doorway. If a Tier 3 investigation is called for, sufficient concrete blocks may be removed to allow access for instruments and tools, but in no case will an opening of greater than 1 ft in diameter be made.

Because of the restricted nature of the access to these cells, manned investigations are expected to be defined as a confined space entries and will be controlled per 29 CFR 1910.146 and PP 1275.8, "Confined Space Entry and Work."

On the basis of the few facts known about this building, the north cell is estimated to fall into the Tier 1 or Tier 2 range. The south cell, which contains a cesium crystallizer and hold-up tank, is estimated to be in the Tier 2 or Tier 3 range.

6.2 INITIAL ES&H SITE SURVEY

Before a cell is entered, the outside of the building will be surveyed to determine radiological conditions and possible industrial hazards. Survey results will be recorded in a field logbook.

The initial entry into a cell will be by EH&S personnel, who will determine or verify health and safety assumptions as reflected in the HWP. The initial entry will be primarily for monitoring, as defined in PP 1220, "Initial Site Survey." The general radiological and industrial hygiene information gathered during this survey may be used to modify characterization activities in the field.

The initial surveys of the north and south cells will first be done from the outside with a teletector gamma survey meter and by deploying air monitors into the cell as described in Sect. 6.1. For Tier 1 or Tier 2 conditions, ES&H personnel will then enter the cell, if necessary under confined space entry protocols and with appropriate respiratory protection, to complete the initial survey.

6.3 INSPECTIONS AND PHOTOGRAPHY

Following the initial survey, inspections and photography will take place. The inspection will be done by the Team Leader and observations will be noted in the field logbook. If they exist, the Team Leader will note the following conditions:

- structural defects such as cracks, gaps, or sags;
- presence of pipes or conduits leading out of the building through the concrete slab;
- identification and construction of equipment;
- evidence of structural or equipment damage or deterioration;
- presence of standing water;
- evidence of past spills or leaks;
- variations in the materials of construction; and
- any other unusual condition.

The Team Leader will measure and record the gross dimensions of the cell, the access points, and the dimensions of any large equipment.

A structural engineer will perform a site inspection at this time; details of this inspection will be recorded in the logbook, and these observations, along with field photographs, will be used for a structural evaluation of the building. The engineer will follow guidelines in ACI 210.2R-68, "Guide for Making a Condition Survey of Concrete in Service," and in ANSI/ASCE 11-90, "Guidelines for Structural Condition Assessment of Existing Buildings."

Photography will be done with a standard 35mm camera with flash. The cell will be methodically photographed, with close-ups of remaining equipment, access points, damaged or deteriorated areas, and structural details. Photographs will show a ruler or other reference object. All photography shall be in accordance with PP 1110.1, "Field Photography and Control," which requires photograph descriptions to be maintained in a logbook.

Inspection and photography will be abbreviated for Tier 2 conditions. The allowable stay time for these activities will be determined on the basis of ALARA considerations, and the number of photographs, measurements, and observations will be set accordingly.

Tier 3 conditions will require remote photography, which will involve deploying a camera with automatic focus and flash and a remote shutter release into the cell on a long-handled tool. No other inspections will be done for Tier 3 conditions.

6.4 RADIOLOGICAL MEASUREMENTS

General area measurements will consist of gross gamma (directional and omnidirectional), field gamma spectroscopy, and TLD string; these measurements will be used to model radiation sources in the cell and to plan worker radiological exposures during D&D activities. Location-specific measurements will consist of gross alpha, gross mixed beta/gamma, gross gamma (directional and omnidirectional), and smear sampling to model contamination and plan decontamination activities. Both types of measurements will be in accordance with the methodologies discussed in Sect. 4.

6.4.1 General Area Measurements

For each cell, the Task Technical Lead will select the appropriate general area radiological measurements on the basis of the inspection observations, photographs, and ES&H surveys. As a minimum, a hexadirectional gross gamma measurement will be done in the center of the cell; if dose rates allow, one field gamma spectroscopy measurement will also be done. If dose rates significantly exceed background, at least one TLD string measurement will be done to determine the vertical dose profile in the cell.

Tier 1 conditions will allow all measurements to take place. Tier 2 conditions may restrict the total number of measurements. Tier 3 conditions will require measurements to be done with instruments deployed on long-handled tools.

6.4.2 Location-Specific Measurements

For each cell, the Task Technical Lead will select up to 30 locations for measurement on the basis of the inspection observations, the photographs, and the ES&H surveys. These locations will be distributed among the walls, floor, ceiling, and equipment, but may be biased based on radiological survey results and other observations. Fewer than 30 locations may be selected if the general area dose rate in the cell is high enough to cause ALARA concerns.

At each selected location the following tasks will be done in order.

- (1) Using a template, a 10 cm × 10 cm square will be drawn and numbered; the location numbers will be sequential with the format 15-xx-yy, where:

15 = Bldg. 3515

xx = NC or SC (north cell or south cell, respectively)

yy = a sequential number from 01 to 30

- (2) Gross alpha measurement per Sect. 4.
- (3) Gross beta/gamma mixed measurement per Sect. 4.
- (4) Gross gamma measurement per Sect. 4.
- (5) Smear inside the 100-cm² box per Sect. 4.
- (6) Photograph the location.

Tier 1 conditions will allow all measurements to take place. Tier 2 conditions may restrict the total number of measurements. Tier 3 conditions will generally prohibit location-specific measurements.

