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Site Characterization Plan for the Old Hydrofracture Facility 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
CRDL	contract-required detection limit
CRQL	contract-required quantitation limit
CSL	Close Support Laboratory
D&D	decontamination and decommissioning
DOE	Department of Energy
DQO	data quality objective
E/PP	excavation/penetration permit
EPA	Environmental Protection Agency
ER	Environmental Restoration
ES&H	environmental, safety, and health
FFA	Federal Facility Agreement
FWG	field work guide
G-M	Geiger-Mueller
HPGe	high-purity germanium
HWP	hazardous work permit
LLLW	liquid low-level waste
MCA	multichannel analyzer
NEPA	National Environmental Policy Act
NHF	New Hydrofracture Facility
NIST	National Institute of Standards and Technology
OHF	Old Hydrofracture Facility
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
P&A	plugging and abandonment
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
RA	Remedial Action
RH	remote-handled
RI/FS	remedial investigation/feasibility study
RMAL	Radioactive Material Analytical Laboratory
RPD	relative percent difference
SCP	site characterization plan

SLLW	solid low-level waste
S&M	surveillance and maintenance
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
USRADS	ultrasonic ranging and data system
VLA	very low activity
VOC	volatile organic compound
WAC	waste acceptance criteria
WAG	waste area grouping
WM	Waste Management
WMRAD	Waste Management and Remedial Action Division

EXECUTIVE SUMMARY

The aboveground structures of the Old Hydrofracture Facility (OHF) at Oak Ridge National Laboratory (ORNL) are scheduled for decontamination and decommissioning (D&D). This Site Characterization Plan presents the strategy and techniques to be used to characterize the OHF D&D structures in support of D&D planning, design, and implementation.

OHF is located approximately 1 mile southwest of the main ORNL complex. From 1964 to 1979, OHF was used in the development and full-scale application of hydrofracture operations in which 969,000 gal of liquid low-level waste (LLLW) was mixed with grout and then injected under high pressure into a low-permeability shale formation approximately 1/6 mile underground.

The OHF structures to be characterized include

- Building 7852—This building has a control room, an engine pad, and three shielded cells that house the injection wellhead, the grout mixing hopper and tank, piping, and other associated equipment.

- Bulk solids bins—Four bins (raised hoppers) on the north and east sides of Building 7852 were used to store blended solids (e.g., cement, fly ash, clays) before they were mixed with LLLW. Appurtenances to the bins include a blower, bag house, other ventilating equipment, compressed air lines, vent lines, and air slides.

- Pump house—This structure contains a dual-compartment valve pit and a room with two large pumps that were used to draw radiological waste from the OHF underground waste storage tanks to Building 7852. (Note: The underground tanks are the responsibility of the ongoing ORNL remedial investigation/feasibility study for Waste Area Grouping 5.)

- Water tank T-5—The aboveground tank was used to ensure adequate water supply to pumps for priming, to drains and pipelines for flushing, and to system components for process makeup.

- Pump P-3—This pump supplied water to and discharged water from water tank T-5.

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 structures. This information will be used in subsequent planning to develop a detailed approach for dismantling and disposing of the structures: (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. The current D&D characterization scope includes the entire structure, including the foundation and equipment or materials within the structure. To estimate potential worker exposure from the soil during D&D, the characterization scope also includes the soils underneath and surrounding the building to a distance of 5 ft from the structure.

The pump house and Building 7852 are expected to be highly contaminated and have associated high exposure levels, and a remotely operated vehicle will be used to reduce personnel exposure during characterization activities. Methods that may be used to determine the nature and extent of loose and fixed surface contamination and to measure the radiation fields present in the OHF D&D structures include

- 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.

Data and information collected during field activities will be documented, reviewed, and evaluated, 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).

The elements of the OHF site characterization are planning and preparation, field investigation, and characterization reporting. Other level-of-effort activities will include management and oversight, cost controls, meetings, and progress reporting.

1. INTRODUCTION

The aboveground buildings and structures of the Old Hydrofracture Facility (OHF) at Oak Ridge National Laboratory (ORNL) are scheduled for decontamination and decommissioning (D&D). The generic D&D process traditionally involves the following basic tasks (DOE 1983):

- site characterization,
- disposal site selection,
- remedial action implementation [includes defining and evaluating options, conducting the National Environmental Policy Act (NEPA) process, preparing an engineering plan, and conducting the remedial action], and
- site certification.

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 those OHF buildings and structures scheduled for D&D.

1.1 SITE DESCRIPTION

OHF, also known as HF-3, is located approximately 1 mile southwest of the main ORNL complex (see Fig. 1.1). OHF was one of four sites in Melton Valley used in the development and full-scale application of hydrofracture operations. The surface structures were constructed in 1963 to allow experimentation with an integrated solids storage, handling, mixing, and grout injection facility; various improvements and upgrades were made to OHF circa 1968 and 1973.

The hydrofracture process (see Fig. 1.2) was a unique waste disposal method that involved injecting waste materials mixed with grout and additives under pumping pressures of 2000 psi or greater into a deep, low-permeability shale formation. The injected slurry spread along fractures and bedding planes for hundreds of feet from the injection points, forming thin grout sheets (often less than 1/8 in. thick). The grout, used to immobilize and solidify the liquid wastes, consisted of a mixture of portland cement, fly ash, clays, and a small amount of a set-retarding material.

The facility was used for 7 experimental injection campaigns from 1964 to 1965 and for 18 operational campaigns [grout plus liquid low-level waste (LLLW)] from 1966 to 1979. The approximately 969,000 gal of LLLW injected during this operational period contained approximately 604,000 Ci of cesium-137, 38,600 Ci of strontium-90, 233 Ci of curium-244, and 5.8 Ci of transuranics (TRU) other than curium (Myrick and Stow 1987; see Sect. 2.3.1 for a list of other radionuclides present in the waste). The experimental injections were made at an average depth of 945 ft; the operational injections were made at an average depth of 792 ft (Haase and Stow 1988).

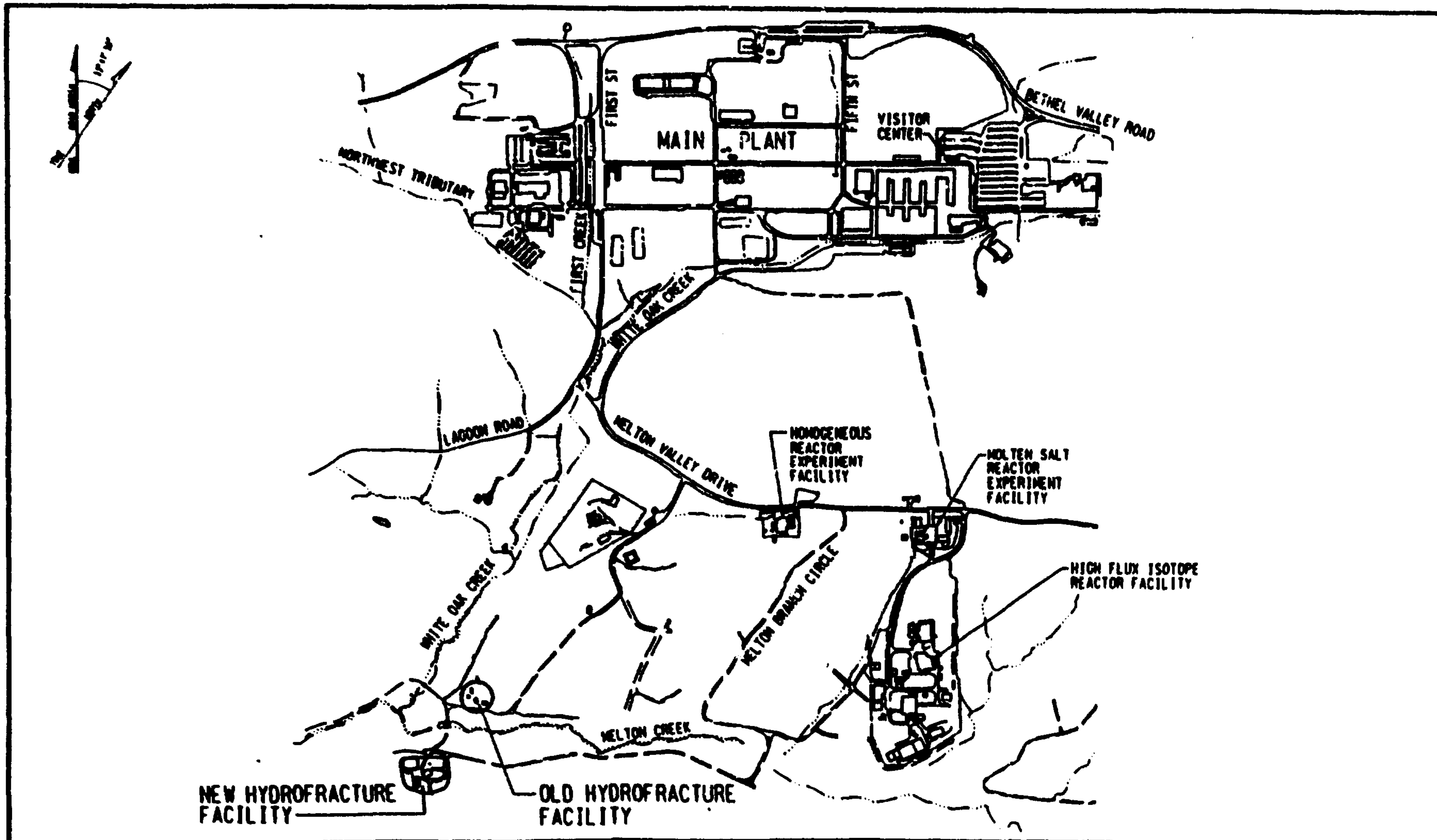

Figure 1.1. Map showing OHF relative to main plant.

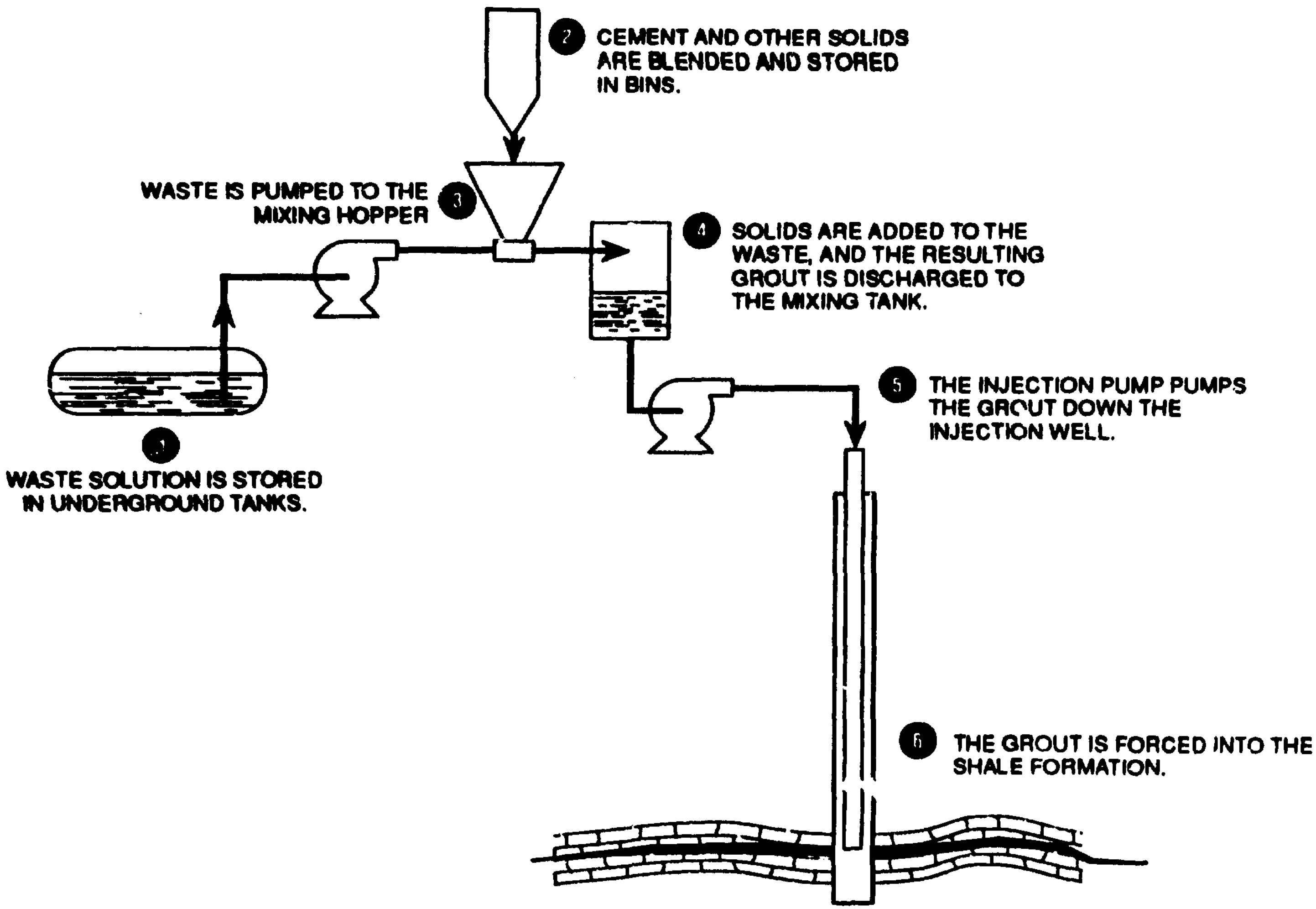

Figure 1.2. **Hydrofracture process.** *Source: ORNL-DWG 81-18667.*

1.2 DECOMMISSIONING ALTERNATIVES

Decommissioning alternatives generally include

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

In 1984, an ORNL ad hoc committee performed a decommissioning alternatives assessment (Reed 1984) for OHF; specific options were reviewed for the aboveground structures, the buried waste tanks, the waste pits, the impoundment, the underground piping, and the wells. Whereas in 1984 all of OHF was under one ORNL program for final decommissioning, the OHF components are now divided among several ORNL programs (see Sect. 1.3). For those OHF structures currently assigned to the ORNL D&D Program, the 1984 ad hoc committee recommended dismantlement and disposal as the preferred alternative. For those OHF components currently assigned to ORNL programs other than D&D, the committee recommended either continued S&M, reconditioning and reuse, entombment, or other limited remedial action, depending on the characteristics of the component and the potential remedial responses available.

The current strategy remains that of dismantlement and disposal for those OHF structures assigned to the ORNL D&D Program. In general, the principal steps for dismantling and disposing of a D&D structure are to

- perform upgrades, if needed, to alleviate health and safety concerns;
- remove uncontaminated equipment and ship that equipment to a salvage or landfill;
- predecontaminate equipment/structures, if needed, to levels allowing for safe dismantlement;
- either decontaminate the facility or remove and gut portions of the facility;
- dismantle the structure; and
- properly dispose of the waste material from dismantlement, depending on contamination levels.

In late FY 1994, the Department of Energy (DOE) plans to reevaluate the current D&D strategy of dismantlement by performing a second alternatives assessment for the OHF D&D structures that will be based on information available at that time. If the preferred alternative changes from dismantlement and disposal to some other limited D&D action, the data obtained during site characterization will be used for planning the implementation of the selected alternative.

1.3 PROGRAMMATIC SETTING

Responsibility for OHF and its immediate environs is currently shared by three ORNL programs: D&D, Waste Management (WM), and Remedial Action (RA) (Bechtel 1992a). Interface is required among the programs for proper coordination and scheduling of all field actions. Each program oversees specific activities (e.g., maintenance, characterization, remediation) for selected OHF structures as well as for portions of the environmental media (e.g., soils, surface water) in the vicinity of the structures. Table 1.1 lists the OHF buildings and other principal structures, briefly discusses each one, and identifies the program responsible for final remediation. Figures 1.3 and 1.4, respectively, are a site map and an aerial photograph of OHF.

The ORNL D&D Program is responsible for Building 7852, the four bulk solids bins, water tank T-5, pump P-3, and the pump house (excluding the valve pit). This responsibility includes the entire structure, plus the foundation and equipment and materials within the structure.

The ORNL WM Program is responsible for Building 7853, a former change room currently used as a storage facility (Huang et al. 1984). This building has been identified as "surplus" by the ORNL WM Program and will probably be transferred to the ORNL RA Program before 1997.

The ORNL RA Program is responsible for remediation of all those OHF areas not currently under the auspices of either D&D or WM; this includes both surface and subsurface facilities and media. The ORNL RA Program is currently conducting a remedial investigation/feasibility study (RI/FS) that includes investigation and assessment of environmental releases and selection of corrective measures. Guidance for the RA Program activities is in accordance with the Federal Facility Agreement (FFA) for the Oak Ridge Reservation (December 1991). The principal regulatory driver under the FFA is the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended. Resource Conservation and Recovery Act (RCRA) requirements, such as cleanup standards, have become applicable or relevant and appropriate requirements under CERCLA.

To facilitate the RI/FS, the ORNL site has been divided into waste area groupings (WAGs), each of which is the subject of separate planning and implementation. OHF is directly associated with WAG 5 (ORNL 1988; 1992a) and WAG 10 (ORNL 1992b):

- WAG 5—OHF is located in the southwest corner of WAG 5 [approximately 90% of WAG 5 is solid waste storage areas (SWSAs) used for shallow land burial]. Within the OHF boundary, WAG 5 is principally responsible for the valve pit in the pump house, the impoundment (or retention pond), the T-4 waste pit, the five underground waste storage tanks, and various shallow monitoring wells. WAG 5 is also responsible for contaminated environmental media on the surface and the shallow subsurface, for all piping external to the D&D structures, and for associated spill sites. The piping includes waste feed, recirculation, drain, and water lines. Figure 1.5 is an area piping general plan redrawn from 1966 ORNL schematics (e.g., ORNL Drawings P-10002-EE-012-D-3 and C-10002-EA-005-D).

- WAG 10—This WAG is defined as the deep underground component of the four hydrofracture sites (i.e., wells, injected grout sheets, and contaminated media). Within OHF, WAG 10 is responsible for the injection well, including the wellhead in the injection or well cell of Building 7852, and a group of other deep observation and monitoring wells used in the hydrofracture process. The planned remedial response for the WAG 10 wells is plugging and abandonment (P&A). The injection well P&A could occur either before or after the injection cell structure

Table 1.1. OHF areas of concern

Area	Description	Oversight
Building 7852	This building has a control room, engine pad, and 3 shielded cells housing the injection wellhead (WAG 10), grout mixer, piping, and other equipment.	D&D
Bulk solids bins and appurtenances	The four bins (raised hoppers) surrounding Building 7852 were used to store blended solids prior to mixing with waste. Appurtenances include equipment located near, or attached to, the bins.	D&D
Pump house	The pump house contains a two-compartment valve pit (WAG 5) and a room with two large pumps (D&D) that were used to draw radiological waste from the OHF waste storage tanks to Building 7852.	D&D and RA WAG 5
Water tank T-5	The water tank ensured adequate water supply to pumps for priming and to pipes for flushing or process makeup.	D&D
Pump P-3	Pump P-3 pumped water to and from water tank T-5.	D&D
Building 7853	Building 7853 is a "Butler" or portable-type building that was used primarily by OHF workers as a change room; it is used currently for furniture and spare parts storage.	WM
Septic tank	The inactive septic tank is a 750-gal-capacity concrete structure used to collect raw domestic sewage from Building 7853; the sewage was periodically pumped into a tanker truck for disposal. The tank is not listed in the FFA.	RA WAG 5
Impoundment	This 100,000-gal-capacity impoundment (or retention pond) was used as an emergency storage basin for grout during hydrofracture. The sides are lined with riprap. Inflow was at the south end via an 18-in. line from the injection well cell.	RA WAG 5
T-4 waste pit	The pit is comprised of three separate concrete-walled cells, each measuring 12 ft by 12 ft by 9 ft. The cells allowed recycling of contaminated water during slotting and washup. The southernmost cell is filled with radioactive grout from an experimental injection; the others contain water-covered sludge.	RA WAG 5
Waste storage tanks	The inactive carbon steel tanks consist of tanks T-1, T-2, T-3, T-4, and T-9. Tank capacities range from 13,000 to 25,000 gal; residual volumes range from 1300 to 10,000 gal (ORNL 1988). The buried tanks were used during OHF operations to store LLLW until it was ready to be blended with grout.	RA WAG 5
Underground pipelines and conduits[a]	Many underground pipelines and conduits connect the buildings, tanks, bins, and pits throughout the OHF site. A flow-measuring station is buried in a 5-ft-deep pit at the southeast corner of the pump house.	RA WAG 5
Wells[a]	Monitoring and observation wells were installed to ascertain nature and extent of contaminant migration.	RA WAGs 5 and 10
Injection wellhead[a]	The top of the injection well is in the well cell of Building 7852.	RA WAG 10

[a]Not shown in Fig. 1.3.