6.5 CONCRETE CORE SAMPLES

Concrete core samples will be collected to determine depth of penetration of contaminants. They will also be inspected for signs of gross structural deterioration, and they will be screened for hazardous and radioactive constituents. Core samples will be collected using a diamond-bit core drill as described in Sect. 4.

If ALARA considerations allow, two core samples will be collected in each cell: one from the floor and one from a wall. In addition, one core sample will be collected from the foundation pad to the south of the building. Locations will be selected and marked by the Team Leader and photographed before and after drilling. Concrete cores will be approximately 3.5 in. in diameter and extend the full depth of the concrete if possible. No as-built foundation drawings are available, so the thickness of the concrete floor is unknown. Additional core samples may be collected, depending on initial site survey observations, access restrictions, and ALARA considerations. Core locations will be selected on the basis of initial survey results; criteria considered will include dose rates, hotspots, presence/absence of coatings, cracks in concrete, and access.

Concrete core sample collection can only be done under conditions that allow manned entry and significant stay times. Tier 1 conditions can limit the number of samples that can be collected if dose rates are at the high end of the range. Tier 2 conditions will likely prohibit concrete coring, and Tier 3 conditions will prohibit concrete coring.

6.6 SUBFLOOR SOIL SAMPLES

Subfloor soil samples will be collected through the floor coreholes drilled per Sect. 6.5 to indicate the release of contaminants from the structure and to plan D&D activities. Soil samples will be collected using either a 2-in. Shelby tube sampler or a 2-in. hand auger. Shelby tubes may be difficult to use because of the hard-packed clay in the area and the likelihood of rocks and construction debris under the foundation of the building. Soil bores will penetrate a maximum of 5 ft into the subsoil, and each location will yield one composite soil sample. One soil sample will be collected from each of the two cells. Tier 2 conditions will likely prohibit subfloor soil sampling, and Tier 3 conditions will prohibit soil sample collection.

6.7 MISCELLANEOUS SAMPLES

Up to 12 miscellaneous samples (liquids, sludges, structural materials, paint scrapings, concrete chips, or any other material that may be hazardous and/or radioactive) will be selected by the Team Leader based on the inspection and ES&H survey. Samples will not be taken from equipment that can only be accessed via destructive entry or disassembly. Miscellaneous samples may be collected from pipes and vessels if operable valves and/or drain lines are available from which samples may be drawn. Miscellaneous sample collection can only be done under conditions that allow manned entry; Tier 2 conditions will limit the number of samples that can be collected, and Tier 3 conditions will likely prohibit sample collection under this plan.

6.8 SMEAR AND SAMPLE ANALYSES

Analyses will be performed in the field and in various laboratories (CSL, ORNL RMAL, and/or off site) for smears and samples collected during the field investigation. The proposed distribution of smears and samples at each location is shown in Table 6.1. Adjustments to the number of smears/samples and analysis locations may be made at the time of sampling.

6.8.1 Field Screening

Radiological screening will be performed in the field for those smears with gross gamma activity exceeding the allowable limit for submittal to the CSL (approximately 5 mR/h). The radiological screening, as permitted by ALARA and contamination control constraints, will include

- gross alpha,
- gross beta,
- gross gamma, and
- gamma spectroscopy.

A field measurement location will be set up to perform slit scanning of core samples (see Sect. 4.7.3). High-activity smears will also be analyzed at this location.

6.8.2 CSL Screening

The CSL will be used to (1) analyze smears (see Sect. 4.1), (2) analyze grab air and air monitoring samples (see Sect. 4.12), and (3) screen samples prior to shipment to the off-site laboratory. The PP 1260 series provides guidance on the mechanics of transporting radioactive materials from ORNL to an off-site laboratory.

The smears (maximum of 70) will be submitted to the CSL for the following radiological analyses:

- gross alpha,
- gross beta,
- gross gamma,
- gamma spectroscopy, and
- total radioactive strontium.

Those smears with gross gamma activities that exceed the CSL's allowed analytical limit will be screened in the field.

6.8.3 Off-Site Laboratory Analyses

Off-site laboratory analyses of samples are often performed when the field or CSL screening measurements cannot provide the type or sensitivity of analyses required. An off-site laboratory may also be needed if the radiation background or presence of analytes in the field interferes with field or CSL screening and a lower background or noncontaminated analytical environment is needed.

Table 6.1. Building 3515 sample analysis

Sample type	Planned Analysis Locations			
	Field (radiological screening)	CSL (radiological screening)	Off-site laboratory (radiological and chemical analyses)	ORNL ^a (radiological and chemical analyses)
Smears ^b	Up to 70 ^c	-	-	-
Miscellaneous grab samples	-	-	-	Up to 12
Concrete cores ^d	-	-	1	4
Soil samples ^e	-	3	3	-
Grab air and air monitoring samples	-	10	-	-
TLDs	-	-	-	As needed

^aSamples unacceptable for shipment to the off-site laboratory will be submitted to the ORNL RMAL for analyses.

^bSmears unacceptable to the CSL will be screened in the field.

^cConcrete cores will first be slit-scanned (see Sect. 4.7.3) and then shipped to the off-site or ORNL RMAL for further characterization.

^dIf the subfloor soils are extracted as a core by a Shelby tube rather than as bulk particulates by a hand auger, the soil core will be slit-scanned (see Sect. 4.7.3) prior to shipment to the off site lab or ORNL RMAL for further characterization.

Note: One set of 4 QC samples will be required for every 20 samples.

Samples to be submitted to the off-site laboratory include up to 12 miscellaneous samples, 4 concrete cores, and 2 soil samples. Analytical methods for these samples are summarized in Table 5.2.

Radiological analyses (EPA analytical support level V) proposed for the off-site laboratory are

- gross alpha,
- gross beta,
- gamma spectroscopy,
- total radioactive strontium,
- plutonium isotopics (Pu-238, Pu-239/-240),
- thorium isotopics (Th-228, Th-230, Th-232), and
- uranium isotopics (U-232, U-233, U-235, U-234/-238).

The proposed radiological analyses were selected on the basis of review of the building's history and on soil bore sample results (see ORNL 1992) obtained during the WAG 1 remedial investigation for an area near Building 3515. Analysis for ruthenium-106 is not considered in the sample characterization; although it was a major process analyte in Building 3515, its 372-day half-life is many factors less than the 35 years that the facility has been inoperable; therefore, radioactive decay has reduced the ruthenium-106 activity to minor levels.

Chemical analyses (EPA analytical support level IV) proposed for the off-site laboratory are

- TAL inorganics,
- TCL VOCs,
- TCL SVOCs, and
- TCL pesticides/PCBs.

Chemical analyses will follow EPA's Statements of Work for Organic and Inorganic Analyses (EPA 1991b,c). The chemical analysis detection limits (shown in Appendix B) will not be attainable for samples that require dilution prior to analysis.

6.8.4 ORNL Laboratory Analyses

Analyses similar to those performed at the off-site laboratory will be performed at ORNL for those samples that exceed the radioactivity levels permitted for off-site shipment. In addition, ORNL will analyze TLDs, if any, in its dosimetry laboratory.

7. DATA ANALYSIS AND MODELING

Data and information collected during field activities will be reviewed, and the necessary calculations and modeling will be performed to infer loose and fixed contamination levels; general area radiation exposure rates; relative isotopic distribution of contaminants; and general building conditions (industrial hazards, volume of material, and numbers and sizes of remaining equipment).

7.1 GROSS CONTAMINATION/RADIATION FIELD

Loose and fixed contamination levels will be estimated through careful study of the results of field gross direct measurements and smear data. The smears provide information about loose contamination.

7.1.1 Alpha Contamination

Gross alpha activities will be estimated using results of smears and direct field measurements. These values will be reported only for loose surface contamination because alpha particle ranges are very short (2 to 3 cm in air for 4.5-MeV alpha). Results from direct field alpha measurements will be compared with those obtained from smear-counting, taking into account the ratio of the area subtended by the detector and the area used to collect the smear along with counting geometry corrections and detection system calibration and background information. Alpha particles emitted from radionuclides within the materials (fixed contamination) will not be able to penetrate because of self-shielding. The gross alpha activity for fixed contamination will be estimated using the results of core sample analyses.

7.1.2 Beta Contamination

Gross beta activities for fixed contamination will be estimated using results of direct field measurements and sample analyses. Loose surface activities will be determined from results of the smear analyses. The difference between direct field measurements and smear results will be attributed to the portion of the fixed beta activity created within the materials that escapes through the surfaces. Direct field measurements will be compared with those obtained from smear counting, taking into account the ratio of the area subtended by the detector and the area used to collect the smear along with counting geometry corrections, detection system calibration, and background information. Beta activity obtained from direct field measurement results is the difference between mixed beta/gamma field measurement and gamma field measurement as described in Sect. 4.3. Information obtained from laboratory core sample analyses will provide an estimate of fixed gross beta contamination levels within the materials (floor, walls, etc.).

7.1.3 Gamma Contamination

Gross gamma activities for loose contaminants will be estimated using results of smear counting. Relative isotopic distribution results from gamma spectroscopy of smears will be used along with the gross gamma measurements to estimate the activity of each isotope present and the contribution of each isotope to the total gamma field generated from loose contaminants. General area exposure rates will be estimated from omnidirectional field gross gamma measurements. For each location from which a smear is collected, the exposure contribution from fixed contamination will be estimated by subtracting the smear gross gamma counting results from the directional field gross gamma measurements. In doing this, a correction will be made for the ratio of the area subtended by the detector and the area used to collect the smear along with counting geometry corrections, detection system calibration, and background information.

Information obtained from the results of subtraction plus information obtained from core scanning and gamma shielding models will be used to estimate the isotopic distribution and the amount of radionuclides within the fixed contamination region. Information obtained from individual locations can be combined to produce maps describing the exposure/contamination levels and their spatial distribution in a given area.

7.2 GAMMA SPECTROSCOPY

Results obtained from gamma spectroscopy measurements will be used to estimate relative isotopic distributions of radionuclides in the areas of interest. This will be achieved by inspecting a spectrum collected in or from an area or object during the field activities and identifying the gamma lines associated with isotopes producing them. Isotope strength will be estimated by taking the ratio of its characteristic gamma line determined from a field-measured spectrum to the efficiency of that line obtained during calibration measurements. Corrections will be made for the area subtended by the detection system during the field and calibration measurements, for counting geometries, and for detection system calibration and background information.