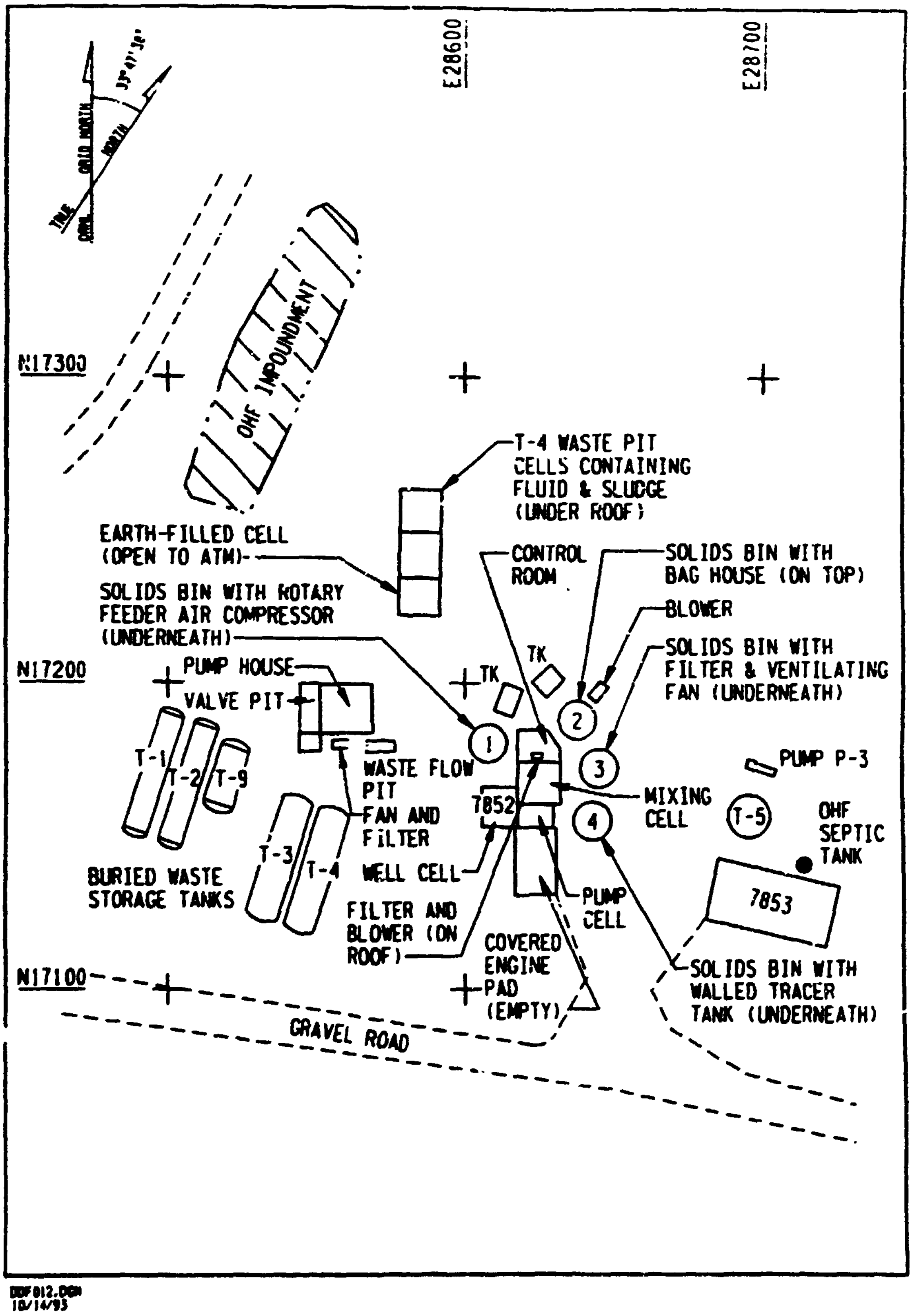

Figure 1.3. OHF site plan.

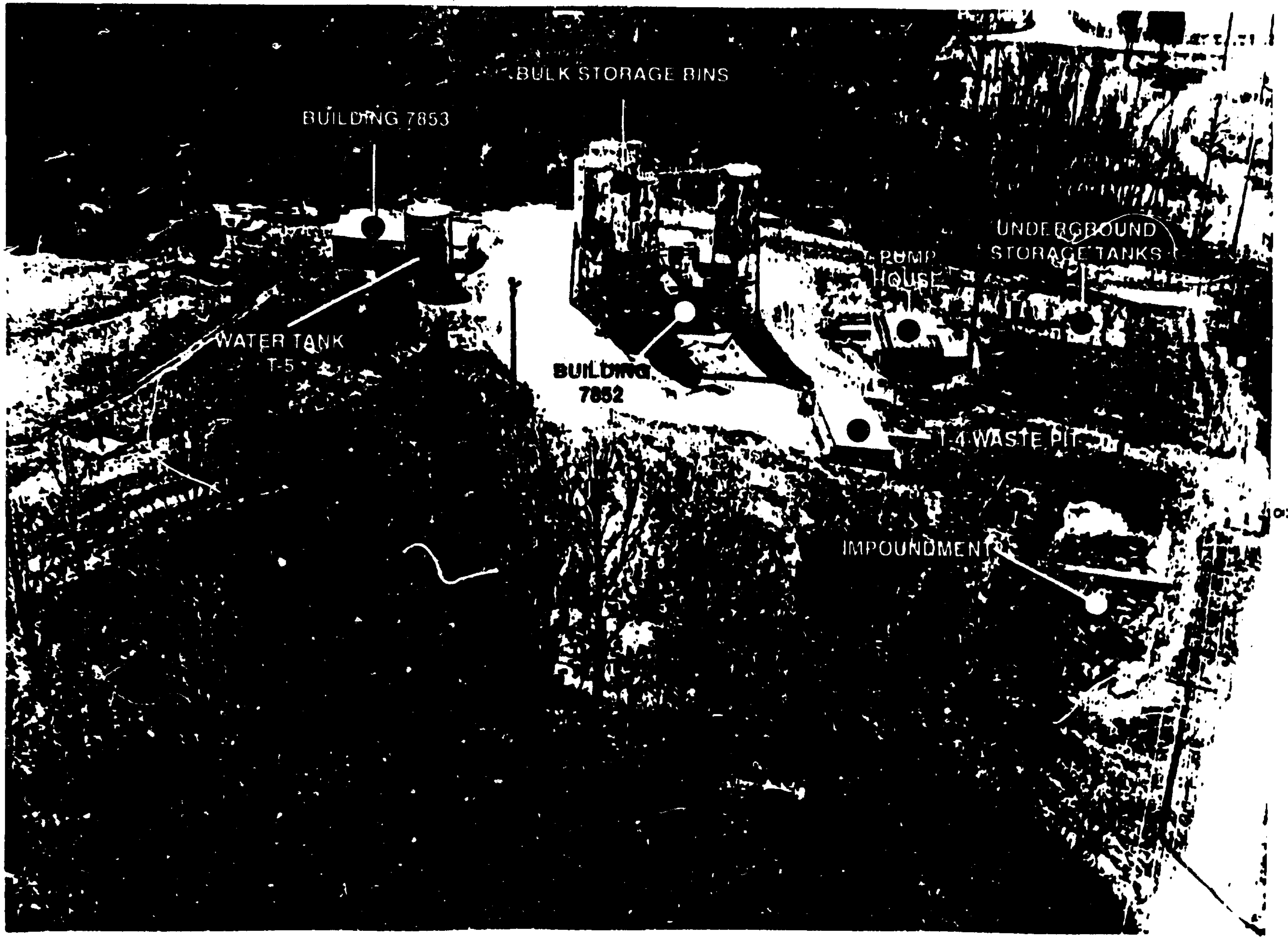

Fig. 1.4. Aerial photograph of OHF. *Source: ORNL Photo 2525-89.*

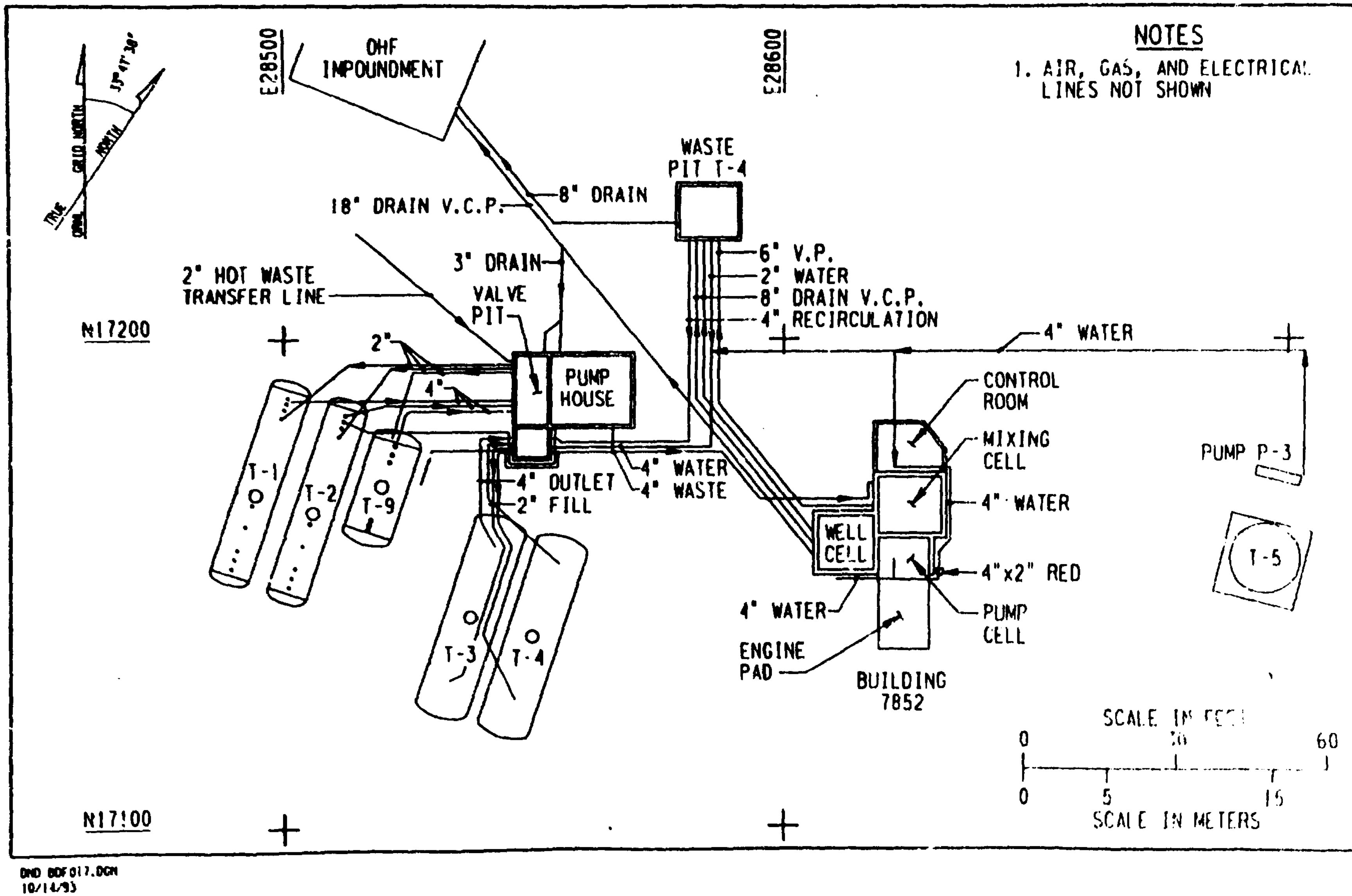

Figure 1.5. Yard piping near OHF D&D structures.

is fully or partially dismantled. Integration of the D&D/P&A methodology will depend on the degree of access needed to the wellhead, exposure potential, and whether the contamination is isolated at the wellhead or has spread to other areas (e.g., walls or floors) of the injection cell.

The OHF D&D structures are within or adjoin the administrative boundaries of RA's WAG 5 and WAG 10. Because of this proximity, WAG remediation, which is subject to CERCLA regulations, is integrated with OHF D&D. Site characterization of the OHF D&D structures will be performed to support D&D planning and design (see Sect. 1.4); however, the characterization data will also be reviewed and assimilated by WAGs 5 and 10 as needed.

1.4 OBJECTIVES AND SCOPE

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 OHF buildings and structures scheduled for D&D.

The field investigation (see Sect. 5) will consist principally of inspections; radiological surveys; concrete, soil, and miscellaneous sampling for chemical and radiological constituents; field photography; and physical measurements. The investigation will be limited to accessible (external) surfaces and will be performed within appropriate environmental, safety, and health (ES&H) constraints. Data and information collected during field activities will be reviewed, general conditions and characteristics of the investigated structures will be evaluated, and the necessary calculations and modeling will be performed to infer loose and fixed contamination levels; contaminant penetration in concrete and soils; general area and location-specific radiation exposure rates; and relative isotopic distribution of contaminants (see Sect. 3 for additional detail on data needs, uses, and collection methods).

A Site Characterization Report will be developed to document data and sample collection and analysis. This information will be used in subsequent planning to develop a detailed approach for dismantling and disposing of the facilities: 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 types and volumes of wastes generated during D&D activities and support decisions on waste disposal (e.g., waste forms and disposal locations). The extent to which these ultimate purposes can be achieved will depend on the quantity and quality of data obtained, which will be a function of the scope limitations.

The site characterization effort described in this plan focuses principally on the structures for which the ORNL D&D Program is responsible: Building 7852, the four bulk solids bins, water tank T-5, pump P-3, and the pump house (excluding the valve pit). For the purposes of characterization only, this plan also addresses three items that are assigned to ORNL RA for remediation:

- the dual-compartment valve pit on the west side of the pump house,
- the injection wellhead in Building 7852, and
- the soil underneath and surrounding the D&D structures (i.e., Building 7852 and the pump house) to a distance of 5 ft from the structures.

Field investigation of ancillary, external piping within 5 ft of the D&D structures will be limited to visual identification and cross-referencing to existing drawings; no excavation will be performed to locate or characterize underground piping or drains.

It is beyond the current scope of work for the D&D site characterization effort to sample the contents or obtain interior smears 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 open, and no waste samples will be collected from inside sealed equipment. However, if liquids or sludges are found external to the equipment or in open containers, or if operable valves and drain lines are available, grab samples may be collected and analyzed. Although sealed equipment will not be opened during the investigation, characterization of the equipment internal surfaces and contents of the equipment may still occur in the form of external, direct radiological measurements and their evaluation.

It is also beyond the scope of work to characterize the site with regard to asbestos. The Energy Systems Industrial Hygiene group will conduct a separate investigation 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.

1.5 REPORT ORGANIZATION

The remainder of this SCP is organized as follows.

- Section 2 summarizes currently available site information specific to the D&D structures and briefly discusses the site conceptual model based on that information.
- Section 3 specifies the data needs of the decision-makers, discusses how the data will be used, and presents a summary of data quality objectives (DQOs) for the project, for the field radiological measurements, for sample collection, and for laboratory analyses. This section also lists plans, policies, and procedures to which project personnel will adhere.
- Section 4 describes the types of instruments and measurement techniques that may be used in the field to assess the nature and extent of contamination.
- Section 5 delineates the technical approach for accessing the building, investigating site conditions, conducting radiological measurements, and collecting samples. This section also discusses 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 6 discusses how the results of the field investigation and laboratory analyses are used to estimate contamination and radioactive sources.
- Section 7 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 B 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 OHF FACILITIES SCHEDULED FOR D&D

As mentioned in Sect. 1.3, the D&D site characterization effort focuses principally on eight structures at OHF: Building 7852 (including the injection wellhead), the four bulk solids bins, the pump house (consisting of both the pump room and the adjacent valve pit), water tank T-5, and pump P-3. Also included are associated equipment located either outside or inside the structures and the soils within 5 ft of Building 7852 and the pump house. The eight structures and their associated equipment are discussed in turn below. Figure 2.1 is a generalized schematic of the OHF process.

2.1.1 Building 7852

Building 7852 comprises five areas: mixing cell, pump cell, well cell, control room, and engine pad. Figure 2.2 shows the Building 7852 layout, and Table 2.1 lists some of the dimensions of the areas or rooms. The general area around Building 7852 is gravel-covered and generally flat. The three "hot cells" (mixing cell, pump cell, and well cell) were used in mixing, pumping, and injecting the grout mixture into the subsurface formations. (For the purposes of this report, the term "hot cells" refers to the radiologically contaminated mixing cell, pump cell, and well cell, and should not be confused with the heavily shielded caves equipped with remote manipulators that are also often called hot cells.) Each of the three cells has 12-in.-thick concrete walls whose inside surfaces are not lined but are painted. According to Reed (1984), the cell roofs are of triple-layered steel (two 1/4-in. plates on either side of steel grating). The mixing cell roof is fixed in place, but the roofs of the pump and well cells are removable. Seven windows were installed in the hot cells (see Table 2.2).

The mixing cell (see Fig. 2.3) contains an accumulating or mixing hopper, a mixing tank, ancillary valves and piping, equipment support legs, and a mirror. The vertical, conical-shaped hopper received bulk solids for grout formulation from the storage bins surrounding Building 7852. The hopper diameter is approximately 5 ft at its top and 7 in. at its bottom; the hopper height is approximately 5.5 ft. Attached to the hopper bottom is a mixer assembly that combined the solids exiting the hopper with LLLW arriving from the pump house, and then fed the resulting slurry to a mixing tank.

The original mixing tank, or "tub," installed in 1963, was rectangular in shape (ORNL Drawing M-10002-EE-009-D-2). Inside the tub was a densimeter pump that circulated grout to two densimeters located elsewhere in the mixing cell. A hydraulic oil pump outside the mixing cell circulated oil to the densimeter pump in the tub. The tub (and attached piping) was replaced circa 1973 by a vertical, cylindrical mixing tank with an agitator (ORNL Drawing P-20974-EE-004-D). The mixing tank is almost 6.5 ft in height and 3 ft in diameter. The tops of the enclosed hopper, enclosed mixing tank, and the agitator motor extend through the mixing cell roof and are therefore exposed to the environment. Grout feed lines run from the bottom of the mixing tank into the adjoining pump cell.