7.3 MODELING

Gamma shielding models will be used to help estimate exposure rate and isotopic distribution/strength of radionuclides for areas where sampling and isolated direct measurements cannot be performed. These areas will be modeled as closely as possible to the actual geometry using shielding codes such as QAD-CG-GP (Cain 1977) and Microshield 4.0 (Negin and Worku 1992), both of which are based on a point kernel calculation method. Microshield will be used for simpler geometries, and more complex geometries will be handled with QAD. To estimate the strength of an isotope in a designated area or an object, the contribution to the gamma radiation fields generated at a detector location will be modeled assuming a fixed source strength and geometry. The source geometry can be varied to produce a range of values, and changes in source geometry assumptions will be based on field directional measurements and historical use of the area.

or subject. These results, combined with field spectroscopy and directional measurements, will be used to determine a ratio factor between field measurement results and values produced by the modeling to estimate isotopic strength for the area or object of interest.

7.4 GENERAL INFORMATION

General building conditions (industrial hazards) will be estimated using the field logbook notes and photographs taken during field activities. A series of calculations will be performed using physical dimensions and photographs of the areas and equipment to estimate the volume of the material. The numbers and sizes of residual equipment will be determined using logbook notes, photographs, and physical dimension measurements taken during field activities.

8. PLANNING AND SCHEDULING

The basic elements of the site characterization for Buildings 3506/3515 are planning and preparation, field investigation, and characterization reporting. Other level of effort activities will include management and oversight, project controls, meetings, and progress reporting. All personnel associated with the actual field activities must be badged, trained, and medically examined in accordance with project procedure prior to access to the site.

The planning phase began as the SCP was being prepared. Existing ORNL data (e.g., pictures and personnel interviews) were collected and reviewed, and a request for an HWP for walkdown survey was submitted. The walkdown survey was performed to inspect the conditions in and around the building, determine the best method of entry, and identify potential obstacles that could affect the field investigation. The walkdown survey was used in development of this SCP.

When the SCP is submitted, the implementation documentation activities will begin, succeeded by the remaining field investigation and reporting activities as shown on Figs. 8.1 and 8.2. The FWGs will be reviewed internally, revised, and submitted to Energy Systems for approval. Other permit requests to be submitted to Energy Systems include HWPs to allow entry into the buildings and an excavation/penetration request for corehole drilling. When the FWGs are complete, the QAA/QAAP will be developed and reviewed. A meeting will be held to review all plans before field work begins.

Building 3506 field investigation activities will begin with a radiation survey and inspection followed by collection of smears, air samples, and miscellaneous samples for analysis at the CSL. The radiation survey results will be documented in an ES&H writeup, and the CSL analyses will be documented in a Technical Bulletin. Corehole samples will also be taken, but not until the E/PP is received. This sequence of activities will be implemented for the east gallery, the north cell, and the south cell as illustrated in Fig. 8.1. The samples collected from the coreholes will be screened at the CSL and analyzed at the off-site laboratory or the ORNL RMAL, depending on the level of contamination.

Building 3515 field investigation activities will begin with construction of a containment structure at the north cell entrance. Survey, inspection, and sample collection tasks will then be completed there. The containment structure will then be reassembled at the south cell entrance, and characterization of that cell will be conducted. Subsequent activities are similar to those for Building 3506. The sequence of activities is illustrated in Fig. 8.2.

Data analysis and calculations will begin as soon as data become available from the CSL and will continue for approximately three weeks following receipt of all results from the off-site laboratory and the ORNL RMAL. The draft Site Characterization Report, to be prepared following completion of data analysis, will take approximately five weeks to prepare. The draft report will be reviewed internally, revised, and submitted to Energy Systems/DOE for review. The schedule assumes a one-month review cycle, followed by a two-week revision period before the final report is submitted to Energy Systems.

WEEKS

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
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PREPARE DRAFT SITE
CHARACTERIZATION REPORT

INTERNAL REVISION
DRAFT SC REPORT 3506

INTERNAL REVIEW -
DRAFT SC REPORT 3506

FINAL REVISION -
SITE CHAR REPORT 3506

ES/DOE REVIEW SITE
CHAR REPORT 3506

ES APPROVAL OF SITE
CHAR REPORT 3506

3506 SC

Fig. 8.1. Building 3506 schedule.

IMPLEMENTATION DOCUMENTATION

FIELD INVESTIGATION

CHARACTERIZATION REPORTS

Fig. 8.2. Building 3515 schedule.

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APPENDIX A

Hazard Analysis for the D&D Investigation of Buildings 3506 and 3515

A1. INTRODUCTION

Buildings 3506 and 3515 are located near the South Tank Farm. Building 3506 was an evaporator building where radioactive wastes were concentrated. Building 3515 housed a cesium recovery facility utilizing ion exchange and crystalizers to separate cesium and strontium and then to concentrate cesium for use.

Both buildings have been inactive for approximately 30 years. For the most part, Building 3506 is devoid of equipment, and reported contamination levels and exposure rate are low. Building 3515 is thought to contain all processing equipment necessary for the cesium recovery process, and the building has been sealed and roofed over; contamination and radiation levels are known to be high in the building.

A2. HAZARD ASSESSMENT

A2.1 EXTERNAL RADIATION EXPOSURE HAZARD

A2.1.1 Initial and Assumed Conditions—Buildings 3506/3515

Building 3506 is anticipated to have low external exposure rates because of the pre-abandonment equipment removal and decontamination. There are no available recent survey data; however, interviews with ORNL radiological controls personnel indicate the exposure rates inside the structure are in the range of a few mrad/h to a few tens of mrad/h.