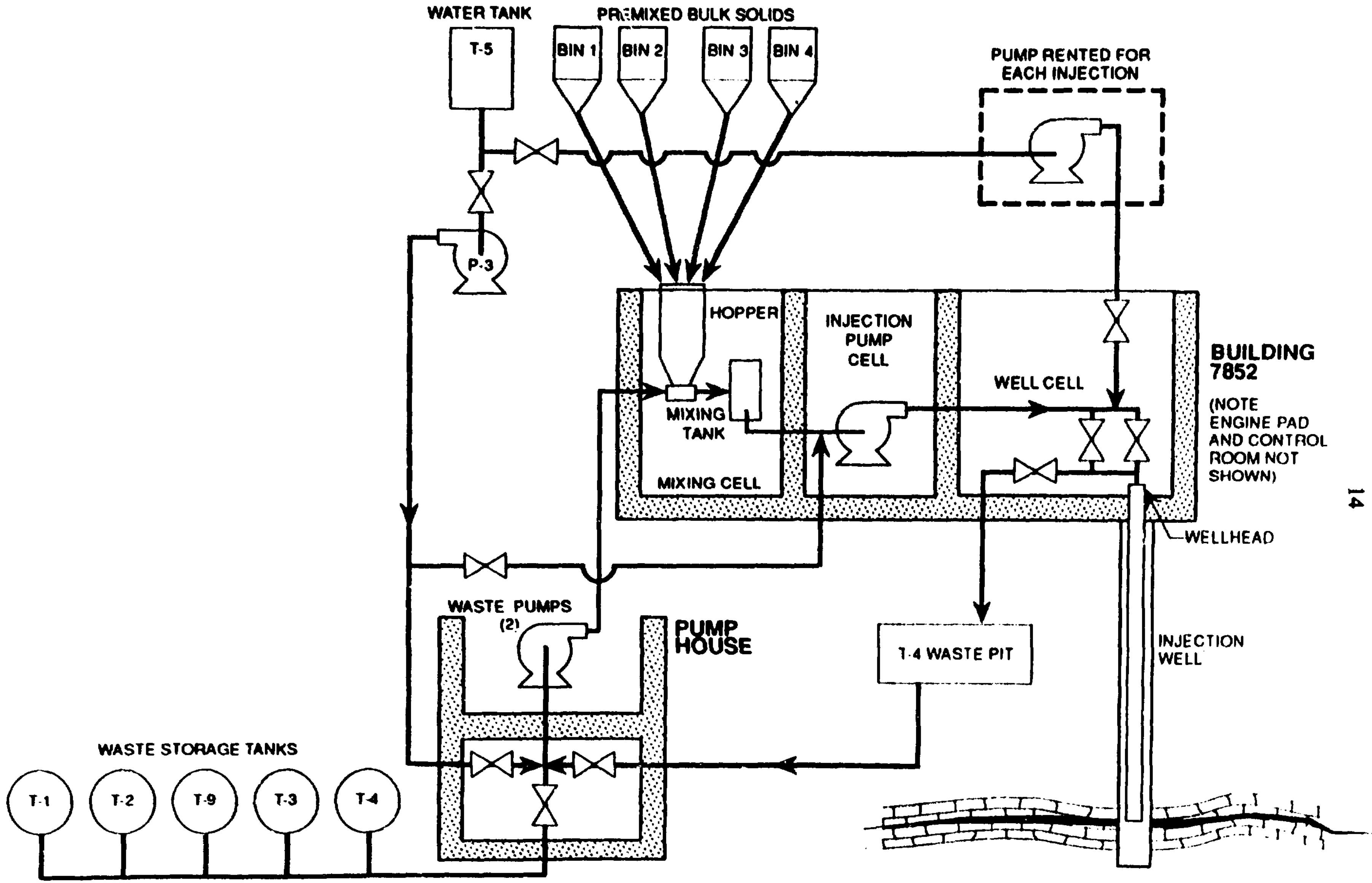

Figure 2.1. OHF schematic flow diagram.

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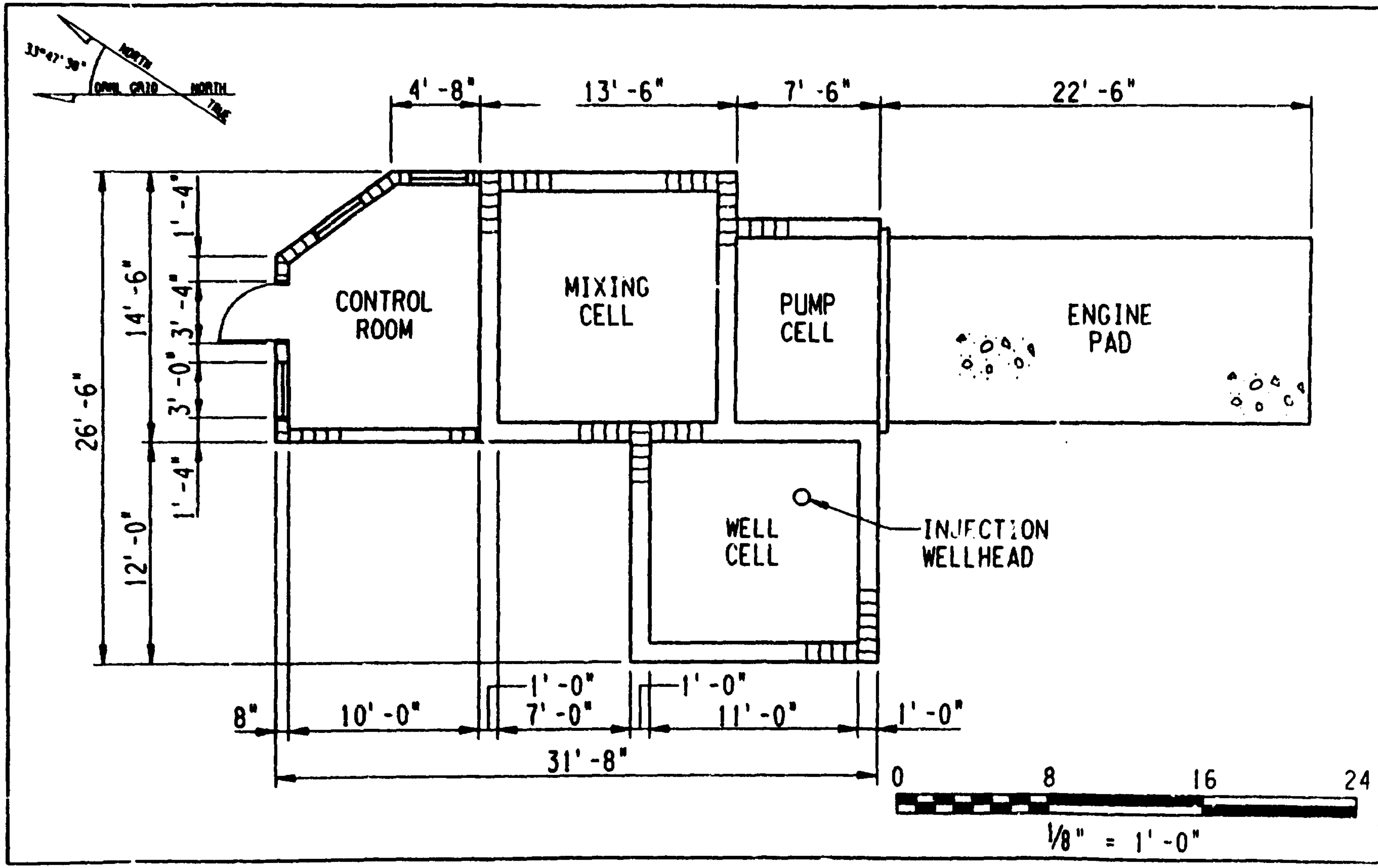

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Figure 2.2. Floor plan, Building 7852.

Table 2.1. Dimensions of Building 7852 rooms

Room	Length	Width	Height	Wall thickness
Mixing cell (interior)	12 ft 6 in.	11 ft 6 in.	7 ft 10 in.	12 in.
Pump cell (interior)	10 ft	7 ft 6 in.	7 ft 10 in.	12 in.
Well cell (interior)	11 ft	11 ft	9 ft 10 in.	12 in.
Control room (interior)	13 ft 2 in.	10 ft	10 ft 8 in.	8 in.
Engine pad	22 ft 6 in.	9 ft 10 in.	6 in.	NA

Source: ORNL drawings A-10002-EB-011-D, S-10002-B-003-D, and S-10002-B-004-D.

Table 2.2. Hot cell windows

Cell	Location	Material	Approximate dimensions (in.)	Comments
Mixing cell	North wall[a]	Plexiglas™	20 × 18 × 3/8	
	West wall	Plexiglas™	26 × 18 × 3/8	Covered with metal hatch
	East wall	Plexiglas™	26 × 18 × 3/8	Covered with metal hatch
Pump cell	Two windows on east wall	Bullet-resistant plate glass	23 × 15 × 1 17 × 15 × 1	
Well cell	North wall	Bullet-resistant plate glass	23 × 15 × 1	Covered with metal hatch
	South wall	Bullet-resistant plate glass	23 × 15 × 1	

Source: ORNL Drawings S-10002-B-006-D, -007-D, and -008-D.

[a]This window is situated between the control room and the mixing cell.

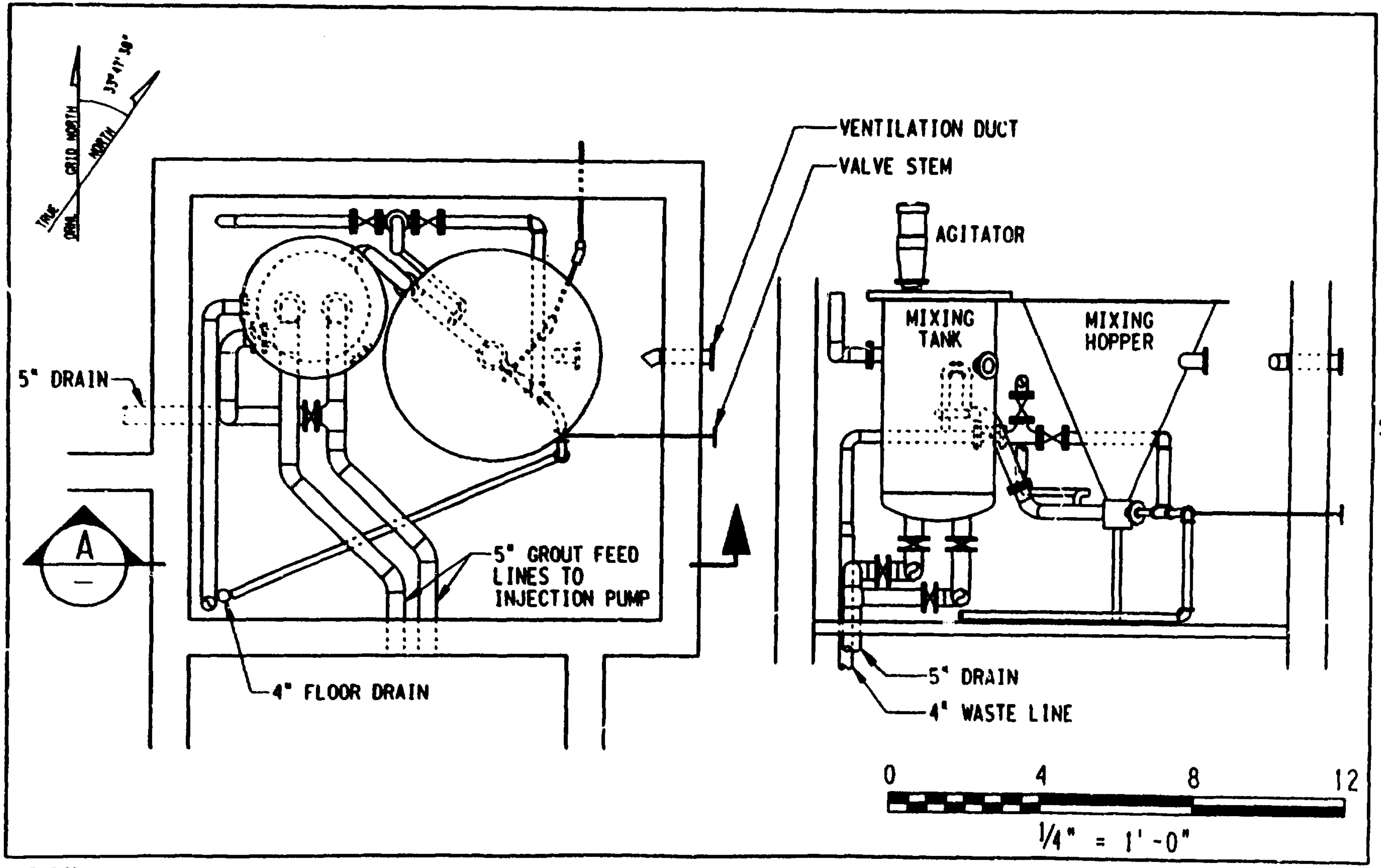

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Fig. 2.3. Mixing cell plan and section, Building 7852.

One of the improvements made to OHF circa 1973 was the installation of a 1-ton-capacity hoist and steel hoist frame above the mixing hopper. The frame measures roughly 9 ft by 5 ft by 9 ft high. Another improvement was the addition of 1/2-in.-thick lead and steel sheets on the roof of the mixing cell for shielding purposes.

The pump cell contains only minor equipment (e.g., hoses, ladders); the high-pressure injection pump and driver were moved from the pump cell to the New Hydrofracture Facility (NHF), south of OHF (see Fig. 1.1). ORNL Drawing S-20974-EB-007-D indicates that a 1/2-ton-capacity trolley hoist and support beam were installed in the pump cell circa 1973 to facilitate maintenance on the pump head; however, the existence of the hoist has not been visually verified. The only access to the pump cell is through the roof. Access was previously available through the wall on the pump cell's south side (the wall between the pump cell and the engine pad), but it was covered with sheet metal and sealed by Energy Systems when it was noticed that rainwater was infiltrating the pump cell.

The well cell contains piping, piping support, valves, and the top of the injection well. Most of the piping and valves are along the north and west walls. The wellhead is in the southeast quadrant of the cell, approximately 3 ft from the south and east walls. ORNL personnel indicate that no sampling ports exist in the piping. Reportedly, a sampling port had been installed on the wellhead but was eventually removed.

When first constructed in 1963, the north exterior face of the mixing cell was attached to a shed and an operators' platform (ORNL Drawing S-10002-EE-039-D). The elevated platform allowed the operators to view the mixing cell through windows in the cell wall and to access an instrument panel attached to the wall. The shed was apparently replaced by new construction (circa 1968) of a control room or operators' area enclosure (ORNL Drawing A-10002-EB-011-D). The control room walls are concrete block, the affixed roof is metal decking, and there are eight windows and a door. The control room reportedly contains several instruments, some radioactive samples (eight 2-gal cans), and a few stored items (Huang et al. 1984).

The engine pad, a concrete slab measuring approximately 10 ft by 22.5 ft, extends southward from the pump cell. The pad, covered by a corrugated metal roof, was built to accommodate a diesel engine on a skid to drive the injection pump. According to ORNL drawings, the engine pad was adjoined by a smaller (4 ft by 7 ft) concrete pad that supported a 275-gal-capacity diesel fuel tank; however, neither the tank nor the pad was found in a recent site walkover. Absorbent materials currently lie on the pad near the pump cell, supposedly to prevent rainwater from entering the pump cell.

On the roof of Building 7852 are a hoist (above the mixing cell), an air filter and blower (above the control room), and three disconnected solids conveyors that run from the solids bins. Sticking out of the ground near the southwest corner of Building 7852 are the tops of two vertical buried pipes in which well tools were stored. The pipe depths were not indicated in those ORNL drawings obtained by the Bechtel Team.

2.1.2 Bulk Solids Bins

Four bulk solids storage bins to the north and east of Building 7852 (Fig. 2.4) are reportedly empty (Reed 1984), are considered to be relatively uncontaminated, and are expected to represent no serious radiological impacts; however, the structures of these bins are deteriorating and may cause safety hazards. The bulk solids bins were used to store cement, fly ash, and other solids prior to their mixing with waste to form the pumpable grout. These vertical cylindrical bins have conical bottoms and are elevated to permit gravity flow through air slides to Building 7852. Each bin measures 12 ft in diameter and 20 ft in height. Only one air slide is now connected to the mixing hopper in Building 7852. The bins are interconnected by piping and by a catwalk.

Appurtenances to the bins (see Fig. 1.3) include a blower (by bin 2), a bag house (on top of bin 2), ventilating equipment (underneath bin 3), an air compressor (underneath bin 1), compressed air lines, vent lines, and air slides. According to ORNL personnel, the air compressor is relatively new and is used to pressurize the buried waste storage tanks. The ventilating equipment underneath bin 3 is part of the exhaust and filter system that connects to each cell in Building 7852. Reed (1984) reported that a small vessel once used to contain a very short-lived radioactive tracer fluid was located under bin four, surrounded by concrete shielding blocks; this tracer tank was not identified in recent site walkovers and may no longer be present. These appurtenances are considered to be the responsibility of D&D rather than RA, but any action regarding them will be coordinated with RA. With the exception of the tracer tank (if present) and perhaps the ends of the air slides near the mixing hopper, these appurtances are believed to be uncontaminated.

A weigh tank and two 820-ft^3 solids-blend tanks, previously situated just north of bins 1 and 2, were removed to NHF; however, the concrete foundations or pads that supported the tanks still exist.

2.1.3 Pump House

The concrete block pump house (see Fig. 2.5) is northwest of Building 7852. This 360-ft^2 building is partially underground; only the corrugated steel sheet roof and the door (southeast corner) are fully exposed (see Fig. 2.6). The east end of the pump house is a room containing two 30-hp progressive-cavity-type (Moyno) pumps and their drivers. These pumps were used to draw radioactive waste from the OHF waste storage tanks and feed it to the mixing assembly in Building 7852 through 4-in.-diameter underground piping. The pumps in the pump house are operable and are occasionally used to pump wastewater from the waste pit to the LLLW system. The pumps are supported off the floor with L-shaped concrete pads.

According to ORNL drawings, one of the OHF improvements made circa 1973 was the installation of lead sheets around the pump heads and piping to provide radiation shielding. Lead sheet (1/2 in. thick) was hung on both sides of the pump head from an overhead support. Lead shielding (1 in. thick) was also attached to a unistrut framework set in place over the suction piping.

The west end of the pump house is a dual-compartment valve pit. Reed (1984) describes the valve pit as follows:

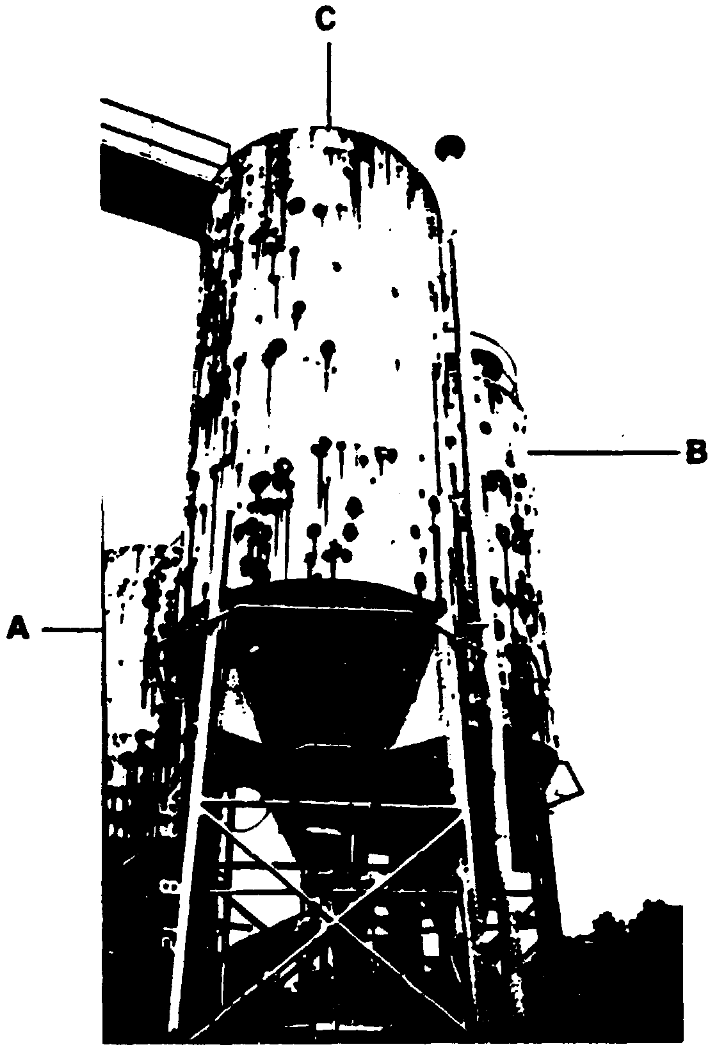

Fig. 2.4. Bulk solids bins: (A) bin 1, (B) bin 2, (C) bin 3. Note: Bin 4 not shown in photograph.

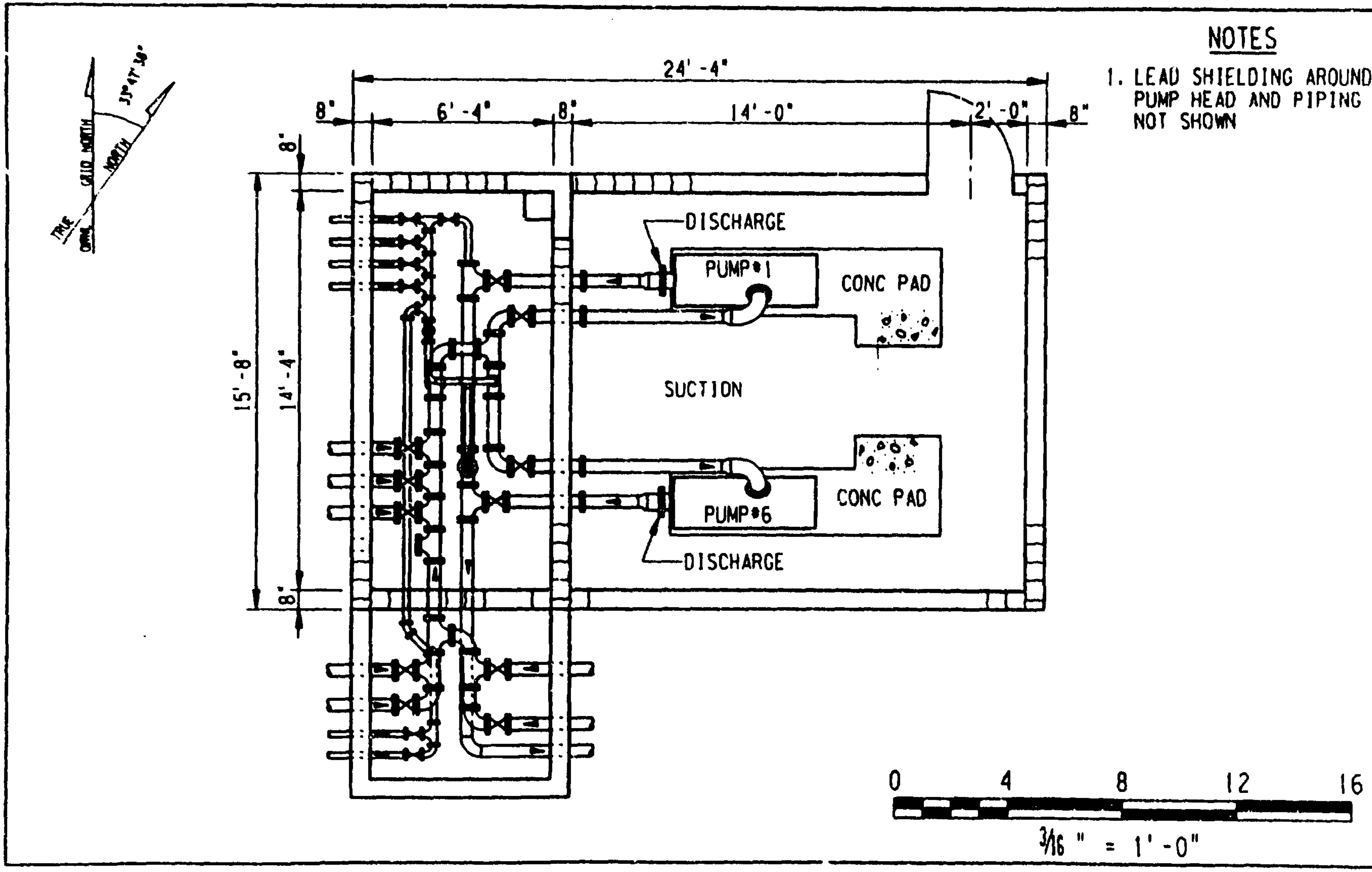

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Figure 2.5. Floor plan, pump house.

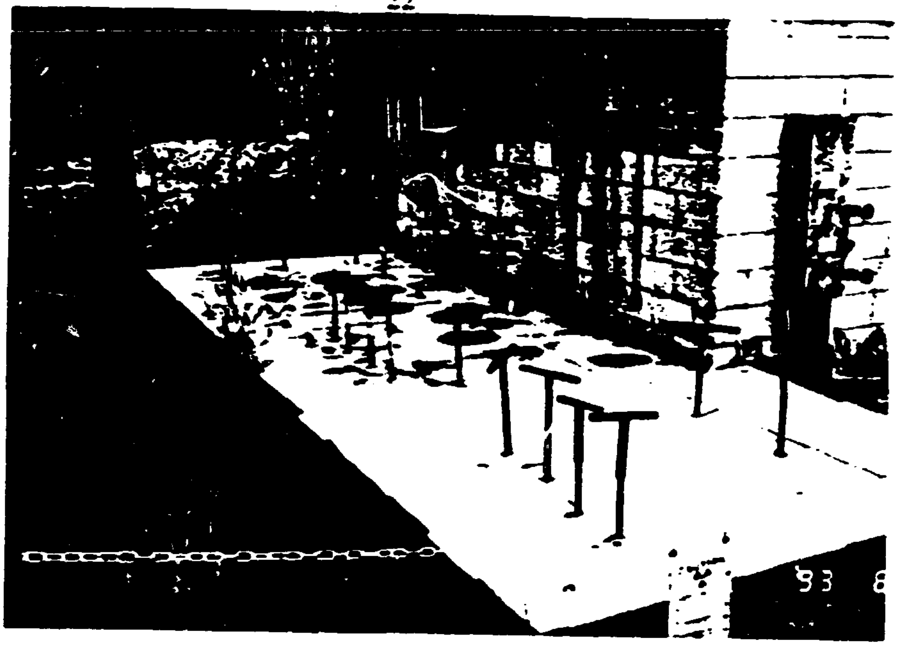


Fig. 2.6(a). Pump house, southwest corner, overlooking covered (shielded) valve pit.

Fig. 2.6(b). Pump house, northeast corner.

The west end of the pump house has its floor at the same elevation as the rest of the building, but it has four short walls (no door) that barely extend out of the ground. This end of the building is called a valve pit and it has been extended to the south. The entire valve pit is 6 ft 4 in. by 21 ft in plan area, and it is covered with metal plates through which valve handles extend upwards to the outdoors.

Immediately south of the pump house are a fan and filter exhaust system used to exhaust the waste storage tanks and the pump house (see ORNL Drawing H-20974-EG-001-D). Approximately 3 ft from the southeast corner of the pump house is a concrete box, called a waste flow metering pit, which is almost all below grade and is covered with steel bar grating and an aluminum sheet. Traversing the length of the box is a 4-in.-diameter waste transfer line that originates from the nearby valve pit. Neither the exhaust system nor the metering pit is included in the D&D characterization effort; these are under ORNL RA's jurisdiction.

2.1.4 Water Tank T-5

The 25,000-gal cylindrical water tank T-5 (see Fig. 2.7) sits on a concrete pad approximately 15 to 20 ft north of Building 7853. A fire extinguisher and housing are located on the west side of the pad, next to the tank. The tank supplied water to Building 7853, to the injection pump and pump house pumps for priming, to drains for flushing, and to other parts of the grout injection system as process makeup water. The tank supplied water via gravity feed or pump P-3. Uncontaminated water is currently stored in tank T-5 for possible use in fire protection (Reed 1984).

2.1.5 Pump P-3

Pump P-3, just north of Building 7853 (see Fig. 2.8), supplied water to and discharged water from tank T-5. The piping and associated valves connecting the Moyno pump and tank are above ground. The pump structure is considered to be relatively uncontaminated, and no serious radiological impacts are expected. The L-shaped pump foundation is a poured concrete slab measuring approximately 10 ft in length by 3.5 ft in width (maximum) by 1.5 ft in height. The pump is reportedly not operable (Reed 1984).

2.2 PAST AND PRESENT SITE CHARACTERIZATION ACTIVITIES

2.2.1 1984 Preliminary Site Characterization

A preliminary radiological characterization of OHF was completed in 1984 by Huang et al. Procedures used during the characterization included

- surface and subsurface soil sampling using hand coring and deep soil coring techniques;
- walkover surveys using 20-ft grids for outdoor areas;
- liquid and sediment samples from the waste retention pond and the T-4 waste pit;

Fig. 2.7. Water tank T-5.

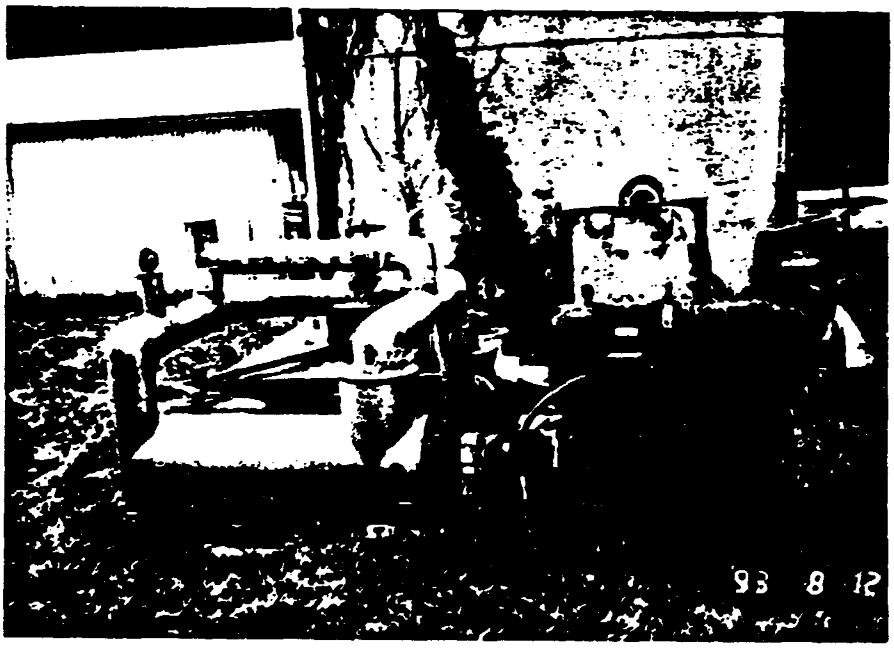


Fig. 2.8. Pump P-3 with water tank in background.

- beta/gamma radiation surveys of interior surfaces using a Geiger-Mueller (G-M) meter, a Victoreen 440 (a low-range air ionization chamber), or a Cutie Pie (an ionization chamber); and
- smear samples over ~100-cm² areas of interior surfaces.

The results of these procedures are discussed below as they apply to OHF D&D characterization.

Soil samples

Seventeen soil cores, drilled to depths of 8 to 24 ft, were taken near potential radiation hazards at OHF. Huang et al. (1984) report that soil analyses showed that most of the surface and subsurface soil samples from the OHF vicinity were uncontaminated. Of the 17 soil cores, 3 were drilled near (within 20 ft) a D&D structure (see Fig. 2.9); specifically, core site 10 was near the pump house and cores 12 and 13 were taken near Building 7852. The reported gamma activity ranged from 25 to 470 counts per second per kilogram (cps/kg) of moist soil for samples from core site 10, 34 to 240 cps/kg from core site 12 samples, and 37 to 260 cps/kg from core site 13 samples. Huang et al. (1984) report that natural background is approximately 20 to 40 cps/kg on the detector used for the measurements [a 15 cm by 15 cm NaI(Tl) detector with energy span from 100 to 1500 keV].

Walkover surveys

Slightly elevated absorbed dose rates were detected during the 1984 walkover survey with standard ORNL portable survey instruments. Huang et al. (1984) report that at 1 to 3 cm above the surface, direct beta/gamma readings ranged from 0.48 to 2.3 mrad/h around Building 7852 and 0.48 to 1.1 mrad/h around the pump house.

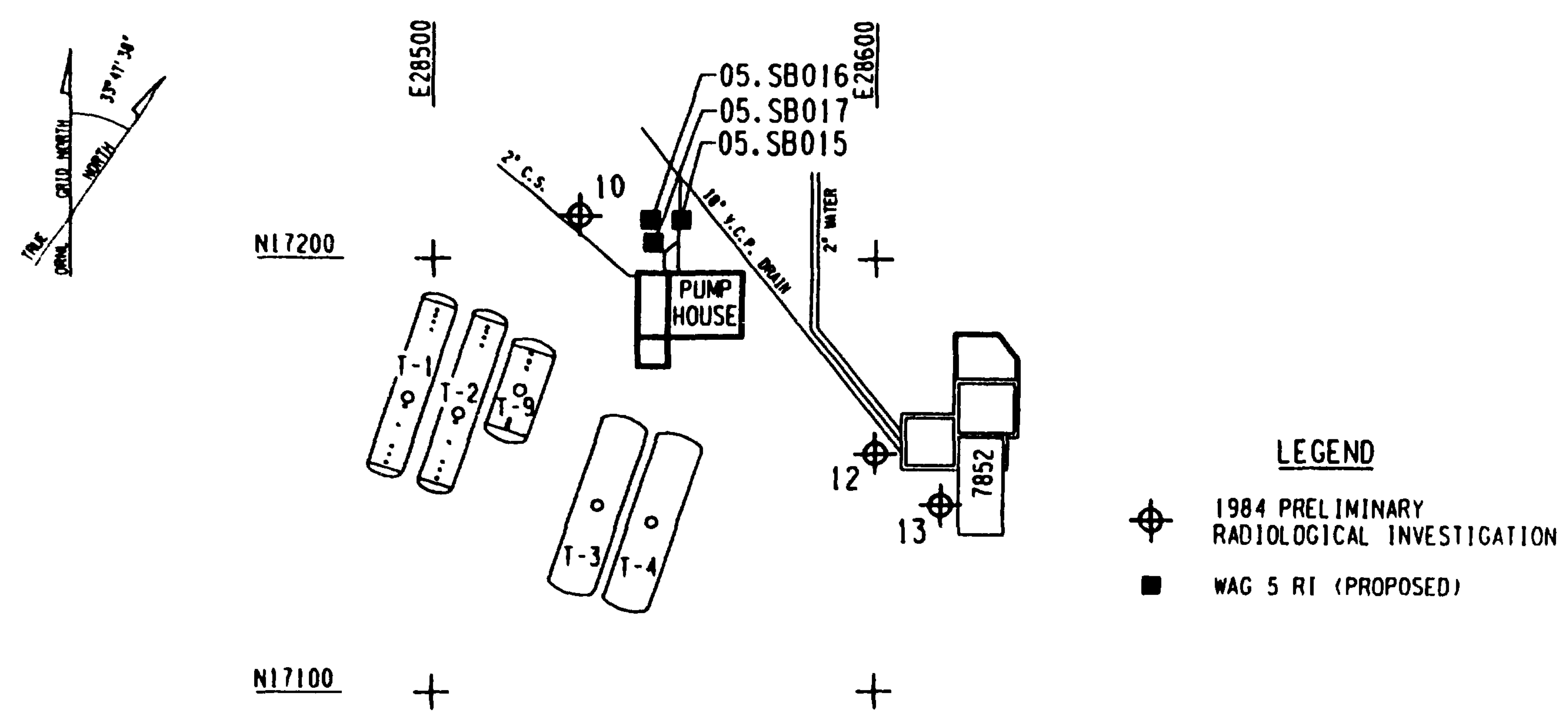
Pond and waste pit samples

Analytical results of impoundment and waste pit samples have no direct application to OHF D&D characterization and are not summarized here.

Beta/gamma radiation survey and smear sampling of interior surfaces

Figure 2.10 summarizes the interior radiological characterization results from Huang et al. (1984) for OHF: specifically, the beta/gamma survey and the smear analysis for Building 7852 and the pump house. Interior measurements were not made for the bins and other D&D structures. Wet paper towel techniques were used for the smear sampling because of the high levels of transferable contamination and the rough surfaces. Fixed and removable radioactivity were detected on the interior surfaces of the pump house and Building 7852.

An absorbed dose rate of 600 mrad/h was detected on items stored in the control room. In the control room itself, the absorbed dose rates were 75 to 600 mrad/h, and the smearable activity per 100-cm² area was 21,000 to 49,000 dpm beta/gamma and <20 to 40 dpm alpha.



CHARACTERIZATION ACTIVITY	DATE	SOIL SAMPLE LOCATION			SOIL SAMPLE TYPE
		ID	NORTH	EAST	
PRELIMINARY RADIOLOGICAL	1984	CORE SITE 10	[illegible]	28533	VERTICAL COMPOSITE TO 16'
		CORE SITE 12	17155	28600	VERTICAL COMPOSITE TO 14'
		CORE SITE 13	17143	28615	VERTICAL COMPOSITE TO 22'
WAG 5 RI	(ON GOING)	05.SB015	17209	28556	SURFACE SOIL, AREAL COMPOSITE
		05.SB016	17209	28549	SURFACE SOIL, AREAL COMPOSITE
		05.SB017	17203	28550	SURFACE SOIL, AREAL COMPOSITE

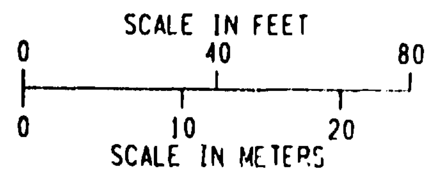


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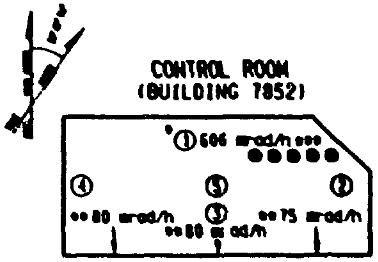
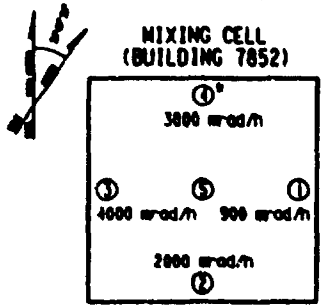
Figure 2.9. Soil sampling locations near OHF D&D structures.