Building 3515 was sealed in a highly contaminated state, and process equipment remains in the building. No survey data are available for the interior of this building. Interviews with process and Radiological Controls personnel indicate that radiation exposure rates will be very high near process equipment. General area exposure rates are postulated to be in the range of 100 mrad/h to >500 mrad/h. Near process equipment, hotspots and equipment may exhibit exposure rates in excess of 1 rad/h.

Beta skin, eye, and extremity exposure is anticipated to be high as result of strontium compounds in both loose surface contamination and contamination absorbed into the concrete floors.

A2.1.2 External Radiation Exposure Controls

In the case of Building 3506, administrative radiological controls will be utilized to maintain exposures ALARA. An ALARA goal for this building has been established at 100 mrem maximum exposed individual with a maximum collective dose equivalent goal at 0.5 man-rem.

The investigative activity will be planned in accordance with Project Procedure (PP) 1132, "Preparation of Project Field Work Guides," providing a detailed description of task elements. Work guides must be reviewed and approved by the project ES&H Department. As specified in the task description and work flow in the FWGs, the ES&H Department conducts a pre-job ALARA evaluation and specifies the controls to be reflected in the Hazardous Work Permit. Initial conditions will be evaluated in accordance with PP 1220, "Initial Site Survey"; PP 1280.1, "Methodology for Performing Radiological Contamination Surveys"; PP 1280.5, "Radiological Dose Rate

Measurement"; and PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." Administrative control limits and protective clothing and equipment requirements are established, and ES&H hold-points are developed to maintain exposures within ALARA goals. These data and determinations are used in the preparation of the HWP in accordance with PP 1235, "Hazardous Work Permits."

Building 3515 represents a greater potential for worker exposure. Because the nature of the building radiological conditions is not known, a general area exposure rate limit has been established at 500 mR/h penetrating and 2 rad/h beta. Should initial conditions in excess of those listed be found on remote penetration of the building, no manned entry will be attempted and replanning for remote or other investigative methodology will be conducted. Should conditions permit, a combination of engineered controls (e.g., beta shielding of floors, lead blanket temporary shielding of hotspots and equipment, etc.) and administrative controls will be utilized. Under manned entry conditions an ALARA goal of 500 mrem to the maximally exposed individual and a collective dose equivalent goal of 4 man-rem has been established.

As with Building 3506, the investigative activity will be planned in accordance with PP 1132, "Preparation of Project Field Work Guides," providing a detailed description of task elements. Work guides must be reviewed and approved by the project ES&H Department. As specified in the task description and work flow in the FWGs, the ES&H Department conducts a pre-job ALARA evaluation and specifies the controls to be reflected in the Hazardous Work Permit. Initial conditions will be evaluated in accordance with PP 1220, "Initial Site Survey"; PP 1280.1, "Methodology for Performing Radiological Contamination Surveys"; PP 1280.5, "Radiological Dose Rate Measurement"; and PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." Administrative control limits and protective clothing and equipment requirements are established, and ES&H hold-points are developed to maintain exposures within ALARA goals. These data and determinations are used in the preparation of the HWP in accordance with PP 1235, "Hazardous Work Permits."

A2.2 INTERNAL RADIATION EXPOSURE HAZARD

Building 3506 is anticipated to have low surface contamination levels as the result of pre-abandonment equipment removal and decontamination. There are no available recent survey data; however, interviews with ORNL radiological controls personnel indicate that contamination levels of 100 dpm/100 cm² to several hundred thousand dpm/100 cm², are possible inside the structure.

Building 3515 was sealed in a highly contaminated state. All process equipment remains in the building. No known survey data are available for this building. Interviews with process and radiological controls personnel indicate that contamination levels will be very high throughout the structure. General area smearable contamination levels are postulated to be in the range of 100 mrad/h/100 cm² to greater than 500 mrad/h/100 cm². Near process equipment leak sites, floor drains and other areas where contaminants can accumulate may exhibit smearable contamination levels in excess of 1 rad/h/100 cm².

The potential for uptake of strontium and cesium by an unprotected individual is considered to be very high as a result of high levels of surface contamination. Additionally, strontium titanate, a highly insoluble contaminant, is known to be associated with process activities in Building 3515.

A2.2.1 Internal Radiation Exposure Controls

In the case of Building 3506, administrative radiological controls and appropriate respiratory protection will be utilized to maintain exposures ALARA. An internal ALARA goal for this building has been established at 10 mrem committed maximum exposed individual.

The investigative activity will be planned in accordance with PP 1132, "Preparation of Project Field Work Guides," providing a detailed description of task elements. Work guides must be reviewed and approved by the project ES&H Department. As specified in the task description and work flow in the FWGs, the ES&H Department conducts a pre-job ALARA evaluation and specifies the controls to be reflected in the Hazardous Work Permit. Initial conditions will be evaluated in accordance with PP 1220, "Initial Site Survey"; PP 1280.1, "Methodology for Performing Radiological Contamination Surveys"; PP 1280.5, "Radiological Dose Rate Measurement"; and PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." Administrative control limits and protective clothing and equipment requirements are established, and ES&H hold-points are developed to maintain exposures within ALARA goals. These data and determinations are used in the preparation of the HWP in accordance with PP 1235, "Hazardous Work Permits."