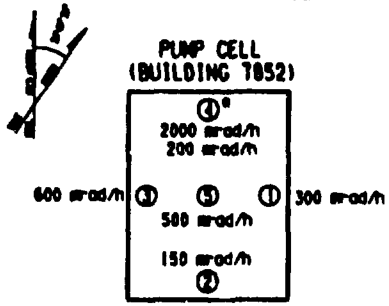
* SMEAR SAMPLE LOCATION
** READING AGAINST THE WALL
*** READING FROM FIVE STORED ITEMS

SMEARABLE ACTIVITY PER 100 cm²		
LOCATION	BETA-GAMMA	ALPHA
1	49,000 dpm	<20 dpm
2	32,000 dpm	<20 dpm
3	63,000 dpm	30 dpm
4	28,000 dpm	20 dpm
5	21,000 dpm	40 dpm



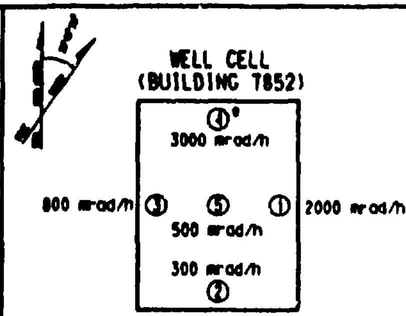
* SMEAR SAMPLE LOCATION

SMEARABLE ACTIVITY PER 100 cm²		
LOCATION	BETA-GAMMA	ALPHA
1	15 mrad/h	100 dpm
2	15 mrad/h	<20 dpm
3	15 mrad/h	<20 dpm
4	5 mrad/h	<20 dpm
5	30 mrad/h	<20 dpm



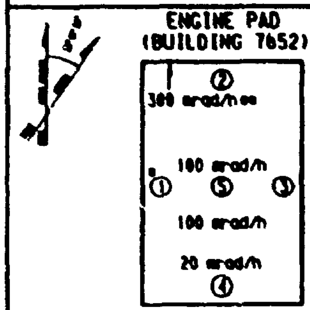
* SMEAR SAMPLE LOCATION

SMEARABLE ACTIVITY PER 100 cm²		
LOCATION	BETA-GAMMA	ALPHA
1	2 mrad/h	<20 dpm
2	4 mrad/h	<20 dpm
3	3 mrad/h	<20 dpm
4	3 mrad/h	<20 dpm
5	5 mrad/h	<20 dpm



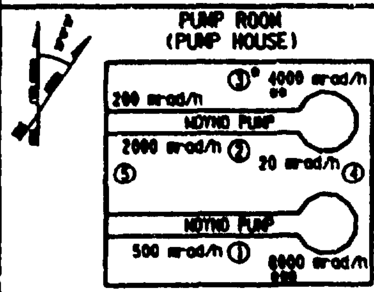
* SMEAR SAMPLE LOCATION

SMEARABLE ACTIVITY PER 100 cm²		
LOCATION	BETA-GAMMA	ALPHA
1	35 mrad/h	<20 dpm
2	35 mrad/h	<20 dpm
3	15 mrad/h	<20 dpm
4	20 mrad/h	<20 dpm
5	10 mrad/h	<20 dpm



* SMEAR SAMPLE LOCATION
** READING AGAINST THE WALL

SMEARABLE ACTIVITY PER 100 cm²		
LOCATION	BETA-GAMMA	ALPHA
1	0.75 mrad/h	<20 dpm
2	0.5 mrad/h	<20 dpm
3	1.0 mrad/h	27 dpm
4	1.0 mrad/h	<20 dpm
5	1.0 mrad/h	<20 dpm



* SMEAR SAMPLE LOCATION
** READING AGAINST THE PUMP
*** READING FROM UNDERNEATH A LEAD SHIELD

SMEARABLE ACTIVITY PER 100 cm²		
LOCATION	BETA-GAMMA	ALPHA
1	0.5 mrad/h	<20 dpm
2	15 mrad/h	<20 dpm
3	10 mrad/h	<20 dpm
4	10 mrad/h	<20 dpm
5	8 mrad/h	<20 dpm

SUMMARY TABLE OF THE INTERIOR SURVEY RESULTS AT THE OHF

LOCATION	DIRECT BETA - GAMMA RADIATION LEVELS (mrad/h)	SMEARABLE ACTIVITY[a] PER 100 cm2	
		BETA - GAMMA[b]	ALPHA
CONTROL ROOM	75-600	21000 - 49000 dpm	<20 - 40 dpm
MIXING CELL	400-4000	5 - 30 mrad/h	<20 - 100 dpm
PUMP CELL	150-2000	2 - 5 mrad/h	<20[c] dpm
WELL CELL	200-3000	10 - 35 mrad/h	<20 dpm
ENGINE PAD	20-300	0.5 - 1 mrad/h	<20 - 27 dpm
PUMP HOUSE	20-8000	0.5 - 15 mrad/h	<20 dpm

a) WET PAPER TOWEL TECHNIQUES WERE USED BECAUSE OF THE HIGH LEVELS OF TRANSFERABLE CONTAMINATION AND THE ROUGH SURFACES.

b) THESE SMEARS WERE SURVEYED WITH PORTABLE INSTRUMENTATION RATHER THAN SMEAR COUNTERS TO PREVENT CONTAMINATION OF THE SMEAR COUNTERS.

c) ALPHA SMEARABLE ACTIVITY ≥20 dpm IS THE CURRENT ORNL GUIDE FOR DEFINING A CONTAMINATION ZONE OR CONTAMINATED EQUIPMENT.

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Figure 2.10. Results of interior radiological survey performed in 1984 at building 7852 and the pump house. Source: *Huang et al. (1984)*

High levels of direct (150 to 4000 mrad/h) and removable (5 to 35 mrad/h beta/gamma and less than 45 pCi alpha per 100 cm^2) contamination were found in the mixing, pump, and well cells.

Elevated absorbed dose rates of 20 to 300 mrad/h were detected 10 cm above the engine pad. The smearable activity per 100-cm^2 area was 0.5 to 1 mrad/h of removable beta/gamma and, at most, 27 dpm of removable alpha.

The interior surfaces of the pump room in the pump house registered direct radiation levels from 20 to 8000 mrad/h. The smearable activity per 100-cm^2 area was 0.5 to 15 mrad/h beta/gamma and <20 dpm alpha.

2.2.2 WAG 5 Remedial Investigation

As part of the WAG 5 RI, three areally composited soil samples will be taken from 5 to 12 ft from the north face of the pump house (see Fig. 2.9) at depths of 0 to 2 ft. Each sample will be analyzed for gross alpha, gross beta, tritium, and gamma spectroscopy analytes to confirm that contamination from an old spill has been cleaned up. Approximately 2300 gal of radioactive waste slurry was discharged on the ground on the north side of the OHF pump house in 1977. Photographs of soil removal activities in this area were recently found by the WAG 5 RI team (ORNL 1992a), suggesting a cleanup effort.

As part of the nonintrusive characterization for the WAG 5 RI, the ultrasonic ranging and data system (USRADS) was used to provide gamma radiation survey information for areal and near-surface (1- to 2-ft depth) contamination. The USRADS survey was performed in January and February 1992 over surveyed grids covering WAG 5, including OHF.

USRADS surveys are omnidirectional and do not differentiate between gamma radiation emitted by contaminated soil and surrounding structures. Near-surface gamma radiation was detected in units of cpm using a sodium iodide (NaI) scintillation detector suspended approximately 15 cm above the ground. For the OHF area, NaI readings were in excess of 100,000 cpm. The exposure rate in units of μR/h was determined by a Victoreen 450-P pressurized ionization chamber hung 1 m above the ground. The exposure rates were approximately 100 to 200 μR/h near water tank T-5 and pump P-3 and approximately 400 to 1600 μR/h near the other D&D structures. These readings are consistent with those reported for the 1984 walkover survey (see Sect. 2.2.1). The areas with the more elevated readings are immediately northwest of Building 7852 (in the area of bin 1), surrounding the engine pad, immediately north of the pump house in the vicinity of the 1977 spill, and immediately south of the pump house near the HVAC system.

2.2.3 Energy Systems Radiological Survey of Valve Pit

Energy Systems reported that a section of the lead shielding and metal cover was taken off the OHF valve pit on July 15, 1993, so that the piping manifold could be inspected and radiation readings obtained. The presence of a "pipe patch," put on the piping in the 1980s to repair a manifold leak, was noted during the inspection. The radiation survey of the pit showed readings of 10 mR/h through the lead shielding and metal cover combined, 50 mR/h through the metal cover alone, 500 mR/h beta/gamma in the general area with the cover removed, 1200 mR/h beta/gamma 4 in. from the pit floor, and 700 mR/h gamma 4 in. from the floor. A smear taken from the pit showed 400 mR/h beta/gamma smearable per 100 cm^2 and 25 mR/h gamma smearable per 100 cm^2.

2.3 CONCEPTUAL MODEL

2.3.1 Contaminants of Concern

Huang et al. (1984) estimate that the average concentration of radionuclides in the grout mixture prior to injection through OHF was approximately 0.26 mCi/mL or less for beta/gamma-emitting radionuclides and 10 nCi/g or less for TRU alpha-emitting radionuclides.

Myrick and Stow (1987) and Huang et al. (1984) report that the two principal radionuclides of concern injected into the impermeable shale formation were cesium-137 and strontium-90; injected quantities of these two radionuclides were approximately 600 kCi and 40 kCi, respectively. Significantly smaller quantities of other radionuclides, including TRU radionuclides, were also injected. Based on analysis of the water and sediment in the OHF impoundment and the T-4 waste pit, as reported by Huang et al. (1984), other probable beta/gamma emitters included cobalt-60, europium-154, and cesium-134, and other alpha emitters included curium-244, plutonium-238/239, americium-241, and uranium-235/238.

Additional information on potential contaminants can be obtained by referring to analytical results of the contents of waste tanks T-1, T-2, T-3, T-4, and T-9, which were sampled during a 1988 sampling campaign of inactive ORNL tanks (Autrey et al. 1990; ORNL 1993). The five buried OHF waste tanks were used to store LLLW until it was ready to be blended with grout, and they still contain significant quantities of liquid and sludge waste. In addition to cesium-137 and strontium-90, other beta/gamma emitters found in the tank contents were cobalt-60, europium-152/154/155, carbon-14, and tritium. Alpha emitters included uranium-233, plutonium-238/239, curium-244, americium-241, thorium-232/238, and californium-252.

An overview of the potential RCRA status of the OHF tank contents is provided by Autrey et al. (1990). None of the waste tanks contained a RCRA ignitable waste or were classified as RCRA corrosive. The pH of the tank liquids was basic (pH of 8.8 and higher). Although toxicity characteristic leaching procedure (TCLP) tests were not specifically performed on the contents, Autrey et al. indicate that potential inorganics of concern include chromium, lead, and mercury based on elevated total concentrations of these inorganics, particularly in the tank sludges. In general, the tank contents contained little organic matter. However, volatile organic compounds (VOCs) of concern (TCLP constituents that were detected in tank samples) consisted primarily of solvents; RCRA-listed semivolatile organic constituents (SVOCs) consisted primarily of various phthalates and polynuclear aromatic hydrocarbons.

2.3.2 Sources, Receptors, and Pathways

The conceptual model describes a site by identifying suspected sources, potential receptors, and the routes of contaminant transport and exposure. (Appendix A, "Hazard Analysis," elaborates on the conceptual model from a worker safety perspective.) The conceptual model for the D&D structures is limited primarily to the structures themselves and does not include the surrounding environmental media and associated pathways that are discussed in the WAG 5 RI Plan (ORNL 1992a).

Potential sources include contaminated surfaces (e.g., walls, floors, equipment), contaminated soil or debris next to the foundation of the D&D structures, and spills or bulk contamination from leaking containers. Interior equipment surfaces or contents are also potential sources. That some significant radiological sources exist cannot be disputed given the OHF process history and past site surveys. Additional source characterization may confirm the presence of suspected contaminants, determine approximately where the contamination is located and in what quantities, and provide information on the forms of the contamination (e.g., loose or fixed; surface only or concentration gradient as a function of depth).

Contaminants in source areas are subject to transformation processes. For radionuclides, the process is radioactive decay; for organic chemicals, it involves photochemical, biological, and chemical transformations.

Personnel exposure to contaminants at OHF D&D structures is currently limited because the building and immediate area are secured against trespassers and contaminants are generally contained within the facility. Exposure in the future to the general public (e.g., a homesteader) is not anticipated because the currently preferred decommissioning alternative is dismantling and disposing of the facility. Occupational exposures may occur during characterization, decontamination, and dismantling of the structures; safeguards will be stipulated and maintained during these efforts to keep these exposures to the D&D workers 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. Inhalation is a significant potential exposure route because of the air's ability to act as a transport/exposure medium. The likely release mechanism for OHF D&D structures is fugitive dust generation; volatilization will probably not be a principal contributor given the types and forms of contaminants expected at the site. Potential dust sources are contaminated surfaces subject to dust generation, contaminated surface soil around and underneath the structures, and bulk contaminants in particulate form. A relatively high potential for dust releases occurs during demolition of the structures and surface decontamination.

2.4 USE OF REMOTELY OPERATED VEHICLE

According to the interior radiological survey performed by Huang et al. in 1984, levels of direct radiation ranged from 20 to 8000 mrad/h for the hot cells in Building 7852 and the pump room in the pump house (see Sect. 2.2.1). Manned entry for sustained periods to perform characterization activities is not practical at these levels of direct exposure. In consideration of the philosophy of keeping exposures as low as reasonably achievable (ALARA), the number of individuals exposed, the maximum individual dose equivalent, and the collective dose equivalent should be kept reasonably low (see Appendix A). Therefore, to limit worker exposure, a remotely operated vehicle with an instrument platform will be obtained to perform radiological surveys at Building 7852 and the pump house (see Sect. 5.4).

3. DATA NEEDS AND QUALITY

This section discusses data needs, data uses, and potential data uncertainties. It also provides the general project, field, and laboratory DQOs for characterization of OHF. These DQOs were developed by evaluating the needs of the decision-makers and determining how the data would be used.

3.1 DATA NEEDS

To properly plan WAG 5 remedial activities, consideration must be given to D&D of the OHF structures located within WAG 5. Otherwise, any improvement of WAG 5 conditions may be adversely affected by future spread of contaminants from the OHF D&D structures. Because of the contamination and direct radiation levels expected in some of the OHF D&D structures, careful planning for D&D is necessary.

A discussion of available historical information on OHF is presented in Sect. 2.2; this information is valuable for determining the approach for site characterization but is insufficient for OHF D&D planning with respect to designing D&D implementation, providing D&D worker safety, and managing the resultant wastes. Table 3.1 lists data needed to both confirm available site information and obtain new information for the development of D&D procedures or specifications.

This site is primarily contaminated with radionuclides, and most of the characterization effort will be aimed toward defining radiological conditions; however, characterization for other hazardous chemicals and conditions will also be performed. Characterization for both radiological and chemical contaminants will be sufficient to support OHF D&D design, personnel protection, and waste management, within the scope constraints outlined in Sect. 1. This pre-D&D characterization will not attempt to use statistical methods to define the contaminant distribution in such detail as would be necessary for certification of a facility reconditioned for reuse.

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 WAG remediation interface with D&D. As part of NEPA compliance, an environmental assessment will be written (by others) for WAG 5 and OHF combined; no unique data needs have yet been identified to result from 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 future 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).

A preferred D&D alternative for OHF has been selected for program baseline purposes (see Sect. 1.2). The actual preferred alternative will be selected through a formal evaluation process

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[a] on building equipment surfaces	Evaluate effectiveness of pre-decontamination[b]; plan protection against airborne releases; identify personal protection measures	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 and chemical inventory	Determine waste management options	Field gamma spectroscopy; sample analyses

[a]Contamination 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).

[b]Predecontamination of particularly "hot" areas can 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.

[c]If contaminant penetration is shallow, the design contractor may elect to minimize the waste sent to a low-level waste disposal 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.

subsequent to the site characterization effort. In addition, 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 characterization data. Other factors that could influence the approach include management policies, costs, schedules, and interactions with other ORNL activities.

The detailed approach for OHF D&D will also be affected significantly by ES&H considerations for the worker and WM considerations for the building waste. The principal ES&H constraints are radiation exposure hazards, but they also include the building's structural integrity, access limitations, potential for 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., RCRA, radioactive, TRU, mixed) and the waste acceptance criteria (WAC) of the respective storage or disposal sites.

3.2.1 ES&H Considerations

During characterization of OHF, site data relevant to formal exposure assessments, toxicity assessments, and risk estimation need not be collected. (Note: Formal CERCLA risk assessments for the WAGs will be performed by the RA contractor, using existing data, to address risk to the public from potential 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 (OSHA) 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 OHF will be designed and conducted in accordance with radiological standards. Currently, radiological worker dose limits are stipulated in DOE Order 5480.11. Specific limits have been instituted for exposures to the whole body (annual limit of 5 rem based on the sum of internal and external exposure), to body extremities (annual limit of 50 rem), to the lens of the eye (annual limit of 15 rem), to the skin and other organs and tissues (annual limit of 50 rem), and to an embryo/fetus of a declared pregnant worker (9-month limit of 0.5 rem) (DOE 1992). To maintain exposures well below these limits, administrative controls are established at levels below the limits. The whole-body regulatory limits and administrative controls are described below to illustrate some of the ES&H worker exposure considerations during site characterization and other D&D activities:

- 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. Exceptions to these ORNL limits may be permitted with the proper signature on a Hazardous Work Permit (HWP). During the site characterization 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 cm^2) for both removable and total (removable plus fixed) surface contamination that can be measured using smears and/or direct scan surveys. The surface is considered contaminated if either removable or total radioactivity is detected in excess of 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 OHF 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 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 g/ft^3 or <1 g total and TRU radionuclide specific activity <100 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 OHF 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$2mSv/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 to 10 mSv/h (200 mrem/h to 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 inaccessibility 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 SWSA 6 or Interim Waste Management Facility.

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 in the north area of SWSA 5 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 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 OHF 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 GAPS

Various limitations on data collection (e.g., no sampling of sealed 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 underestimation of contamination.

- Some areas, such as joints between walls or between walls and the floor, may be highly contaminated. These areas are more difficult to survey and sample than 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.

3.4.1 General DQOs

OHF 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 OHF 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 Data Quality Indicators for Field Radiological Surveys

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. (Section 4 describes survey techniques; Sect. 5 describes field investigation procedures.)

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 and will be determined using the concept of "relative percent difference" (RPD).

During the course of the characterization, 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 separate measurements.) If the RPD between repeated measurements falls outside a control limit of two times the standard deviation (or 2σ), 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 cannot 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, each field survey instrument will be source-checked at the beginning and end of each day, when in use. If the source check falls outside a 2σ 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 and 5. 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 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. The goal is to appropriately perform as many of the planned measurements as reasonably possible. However, 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 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 documentation 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 typically be reviewed as a case, where a case is a group of data of 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 cm^2 (surface activity), mR/h (exposure rate), pCi/L (liquid concentration), or pCi/g (solid concentration). Detector background is 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 with the guidelines.

- Background—The background for each instrument will be determined and tracked as part of the routine instrument quality control (QC) checks. This background will be subtracted from measured values.

- Efficiency—Standards traceable to the National Institute of Standards and Technology (NIST) 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 cm^2. This factor will be primarily the ratio of 100 cm^2 to the area subtended by the face of the detector, corrected for distance.

3.4.3 Data Quality Indicators for Sample Collection

The DQOs associated with the collection of miscellaneous samples, concrete cores, soil samples, and grab air samples from OHF are given below. (Section 4 describes sample collection techniques; Sect. 5 describes field investigation procedures and sampling parameters.)

Documentation

Samples obtained during the characterization of OHF 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 OHF 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 samples 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 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 reasonably possible, given the access, sample availability, and ALARA limitations encountered during field efforts.

Comparability

Comparability is increased by 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 Data Quality Indicators for Laboratory Analysis

The DQOs associated with the analysis of samples obtained from OHF are given below.

Documentation

Documentation requirements for samples requiring off-site analysis will be specified on the Request for Analysis. This will be accomplished by referencing a QC level for the particular sample. (Note: The "QC level" discussed in this subsection refers to reporting requirements for analytical laboratory services and is not to be confused with EPA analytical support levels that prescribe methods and types of technology used for analyses.) 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 CLP [Contract Laboratory Program] 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 a laboratory control sample.) QC data, including raw data, are reported in a CLP, or "CLP-like," data package.

The speci^ documenta: .n requirements for radiological data packages are included in Attachment B of the ab. .-referenced technical specification.

Data sources

In general, samples collected at OHF will be analyzed by 'f-site analytical support laboratories or the CSL. However, samples with radiological activity that exceeds applicable Department of Transportation limits for transport (49 CFR 172-178) will be analyzed by the ORNL Radiological Materials Analytical L. oratory (RMAL).

Precision

Precision will be assessed by evaluating laboratory duplicate analyses; RPD limits for analytical precision will be defined by the analytical method selected. (See PP 1503.2, "Validation of Radiological Data," for radiological limits: see EPA 1991b and 1991c for chemical limits.)

Accuracy

Accuracy will be evaluated by the results of matrix spike analyses; spike recovery limits will be defined by the analytical method selected. (See PP 1503.2, "Validation of Radiological Data," for radiological limits; see EPA 1991b and 1991c for chemical limits.) In addition to matrix spikes, method perfo^mance v "l 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 (EPA 1991b,c; 1992). During the 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

Data validation is performed to ensure that analytical results are of known and defensible quality. Chemical data from off-site laboratories will be reviewed in accordance with EPA CLP data validation procedures for organic and inorganic data (EPA 1988a, 1990). Non-CLP analyses from off-site laboratories will be reviewed against data validation procedures designed to meet the format and intent of the CLP (specifically, PP 1503.2, "Validation of Radiological Data").

3.5 PLANS, PROCEDURES, AND PERMITS

The current revision of the following approved ORNL RI/FS Project program plans apply to D&D characterization and 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 OHF 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. Specific guidance for OHF characterization that augments the program ES&H Plan is provided in this SCP (including Appendix A) and subsequent FWGs and HWPs.

- *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 requirements of ANSI/ASME NQA-1 and EPA QAMS-005/80.

- *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. Specific guidance for OHF that augments the program WM Plan, and that will be used for this task, is provided in the WAG 5 Waste Management Plan (Bechtel 1992b).

- *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 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.

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.