Building 3515 represents a greater potential for worker internal exposure. Due to the unknown nature of the building radiological conditions, a general area smearable contamination limit has been established at 500 mrad/h/100 cm². Should initial conditions in excess of those listed be found on remote penetration of the building, no manned entry will be attempted and replanning for remote or other investigative methodology will be conducted. Should conditions permit, a combination of engineered controls (e.g., stripcoat fixative, additional HEPA air controls, etc.), appropriate respiratory protection and administrative controls will be utilized. Under manned entry conditions, an ALARA goal of 10 mrem committed dose equivalent to the maximally exposed individual has been established.

As with Building 3506, the investigative activity will be planned in accordance with PP 1132, "Preparation of Project Field Work Guides," providing a detailed description of task elements. Work guides must be reviewed and approved by the project ES&H Department. As specified in the task description and work flow in the FWGs, the ES&H Department conducts a pre-job ALARA evaluation and specifies the controls to be reflected in the Hazardous Work permit. Initial conditions will be evaluated in accordance with PP 1220, "Initial Site Survey"; PP 1280.1, "Methodology for Performing Radiological Contamination Surveys"; PP 1280.5, "Radiological Dose Rate Measurement"; and PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." Administrative control limits and protective clothing and equipment requirements are established, and ES&H hold-points are developed to maintain exposures within ALARA goals. These data and determinations are used in the preparation of the HWP in accordance with PP 1235, "Hazardous Work Permits."

A2.3 CHEMICAL HAZARDS

No data are available concerning chemical contamination of either building. For ES&H purposes, it is assumed that each building is contaminated with lead and cadmium compounds because these are common materials in nuclear waste processing. Barium is also assumed present.

Potentially present are caustic and nitric acid residues in that in that these are common process chemicals in fission product separations. In Building 3515, titanium dioxide may be present.

It is qualitatively unlikely that either building contains significant volatile hydrocarbons. Nonvolatile oils and/or PCBs may have leaked from any remaining transformers or electrical ballasts.

Planned radiological protective measures (PPE) at Level 3 minimum and Level 4 anticipated as necessary will provide excellent protection to workers against the assumed chemical hazard.

The investigative activity will be planned in accordance with PP 1132, "Preparation of Project Field Work Guides," providing a detailed description of task elements. Work guides must be reviewed and approved by the project ES&H Department. As specified in the task description and work flow in the FWGs, the ES&H Department conducts a pre-job ALARA evaluation and specifies the controls to be reflected in the Hazardous Work Permit. Initial conditions will be evaluated in accordance with PP 1220, "Initial Site Survey," and PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." Administrative control limits and protective clothing and equipment requirements are established, and ES&H hold-points are developed. These data and determinations are used in the preparation of the HWP in accordance with PP 1235, "Hazardous Work Permits."

A2.4 PHYSICAL AND INDUSTRIAL HAZARDS

Both buildings represent unknowns in terms of the soundness and condition of the internal structures. Both are, however, known to be built with time-durable external materials and were constructed at a time when overbuilding was common. The initial assumption is that entry operations represent a potential for external or internal collapse of the structures. Interior elements and attachments may have deteriorated such that excessive disturbance may result in failure of supports, bolts, and anchors holding pipe and equipment.

Initially the buildings will be assumed to represent trip and fall hazards, eye injury hazards, overhead striking hazards, and foot injury hazards from falling materials and sharp punctures from below. The basic PPE ensemble at Level 3 utilizes head, foot, and eye protection meeting or exceeding applicable ANSI standards.

The interior atmosphere of each building is of unknown composition and may be immediately dangerous to life or health as the result of sealing over 30 years ago. Known natural processes have resulted in oxygen-deficient and toxic gas atmospheres in similar sealed structures. Both structures are considered permit-required confined spaces. Atmosphere testing using portable instruments is required, and initial penetration of both buildings will be in self-contained breathing apparatus until atmospheres are tested and proven free from toxic gases, low oxygen, and vapors. Should conditions permit the use of negative-pressure, full-face, non-atmosphere-supplying masks, they will be used only after atmosphere testing.

There are no known electrical or stored energy hazards associated with these buildings. All services were cut off at the time of abandonment.

The investigative activity will be planned in accordance with PP 1132, "Preparation of Project Field Work Guides," providing a detailed description of task elements. Work guides must be

reviewed and approved by the project ES&H Department. As specified in the task description and work flow in the FWGs, the ES&H Department conducts a pre-job ALARA evaluation and specifies the controls to be reflected in the Hazardous Work permit. Initial conditions will be evaluated in accordance with PP 1220, "Initial Site Survey"; and PP 1270.1, "Air Surveillance of Radiological and Chemical Contaminants." Administrative control limits and protective clothing and equipment requirements are established, and ES&H hold-points are developed to maintain exposures within ALARA goals. These data and determinations are used in the preparation of the HWP in accordance with PP 1235, "Hazardous Work Permits."

APPENDIX B

Contract-Required Detection Limits

for TAL Inorganics (EPA 1991c)

and

Contract-Required Quantitation Limits

for TCL VOCs, SVOCs, and Pesticides/PCBs

(EPA 1991b)

Contract Required Detection Limits (CRDLs) for TAL Inorganics

Metals	CRDLs* for Liquids ($\mu\text{g/L}$)
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Cyanide	10
Iron	100
Lead	3
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
*The CRDLs for solids will be higher than those for liquids and will be a function of the percent moisture present in the sample.	

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

<u>Volatiles</u>	<u>CAS Number</u>	<u>Quantitation Limits*</u>			
		<u>Water</u>	<u>Low</u>	<u>Med.</u>	<u>On</u>
		<u>ug/L</u>	<u>Soil</u>	<u>Soil</u>	<u>Column</u>
			<u>ug/Kg</u>	<u>ug/Kg</u>	<u>(ng)</u>
1. Chloromethane	74-87-3	10	10	1200	(50)
2. Bromomethane	74-83-9	10	10	1200	(50)
3. Vinyl Chloride	75-01-4	10	10	1200	(50)
4. Chloroethane	75-00-3	10	10	1200	(50)
5. Methylene Chloride	75-09-2	10	10	1200	(50)
6. Acetone	67-64-1	10	10	1200	(50)
7. Carbon Disulfide	75-15-0	10	10	1200	(50)
8. 1,1-Dichloroethene	75-35-4	10	10	1200	(50)
9. 1,1-Dichloroethane	75-34-3	10	10	1200	(50)
10. 1,2-Dichloroethene (total)	540-59-0	10	10	1200	(50)
11. Chloroform	67-66-3	10	10	1200	(50)
12. 1,2-Dichloroethane	107-06-2	10	10	1200	(50)
13. 2-Butanone	78-93-3	10	10	1200	(50)
14. 1,1,1-Trichloroethane	71-55-6	10	10	1200	(50)
15. Carbon Tetrachloride	56-23-5	10	10	1200	(50)
16. Bromodichloromethane	75-27-4	10	10	1200	(50)
17. 1,2-Dichloropropane	78-87-5	10	10	1200	(50)
18. cis-1,3-Dichloropropene	10061-01-5	10	10	1200	(50)
19. Trichloroethene	79-01-6	10	10	1200	(50)
20. Dibromochloromethane	124-48-1	10	10	1200	(50)
21. 1,1,2-Trichloroethane	79-00-5	10	10	1200	(50)
22. Benzene	71-43-2	10	10	1200	(50)
23. trans-1,3-Dichloropropene	10061-02-6	10	10	1200	(50)
24. Bromoform	75-25-2	10	10	1200	(50)
25. 4-Methyl-2-pentanone	108-10-1	10	10	1200	(50)
26. 2-Hexanone	591-78-6	10	10	1200	(50)
27. Tetrachloroethene	127-18-4	10	10	1200	(50)
28. Toluene	108-88-3	10	10	1200	(50)
29. 1,1,2,2-Tetrachloroethane	79-34-5	10	10	1200	(50)
30. Chlorobenzene	108-90-7	10	10	1200	(50)
31. Ethyl Benzene	100-41-4	10	10	1200	(50)
32. Styrene	100-42-5	10	10	1200	(50)
33. Xylenes (Total)	1330-20-7	10	10	1200	(50)

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

Semivolatiles	CAS Number	Quantitation Limits*			On Column (ng)
		Water ug/L	Low Soil ug/Kg	Med. Soil ug/Kg	
34. Phenol	108-95-2	10	330	10000	(20)
35. bis(2-Chloroethyl) ether	111-44-4	10	330	10000	(20)
36. 2-Chlorophenol	95-57-8	10	330	10000	(20)
37. 1,3-Dichlorobenzene	541-73-1	10	330	10000	(20)
38. 1,4-Dichlorobenzene	106-46-7	10	330	10000	(20)
39. 1,2-Dichlorobenzene	95-50-1	10	330	10000	(20)
40. 2-Methylphenol	95-48-7	10	330	10000	(20)
41. 2,2'-oxybis (1-Chloropropane)*	108-60-1	10	330	10000	(20)
42. 4-Methylphenol	106-44-5	10	330	10000	(20)
43. N-Nitroso-di-n- propylamine	621-64-7	10	330	10000	(20)
44. Hexachloroethane	67-72-1	10	330	10000	(20)
45. Nitrobenzene	98-95-3	10	330	10000	(20)
46. Isophorone	78-59-1	10	330	10000	(20)
47. 2-Nitrophenol	88-75-5	10	330	10000	(20)
48. 2,4-Dimethylphenol	105-67-9	10	330	10000	(20)
49. bis(2-Chloroethoxy) methane	111-91-1	10	330	10000	(20)
50. 2,4-Dichlorophenol	120-83-2	10	330	10000	(20)
51. 1,2,4-Trichlorobenzene	120-82-1	10	330	10000	(20)
52. Naphthalene	91-20-3	10	330	10000	(20)
53. 4-Chloroaniline	106-47-8	10	330	10000	(20)
54. Hexachlorobutadiene	87-68-3	10	330	10000	(20)
55. 4-Chloro-3-methylphenol	59-50-7	10	330	10000	(20)
56. 2-Methylnaphthalene	91-57-6	10	330	10000	(20)
57. Hexachlorocyclopentadiene	77-47-4	10	330	10000	(20)
58. 2,4,6-Trichlorophenol	88-06-2	10	330	10000	(20)
59. 2,4,5-Trichlorophenol	95-95-4	25	800	25000	(50)
60. 2-Chloronaphthalene	91-58-7	10	330	10000	(20)
61. 2-Nitroaniline	88-74-4	25	800	25000	(50)
62. Dimethylphthalate	131-11-3	10	330	10000	(20)
63. Acenaphthylene	208-96-8	10	330	10000	(20)
64. 2,6-Dinitrotoluene	605-20-2	10	330	10000	(20)
65. 3-Nitroaniline	99-09-2	25	800	25000	(50)
66. Acenaphthene	83-32-9	10	330	10000	(20)
67. 2,4-Dinitrophenol	51-28-5	25	800	25000	(50)
68. 4-Nitrophenol	100-02-7	25	800	25000	(50)