Before field measurements and sampling begin, FWGs will be issued and the necessary characterization activity permits will be obtained. The FWGs will detail where and how characterization and sampling will occur. Permits to be obtained will include HWPs, in accordance with PP 1235; and excavation/penetration permits (E/PPs), in accordance with PP 1620. HWPs are issued to address 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 D&D documents for inclusion of quality requirements and will plan, schedule, perform, and report audits and surveillances as required by 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

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
		1240	Emergency Response
		1245	Personnel Decontamination
		1250	Equipment Decontamination and Release for Unrestricted Use
		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	1402	Waste Categorization and 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
		1650	Decontamination Program
1700	Close Support Laboratory	1710	Sample Preparation for Radiochemical Analyses
		1715	Radiological Quality Control Procedure
		1726	Transfer of CSL Data into Project Records
		1727	Reporting CSL Analytical Results
1800	Project Controls	1801	Baseline Management

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 documented in a logbook; 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 (a brief discussion of anticipated hazards is presented in Appendix A) and to comply with applicable state and federal regulations or orders. The HWP lists the basic ES&H training or qualification requirements for personnel working at the field site. For example, all workers assigned to enter controlled areas will receive a minimum of 40 hours of OSHA-required 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. Two other required training courses are waste generator certification training (as outlined in PP 1404) and radiation worker training. Weekly toolbox safety meetings will also be conducted during field operations.

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:

- 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 project 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.

Table 4.1. General description of OHF field characterization

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 split 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

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 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 and ES&H 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 G-M 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 the 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 TRU 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,

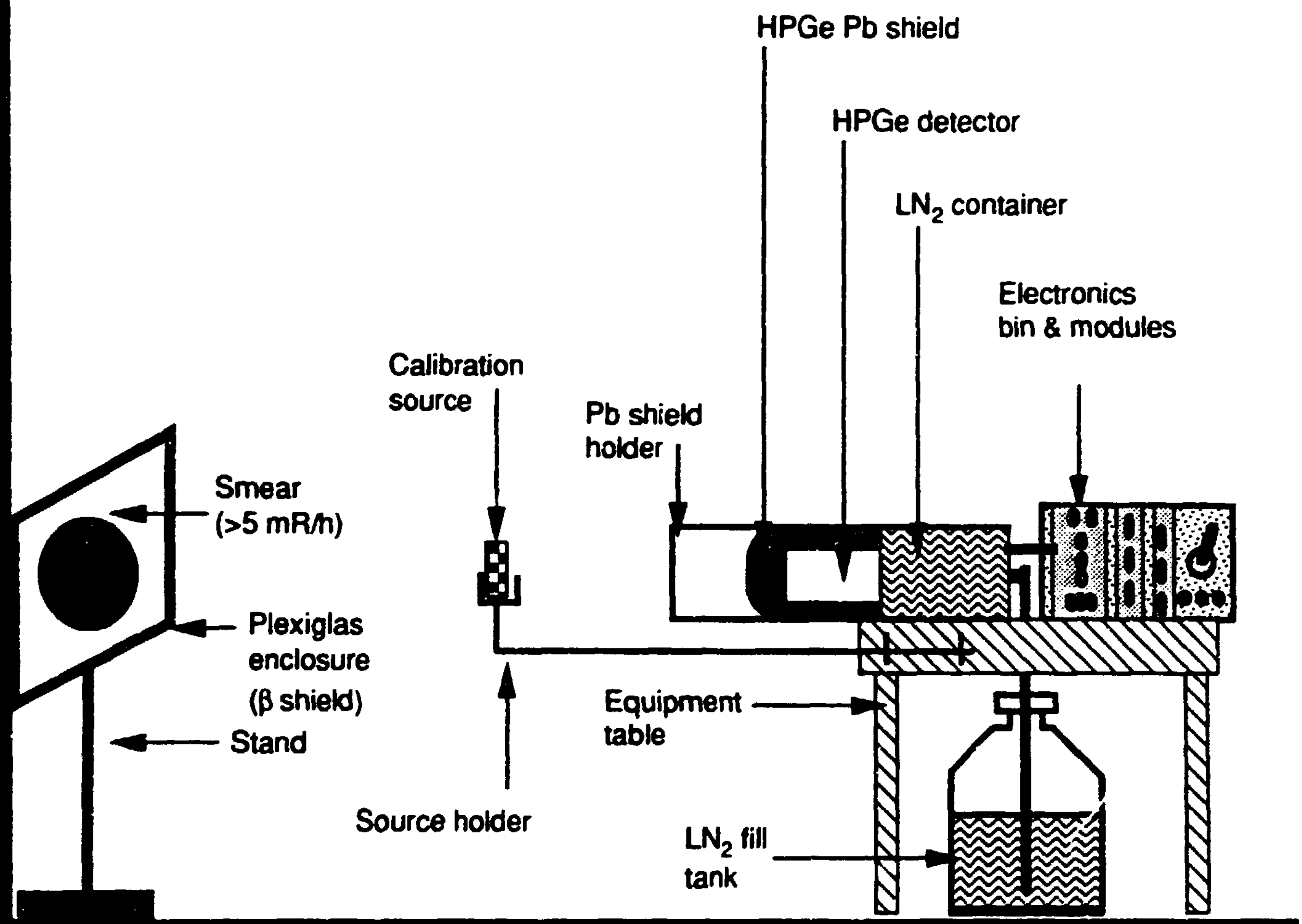

Fig. 4.1. Schematic diagram of gamma spectroscopy of smears reading >5 mR/h.

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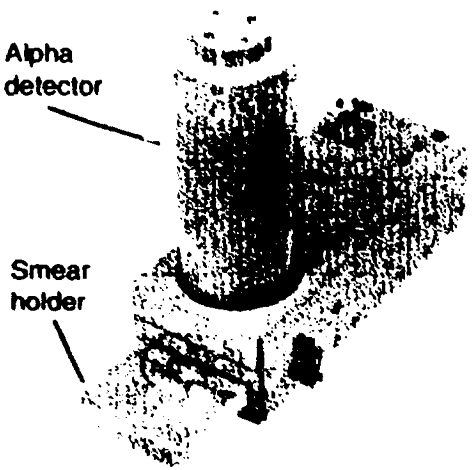
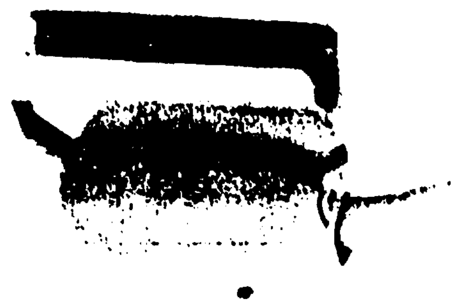


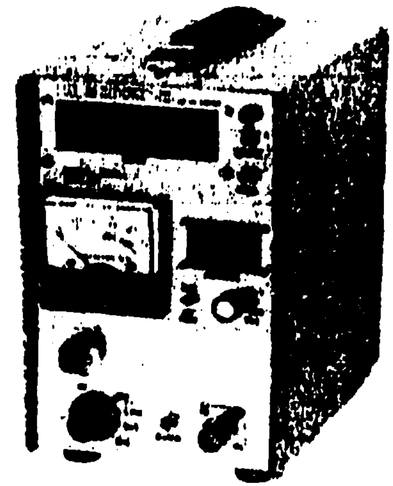
(A) LUDLUM MODEL 43-10

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.

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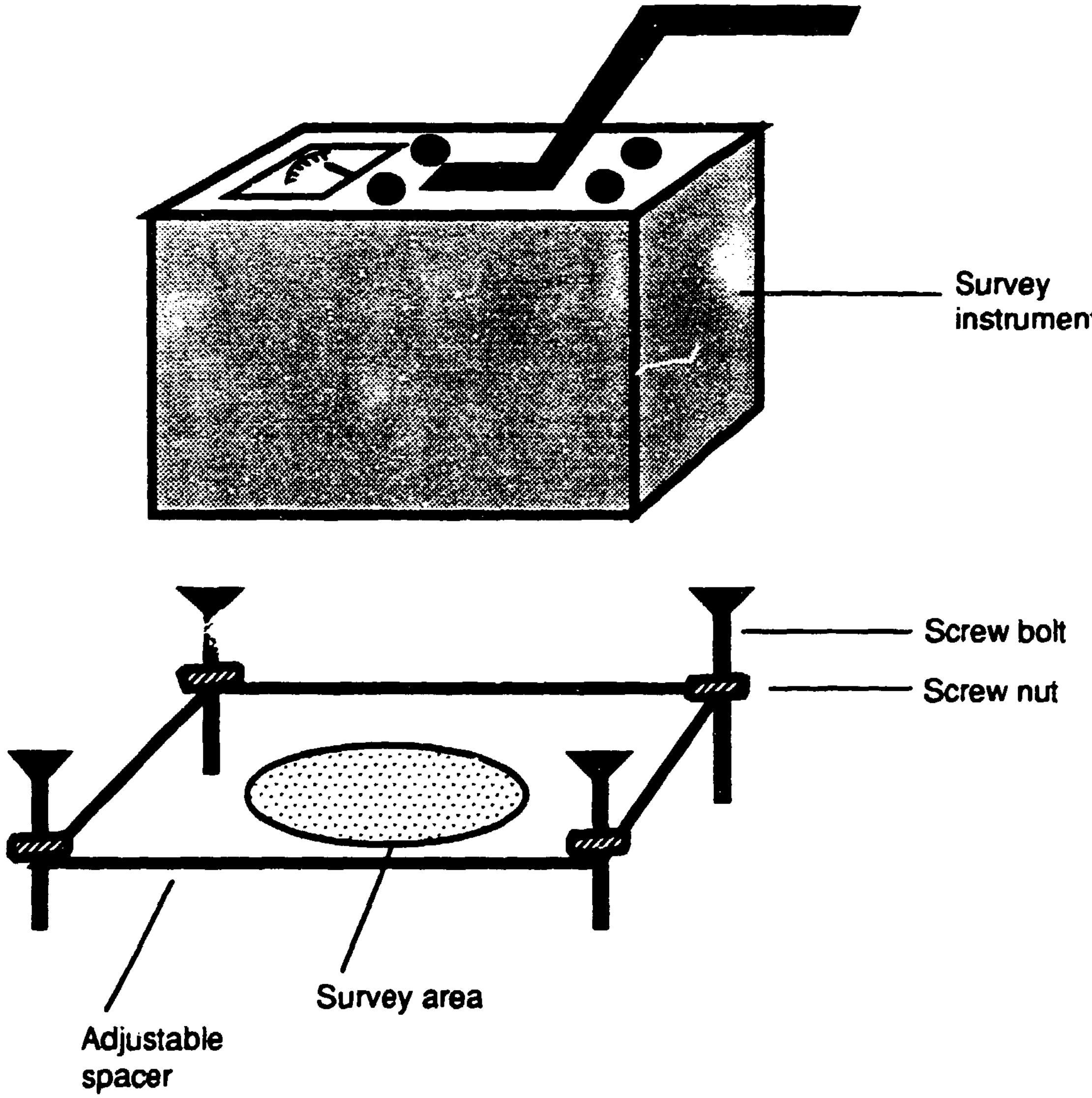
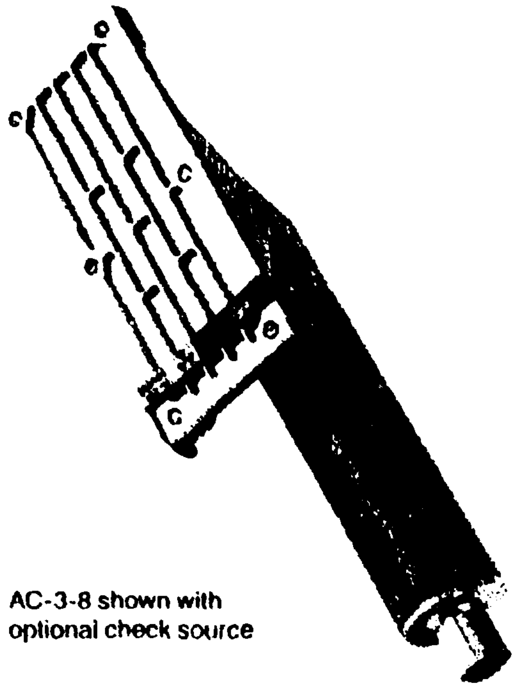
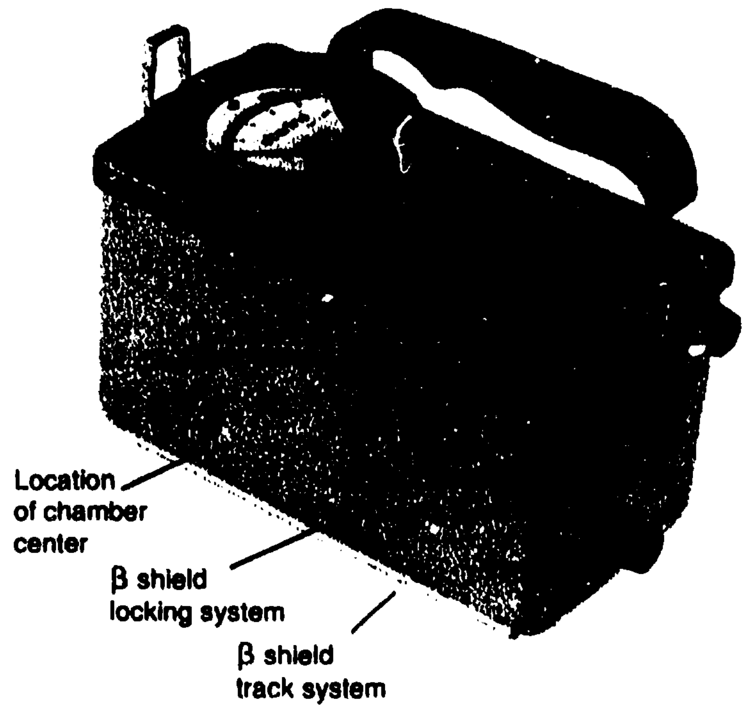


Fig. 4.3. Typical spacer arrangement.



(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.

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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 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.

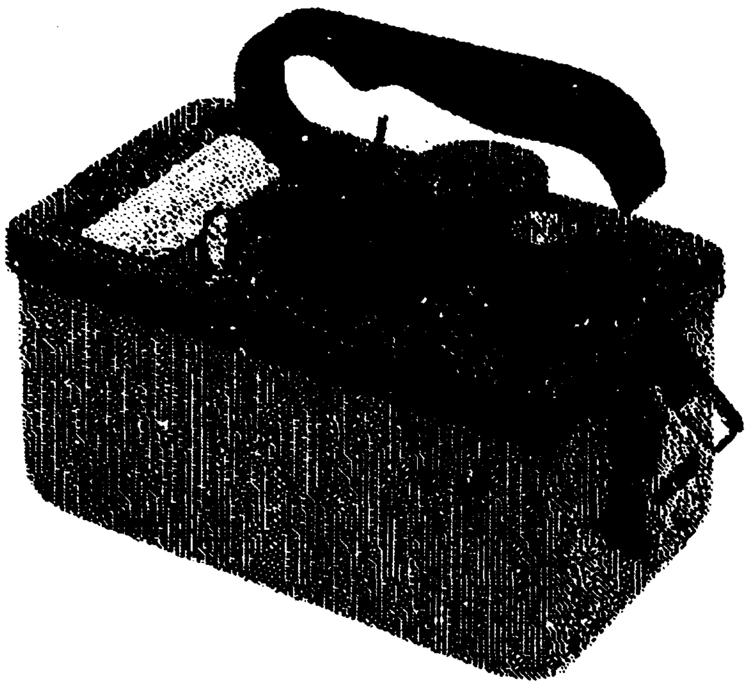
To collect and record the data, an Eberline ASP-1 or Eberline ESP-2 (see Fig. 4.5) or similar instrument may be used to process the signals produced by the scintillator probe photomultiplier tube. Eberline ASP-1 is a digital device (with analog display) that can function either as a ratemeter (output 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).

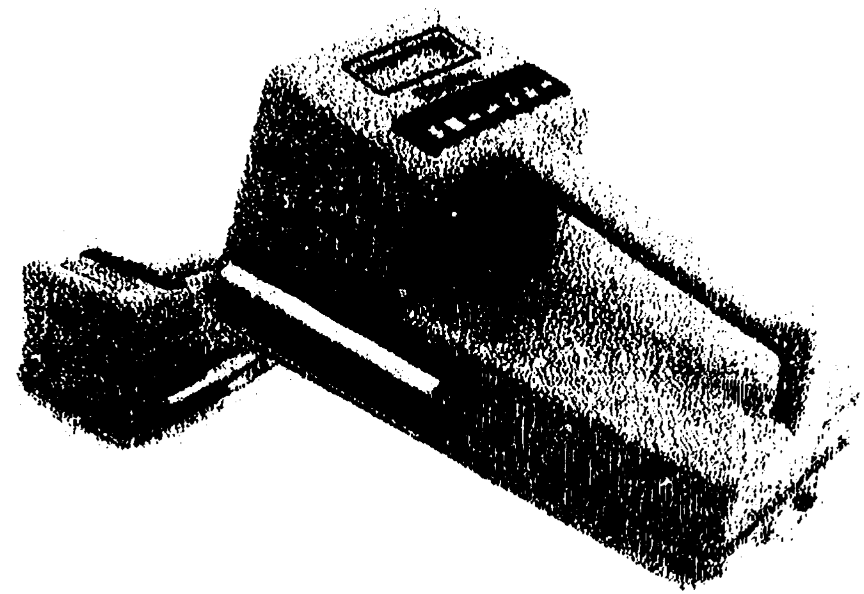
4.3 FIELD GROSS MIXED BETA/GAMMA MEASUREMENTS

An Eberline HP-270 or similar 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 G-M tube with a 30-mg/cm^2-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 G-M 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 G-M 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 G-M 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.

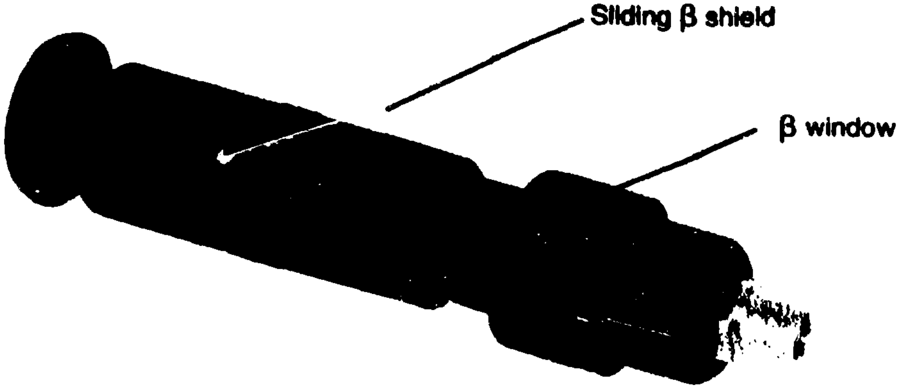


(A) EBERLINE MODEL ASP-1

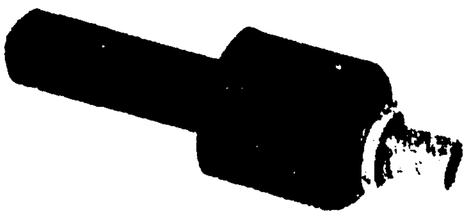


(B) EBERLINE MODEL ESP-2

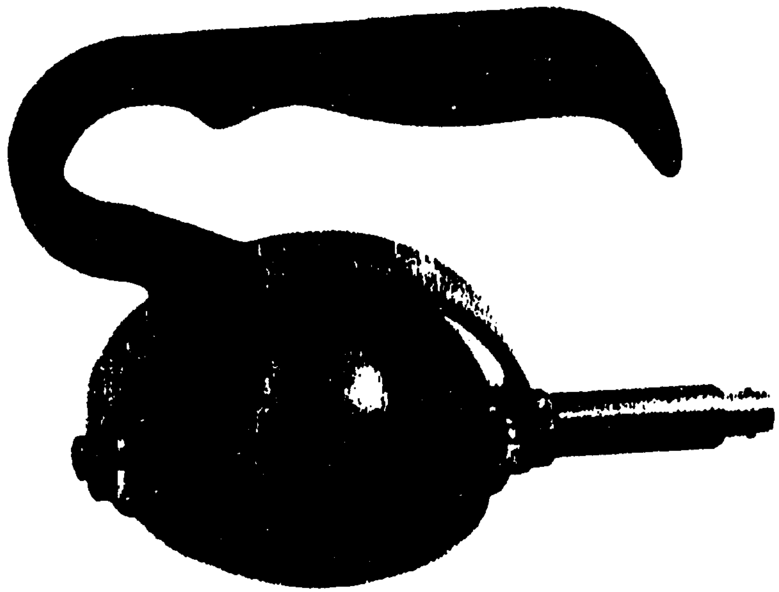
Fig. 4.5. Typical field data collection/recording instruments.



(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.

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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.

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/cm^2-thick phenolic walls inside a 0.13-cm-thick aluminum casing. At the bottom of the instrument, a thin Mylar window (7 mg/cm^2 thick, enough to allow the strontium-90/yttrium-90 betas to pass through) covered with a sliding beta shield (400-mg/cm^2-thick phenolic material) prevents almost all of the 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 G-M tube with a 90-mg/cm^2-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 range of operation of the system is similar to that of the HP-290. 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 G-M tube for detection of relatively high gamma fields. The G-M 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.

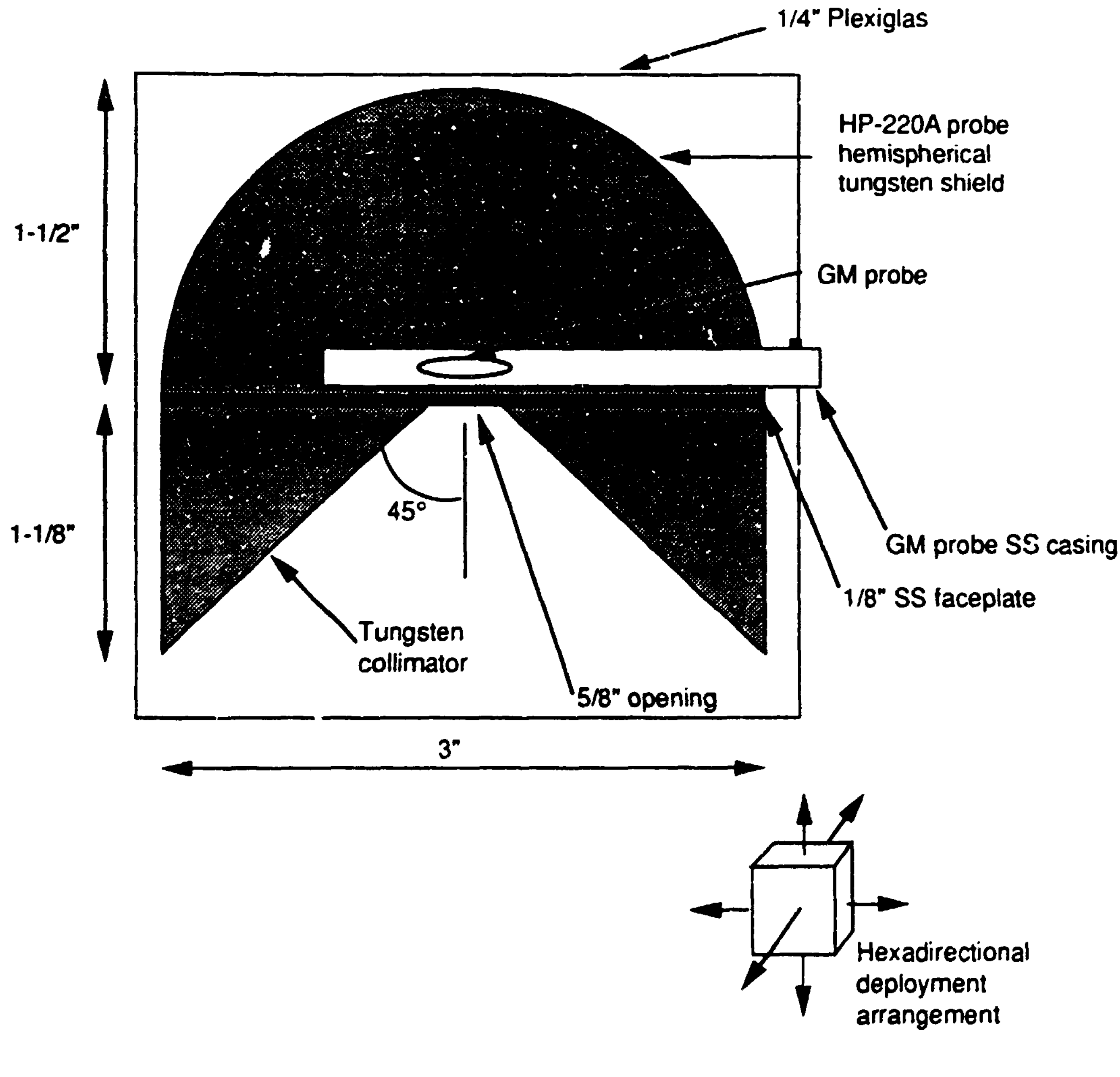


Fig. 4.7. Modified HP-220A used as directional detector with tungsten collimator.

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 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 cm^3). 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).

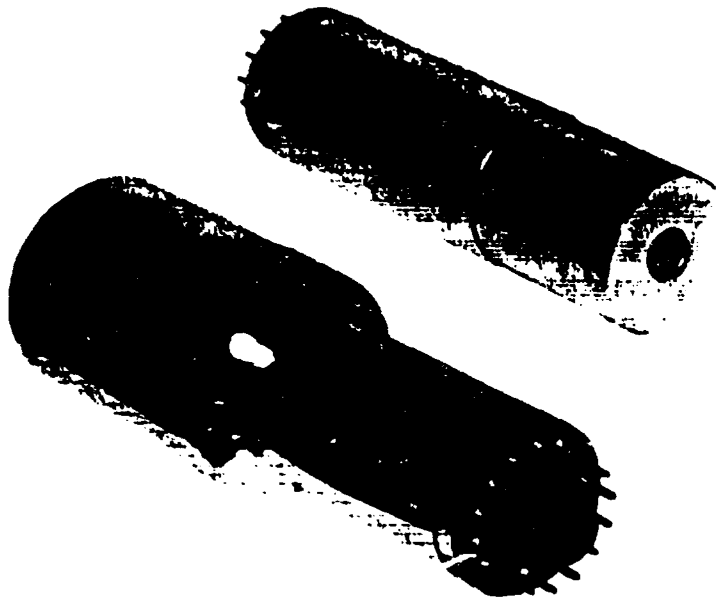
A germanium spectroscopy system is usually chosen for gamma detection because

- 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.

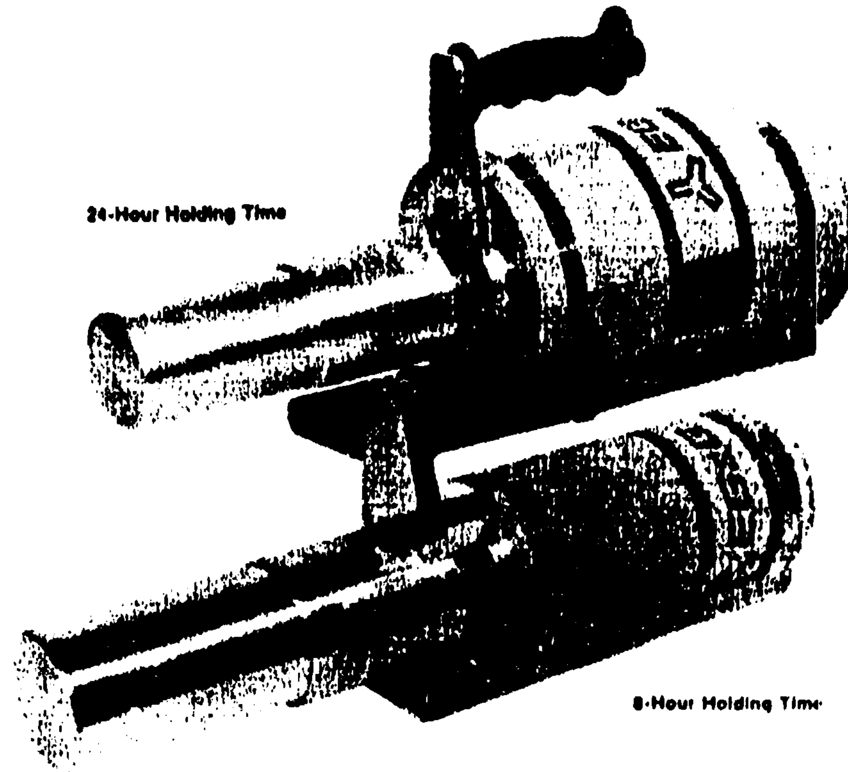
Germanium crystals used for detecting gamma energies above 1 MeV are usually in a cylindrical coaxial configuration. This helps to reduce the crystal thickness between the electrodes by a factor of 2 without compromising crystal volume (Tait 1980).

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 germanium 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.

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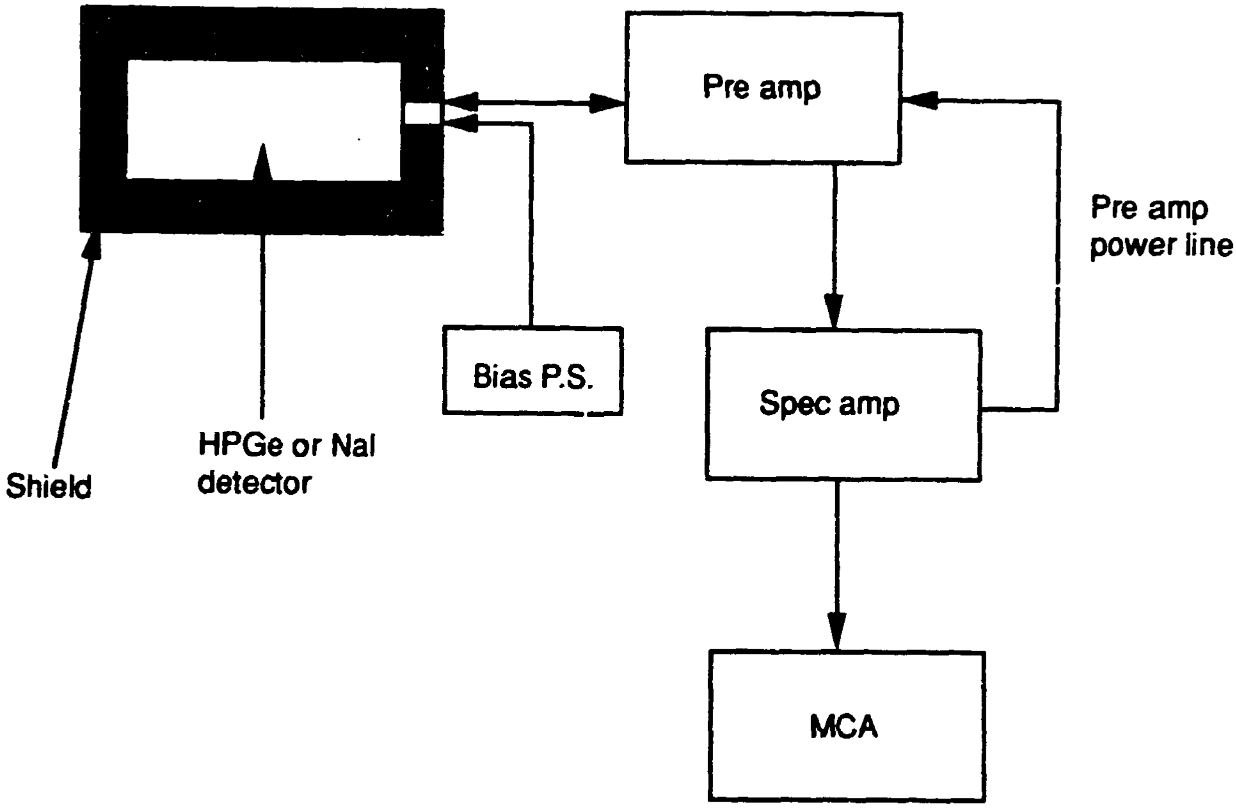

Fig. 4.9. Schematic diagram of typical gamma spectroscopy system.

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 that of 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.

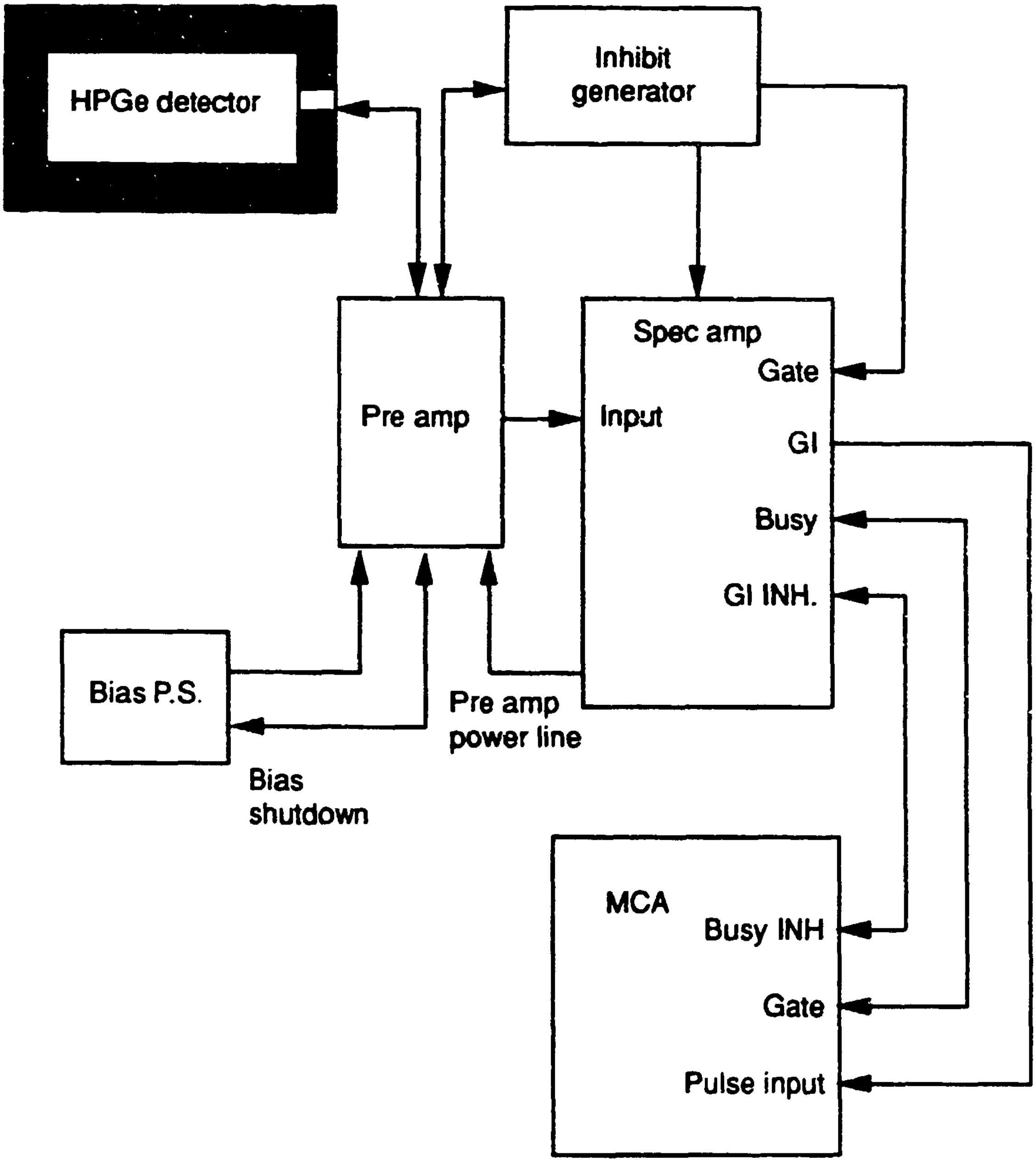

Fig. 4.10. Schematic diagram of HPGe gamma detection system with pulse pile-up rejection.

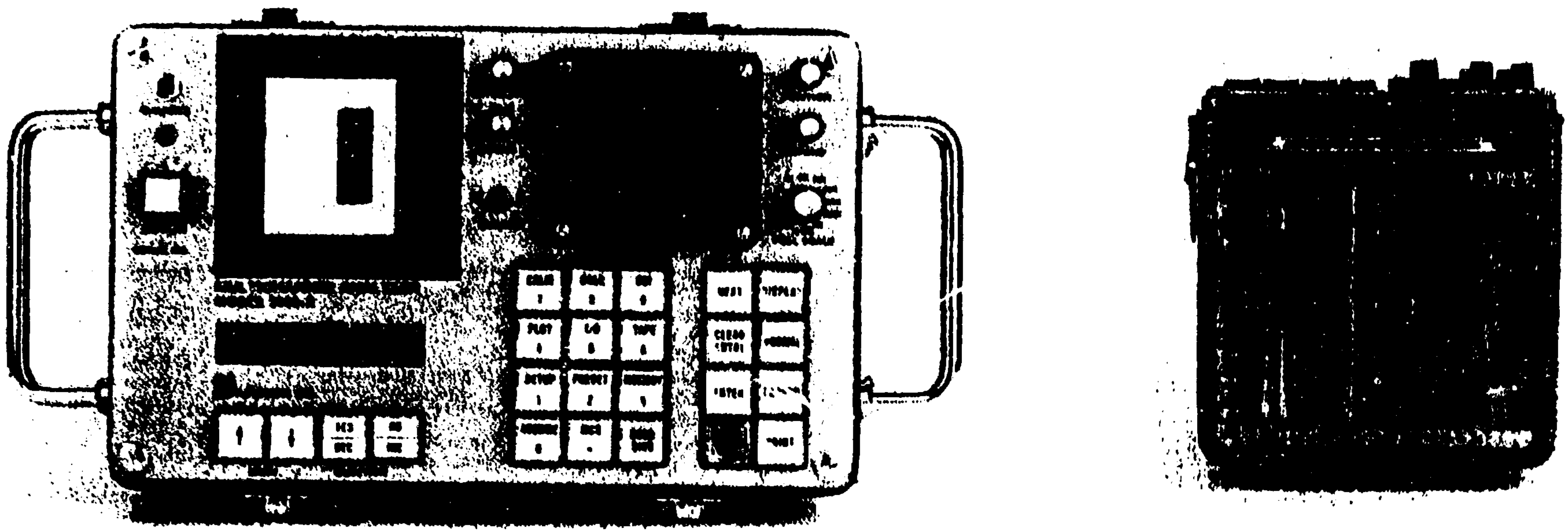

Fig. 4.11. Typical portable Davidson 2056-B multichannel analyzer.

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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. 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) may 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 CORING

Coring to assess the depth of contaminant penetration into concrete is an established sampling technique (Davis 1989; GPU Nuclear Corp. and Bechtel National, Inc. 1984).