* Previously known by the name bis(2-Chloroisopropyl) ether

Semivolatiles	CAS Number	Quantitation Limits*			On Column (ng)
		Low		Med.	
		Water ug/L	Soil ug/Kg	Soil ug/Kg	
69. Dibenzofuran	132-64-9	10	330	10000	(20)
70. 2,4-Dinitrotoluene	121-14-2	10	330	10000	(20)
71. Diethylphthalate	84-66-2	10	330	10000	(20)
72. 4-Chlorophenyl-phenyl ether	7005-72-3	10	330	10000	(20)
73. Fluorene	86-73-7	10	330	10000	(20)
74. 4-Nitroaniline	100-01-6	25	800	25000	(50)
75. 4,6-Dinitro-2-methylphenol	534-52-1	25	800	25000	(50)
76. N-nitrosodiphenylamine	86-30-6	10	330	10000	(20)
77. 4-Bromophenyl-phenylether	101-55-3	10	330	10000	(20)
78. Hexachlorobenzene	118-74-1	10	330	10000	(20)
79. Pentachlorophenol	87-86-5	25	800	25000	(50)
80. Phenanthrene	85-01-8	10	330	10000	(20)
81. Anthracene	120-12-7	10	330	10000	(20)
82. Carbazole	86-74-8	10	330	10000	(20)
83. Di-n-butylphthalate	84-74-2	10	330	10000	(20)
84. Fluoranthene	206-44-0	10	330	10000	(20)
85. Pyrene	129-00-0	10	330	10000	(20)
86. Butylbenzylphthalate	85-68-7	10	330	10000	(20)
87. 3,3'-Dichlorobenzidine	91-94-1	10	330	10000	(20)
88. Benzo(a)anthracene	56-55-3	10	330	10000	(20)
89. Chrysene	218-01-9	10	330	10000	(20)
90. bis(2-Ethylhexyl)phthalate	117-81-7	10	330	10000	(20)
91. Di-n-octylphthalate	117-84-0	10	330	10000	(20)
92. Benzo(b)fluoranthene	205-99-2	10	330	10000	(20)
93. Benzo(k)fluoranthene	207-08-9	10	330	10000	(20)
94. Benzo(a)pyrene	50-32-8	10	330	10000	(20)
95. Indeno(1,2,3-cd)pyrene	193-39-5	10	330	10000	(20)
96. Dibenz(a,h)anthracene	53-70-3	10	330	10000	(20)
97. Benzo(g,h,i)perylene	191-24-2	10	330	10000	(20)

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

Pesticides/Aroclors	CAS Number	Quantitation Limits*		
		Water ug/L	Soil ug/Kg	On Column (pg)
98. alpha-BHC	319-84-6	0.05	1.7	5
99. beta-BHC	319-85-7	0.05	1.7	5
100. delta-BHC	319-86-8	0.05	1.7	5
101. gamma-BHC (Lindane)	58-89-9	0.05	1.7	5
102. Heptachlor	76-44-8	0.05	1.7	5
103. Aldrin	309-00-2	0.05	1.7	5
104. Heptachlor epoxide	1024-57-3	0.05	1.7	5
105. Endosulfan I	959-98-8	0.05	1.7	5
106. Dieldrin	60-57-1	0.10	3.3	10
107. 4,4'-DDE	72-55-9	0.10	3.3	10
108. Endrin	72-20-8	0.10	3.3	10
109. Endosulfan II	33213-65-9	0.10	3.3	10
110. 4,4'-DDD	72-54-8	0.10	3.3	10
111. Endosulfan sulfate	1031-07-8	0.10	3.3	10
112. 4,4'-DDT	50-29-3	0.10	3.3	10
113. Methoxychlor	72-43-5	0.50	17.0	50
114. Endrin ketone	53494-70-5	0.10	3.3	10
115. Endrin aldehyde	7421-36-3	0.10	3.3	10
116. alpha-Chlordane	5103-71-9	0.05	1.7	5
117. gamma-Chlordane	5103-74-2	0.05	1.7	5
118. Toxaphene	8001-35-2	5.0	170.0	500
119. Aroclor-1016	12674-11-2	1.0	33.0	100
120. Aroclor-1221	11104-28-2	2.0	67.0	200
121. Aroclor-1232	11141-16-5	1.0	33.0	100
122. Aroclor-1242	53469-21-9	1.0	33.0	100
123. Aroclor-1248	12672-29-6	1.0	33.0	100
124. Aroclor-1254	11097-69-1	1.0	33.0	100
125. Aroclor-1260	11096-82-5	1.0	33.0	100

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

There is no differentiation between the preparation of low and medium soil samples in this method for the analysis of Pesticides/Aroclors.

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