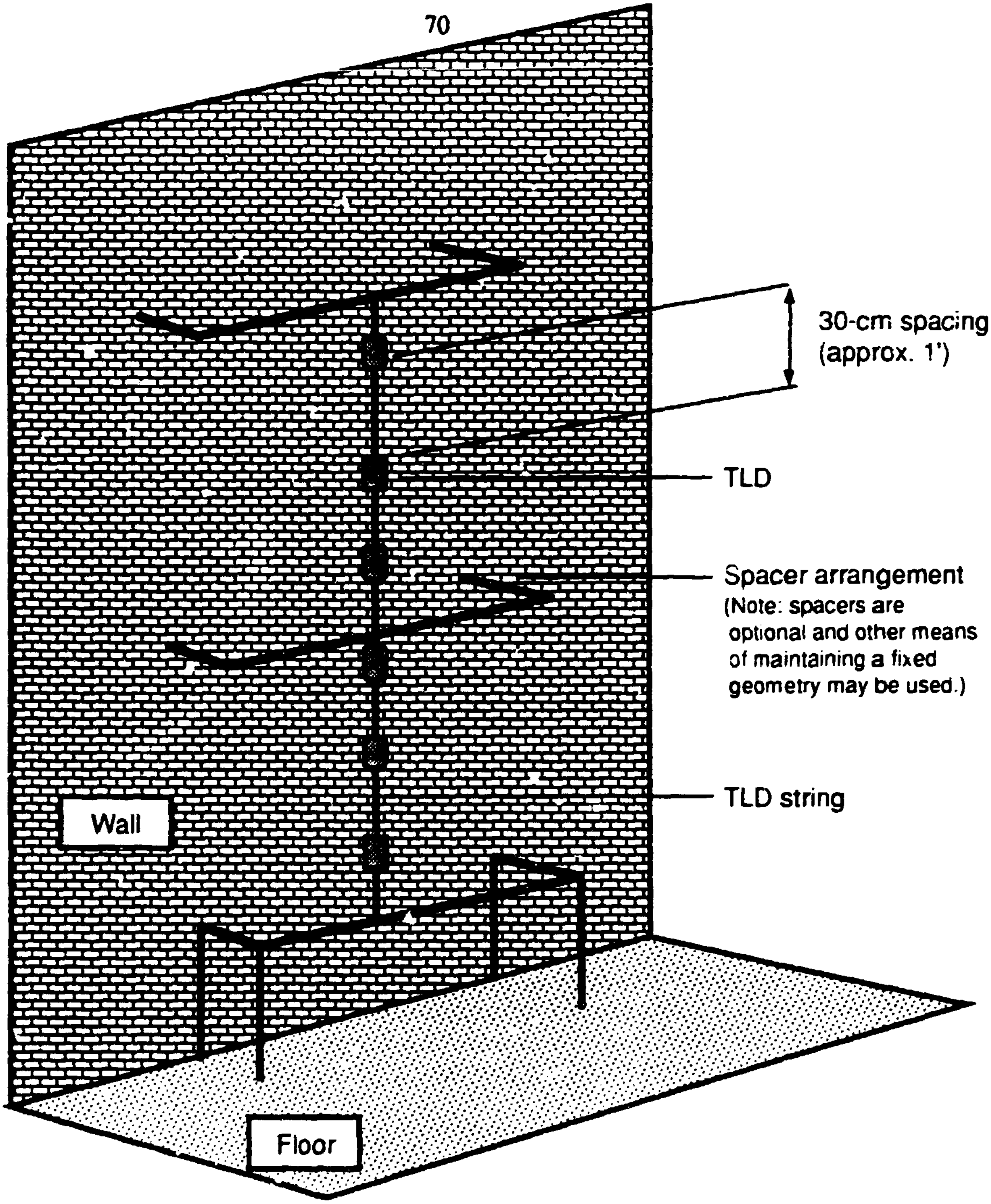

Fig. 4.12. Typical TLD string arrangement.

4.7.1 Coring

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 RI/FS project procedures ("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. 4.7.2 througn 4.7.4 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.

4.7.2 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.

4.7.3 Gross Gamma

This system would be the same as that described in Sect. 4.7.2, with the exception of the detection system. Here, instead of a spectroscopy system, the directional gross gamma measurement system would be employed to perform the measurements.

4.7.4 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.

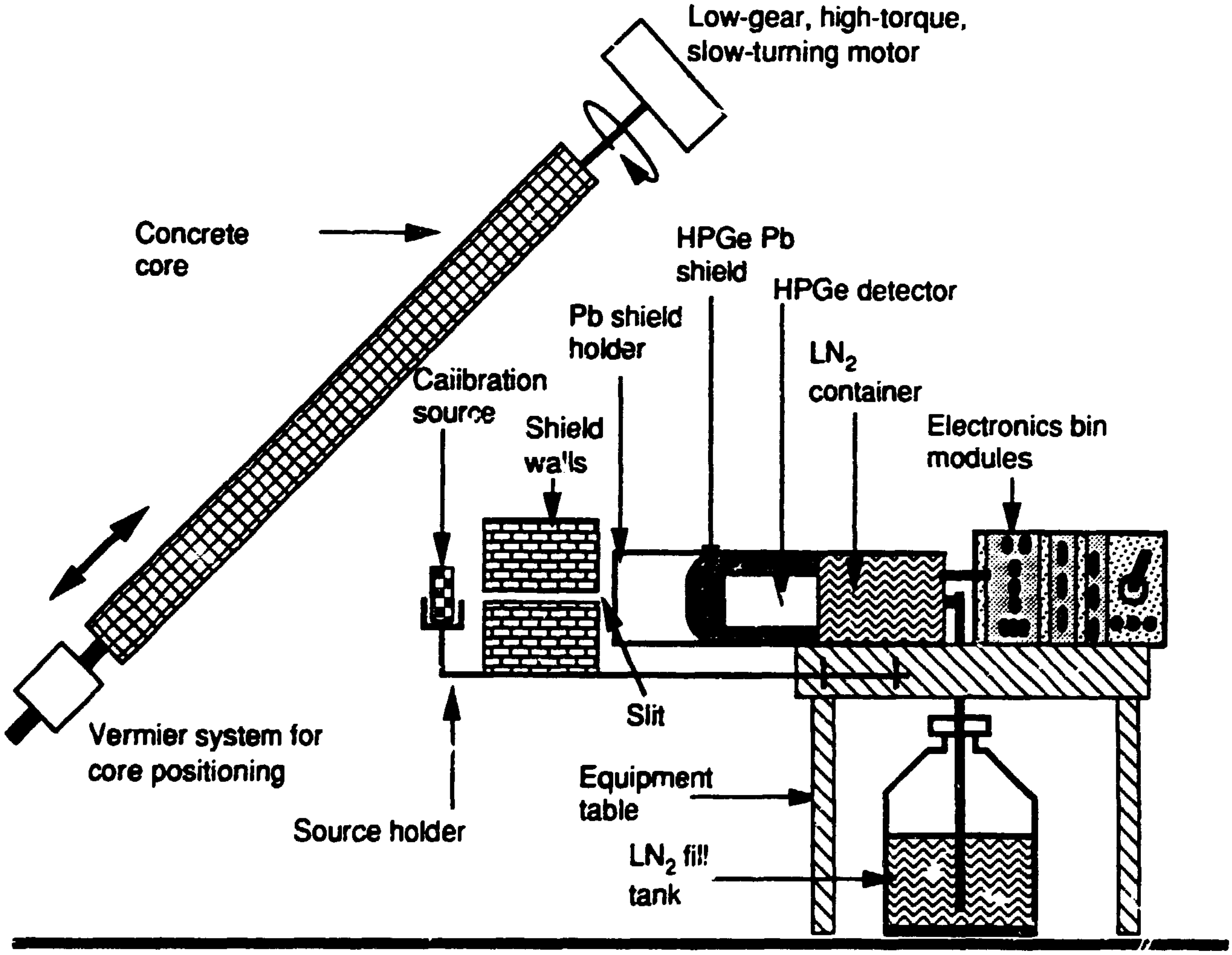

Fig. 4.13. Schematic diagram of gamma spectroscopy of slit scanning of cores.

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4.7.5 Core Analysis

Concrete cores will be analyzed for both radiological and chemical contaminants at the off-site laboratory or the ORNL RMAL. Concrete cores with contact exposure levels of ≤5 mR/h beta/gamma, as determined by field or CSL instruments, will be shipped to the off-site laboratory. Concrete cores with contact exposure levels >5 mR/h beta/gamma will be sent to the ORNL RMAL for analysis. Radiological and chemical analyses to 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 or other similar means may be used to collect composite soil samples from these locations to a maximum depth of 5 ft. Soil samples will also be collected around Building 7852 and the pump house. Sample collection and handling will be in accordance with appropriate 1600 series RI/FS project procedures. If Shelby tube core samples are obtained, a slit scan by a gross gamma measurement system such as the one discussed in Sect. 4.7.3 will be performed on the samples to characterize the radiation exposure levels as a function of depth.

Exterior (or outside) soil samples will receive radiological and VOC screens at the CSL. Subfloor soil samples will be analyzed for both radiological and chemical contaminants at the off-site laboratory or the ORNL RMAL. Subfloor soil samples with contact exposure levels of ≤5 mR/h beta/gamma, as determined by field or CSL instruments, will be shipped to the off-site laboratory. Subfloor soil samples with contact exposure of >5 mR/h beta/gamma will be sent to the ORNL RMAL for analysis. Radiological and chemical analyses to be performed by the off-site and ORNL laboratories 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 the 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.

Table 4.2. Radiological and chemical analyses of subfloor soil and concrete samples at the off-site laboratory or ORNL RMAL

Radiological	Chemical
Gross alpha	TAL inorganics
Gross beta	TCL VOCs[a]
Gamma spectroscopy	
Total radioactive strontium	TCL SVOCs
Curium (isotopic)	TCL pesticides/PCBs
Americium-241	
Plutonium (isotopic)	QC package for TAL/TCL constituents
Thorium (isotopic)	
Uranium (isotopic)	

[a]VOC analyses will not be performed for concrete core samples obtained during site characterization.

4.11 GRAB AIR SAMPLES

ES&H personnel will perform initial entry measurements and routine monitoring of the air for such parameters as oxygen, carbon monoxide, explosive or flammable atmosphere, VOCs, and radiological hazards. If the VOCs upon initial access to the building are relatively high (e.g., a direct reading of >5 ppm from an organic vapor analyzer), a grab sample system may also be used to assess the ambient air. 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. This information will be used to specify respiratory equipment and personnel protection requirements for subsequent entries.

5. OHF D&D FIELD INVESTIGATION

The OHF D&D structures and media may be characterized in the following sequence:

(1) bulk solids bins and appurtenances;
(2) water tank T-5 and pump P-3;
(3) soils (out to 5 ft from the structures) and exterior ("outside") surfaces of D&D structures;
(4) pump house, including the valve pit; and
(5) Building 7852 (engine pad, control room, mixing cell, pump cell, and well cell).

The actual sequence may be varied in the field to take advantage of available personnel and material resources.

The steps in site characterization of an OHF D&D structure, or of a room or cell in a structure, are:

(1) access the structure,
(2) conduct an initial site ES&H survey,
(3) conduct inspections and photography,
(4) conduct radiological measurements and smear sampling,
(5) collect concrete core samples,
(6) collect exterior and subfloor soil samples, and
(7) collect miscellaneous grab samples,

These steps use the methods described in Sect. 4. The following sections describe these steps as they apply to OHF D&D structures.

5.1 ACCESS

5.1.1 Bulk Solids Bins and Appurtenances

The bulk solids bins and other associated or nearby equipment are above ground and exposed to the elements. No special access requirements need to be satisfied for those portions of the bin structure or equipment that are within easy reach of personnel on the ground. No attempt will be made to access, via disassembly, the inside of Building 7852 exhaust system (filter and fan underneath bin 3) or other appurtenances (characterization of "sealed" appurtances will be by external surveys and smears).

At higher elevations, the bins are encircled by railings and are interconnected by a catwalk. A ladder (with a safety cage) on the west side of bin 2 reaches up to the catwalk from ground level. Energy Systems has inspected the ladder and determined that it should not be used by the Bechtel field team during characterization. As an alternative, Energy Systems will probably provide a crane with an approved personnel lifting platform and a crane operator. To investigate each bin, the field team would be lifted to the top of the bin and the lifting platform attached to the catwalk railing. The possibility of access by some means through the bottom of the bins will also be investigated.

The bins are considered to be relatively uncontaminated. If use of the crane and lifting platform is permitted, and if the bins are not empty, confirmatory samples of the contents will be taken through a hatch at the top of the bins. Manned entry to the bins is not planned; however, Energy Systems personnel report that the hatch is large enough to permit manned entry and that ladders exist inside the bins.

5.1.2 Water Tank T-5 and Pump P-3

Water tank T-5, pump P-3. and the connecting piping and valves are above ground and exposed to the elements; hence, no special access requirements exist. Both the tank and pump sit on concrete slab foundations. According to Energy Systems personnel, the tank is filled with water to an approximate depth of 4 ft for possible use in fire protection. A small valve on the north side of the tank could be used for sampling the tank contents.

No provision is made for emptying or draining the water tank at this time, as this is not a component of the D&D characterization scope.

5.1.3 Soils and Building Exteriors

No special access requirements exist for characterizing the exterior surfaces of D&D buildings or the soils around the buildings. Access to the subfloor soils will be through floor coreholes.

5.1.4 Pump House

Access to the pump room (eastern half of the pump house) will be through a padlocked, 7-ft by 3-ft door at the northeast corner of the building. Keys to the pump house are held by the Energy Systems S&M Group, Waste Management and Remedial Action Division (WMRAD). Standard contamination control will be used during access. Negative air pressure in the room will be provided by an existing operational ventilation system on the south side of the building. The ventilation system has a design rating of 320 to 400 cfm and exhausts through both a prefilter and HEPA filter. The ventilation system will be inspected and verified operational by Energy Systems prior to entry.

Access to the valve pit (western half of the pump house) will be through the cover plates over the pit. According to ORNL drawings, the original cover consisted of sheet metal tack-welded to a removable steel grating. Lead plates now lie on top of the metal grating.

5.1.5 Building 7852

The engine pad is open to the environment except for a corrugated metal roof (at a height of 9 to 10 ft above the ground). No special access requirements (e.g., confined entry) need be met to characterize the pad.

The control room will be accessed through a 3-ft-wide, key-locked door on the north side. Keys to Building 7852 are held by the Energy Systems S&M Group, WMRAD.

Access to the mixing cell will be via a 2-ft by 2.5-ft hatch near the southeast corner of the nonremovable roof. ORNL drawings indicate that a metal rung and rail ladder (constructed from 3/4- and 1-1/4-in.-diameter schedule-40 pipe) is attached to the south wall of the mixing cell and extends from the floor to the hatch. Ladder integrity will be verified prior to use.

Access to the pump cell will be via a 2-ft by 2.5-ft hatch near the northwest corner of the removable roof. ORNL drawings indicate that a metal rung-and-rail ladder is attached to the north wall of the pump cell and extends from the floor to the hatch. Ladder integrity will be verified prior to use.

Access to the well cell will be via a 2-ft by 2.5-ft hatch near the southwest corner of the removable roof. ORNL drawings indicate that a metal rung-and-rail ladder is attached to the south wall of the cell and extends from the floor to the hatch. Ladder integrity will be verified prior to use. A second hatch is located directly over the injection wellhead in the southeast quadrant of the well cell roof. ORNL drawings do not indicate an in-place ladder for this second hatch. If a ladder is not in place and the hatch access is needed, 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 hot cells through the roof hatches, 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." Negative air pressure in the hot cells may be provided by an existing, operational ventilation system located under bin 3. HEPA efficiency tests are performed quarterly by Energy Systems. ORNL drawings show that the ventilation system connects to each of the cells with 4-, 6-, or 8-in. ducts and exhausts through both prefilters and HEPA filters. Flow rates for air exiting from each cell range from 500 to 1400 cfm. Energy Systems personnel contacted were unable to confirm that the ventilation system exhausts (or presently exhausts) the hot cells, as shown in the drawings. However, one individual indicated that the control room is under negative pressure and is serviced by the ventilation system—a datum that is not shown in those ORNL drawings in Bechtel's possession. The ventilation system will be inspected and verified operational by Energy Systems prior to manned entry. Protective hand rails currently exist around the edge of the hot cells' roof, which can be reached via a vertical steel rung ladder attached to the well cell's west wall (near the southwest corner) and a slanted steel step ladder attached to the pump cell's east wall. Energy Systems reports that the east wall ladder has been certified safe for use.

5.2 INITIAL ES&H SITE SURVEY

Initial ES&H surveys are conducted by qualified project ES&H personnel before the start of any other field measurements or sampling. The surveys include on-site visual observations, radiological surveys, and hazardous chemical surveys (e.g., oxygen levels, combustible gas), as needed, in accordance with PP 1220, "Initial Site Survey." Before a room, cell, or pit is inspected or entered, the outside of the structure 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 general radiological and industrial hygiene information gathered during this survey may be used in the field to modify characterization activities.

The initial survey of the mixing cell, pump cell, and well cell will begin from outside the cells (from the roof position) by (1) taking direct readings from a teletector or similar instrument (a teletector is a long-handled, remotely operated ES&H gamma survey meter); (2) lowering atmosphere monitors into the cell; and (3) taking remote smears (using long-handled poles). ES&H personnel will then enter the cells under confined space entry protocols and with appropriate respiratory protection to complete the initial survey. These entries will be of limited duration according to dose rates in the cells.

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. This particular task may either be reduced or eliminated if warranted by ES&H considerations (i.e., the ALARA concept) for a particular room, cell, or pit.

A structural engineer will perform a site inspection at this time. Details of this inspection will be recorded in a 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, or other appropriate photography equipment. Video is also an option. The structure will be methodically photographed, including close-ups of remaining equipment, access points, damaged or deteriorated areas, and structural details. All photography will be in accordance with PP 1110.1, "Field Photography and Control," which requires descriptions of the activities shown in photographs to be maintained in a logbook. There are no special inspection or photography requirements for the various rooms or cells.

For a particular room or cell, an evaluation of the ES&H survey, allowable dose limits, and ALARA considerations will be made to determine whether the photographs should be taken remotely (e.g., using long-handled tools) or during manned entry; this decision will be made in the field. Generally, photographs would show a ruler or other reference object; this protocol requires additional preparation time for the photographer and may be modified or eliminated in the case of remote photography or where manned entry durations need to be minimized in accordance with ALARA.

5.4 RADIOLOGICAL MEASUREMENTS

5.4.1 Types of Radiological Measurements

Two types of field radiological measurements will be done—general area and location-specific. General area measurements consist of gross gamma (directional and omnidirectional), gross beta/gamma, field gamma spectroscopy, and TLD string measurements. General area measurements will be used to model radiation sources and to plan worker exposures during D&D activities. Location-specific measurements consist of gross alpha, gross mixed beta/gamma, gross gamma (directional and omnidirectional), and smear sampling. Location-specific 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.

General area measurements

For a particular area or structure, the Task Technical Lead will select the appropriate general area radiological measurements based on inspection observations, photographs, and initial ES&H surveys. As a minimum for a cell, room, or pit interior, a hexadirectional gross gamma measurement will be done in the approximate center of the enclosed space; if dose rates allow, one field gamma spectroscopy measurement will also be done. Five to eight gamma spectroscopy measurements are planned for the characterization effort. If dose rates exceed 100 mrem/h, a TLD string measurement may be used to determine a dose profile (vertical or horizontal as appropriate) in the cell, room, or pit. For planning purposes, it is estimated that one string of TLDs (spaced at approximately 1-ft intervals) will be used in each of the hot cells.

Location-specific measurements

In each area or structure, the Task Technical Lead will select locations for measurement based on inspection observations, photographs, and ES&H surveys. The maximum number of planned location-specific measurements is 150, with a more specific breakdown estimated as

- bulk solids bins and appurtenances—20 total;
- water tank T-5 and pump P-3—10 total;
- pump room in pump house—20;
- valve pit—10;

- engine pad—10;
- control room—20; and
- mixing cell, pump cell, and well cell—20 each.

Up to 10 additional measurements may be taken from miscellaneous surfaces (e.g., pads, building exterior, equipment) if needed.

The smear locations will be distributed among the walls, floor, and equipment, but will be biased based on radiological survey results and other observations. Fewer than the planned maximum number of locations may be selected if the general area dose rate in the cell or room is high enough to cause ALARA concerns.

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

(1) The selected location will be identified and marked. The method followed for performing this task will depend on such constraints as the surface type and condition to be surveyed, access conditions, and exposure rate. A typical approach would be to outline a 10-cm by 10-cm square using a template and marker and then number the area. The location numbers will be sequential with the format OHF-xx-yy, where:

OHF = Old Hydrofracture Facility

xx = BN (bulk solids bins and appurtenances)
= TP (water tank T-5 and pump P-3)
= PR (pump room in pump house)
= VP (valve pit)
= EP (engine pad)
= CR (control room)
= MC (mixing cell)
= PC (pump cell)
= WC (well cell)
= MS (miscellaneous surfaces)

yy = a sequential number from 01 to the planned maximum number of location-specific measurements for the particular area or room.

(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-cm^2 box per Sect. 4.

(6) Photograph the location.

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

5.4.2 Use of Remotely Operated Vehicle

Three options exist for performing field radiological measurements: manned entry, remote measurements using long-handled tools, and remotely operated vehicle entry. A combination of these options is planned for some of the OHF D&D structures. A remotely operated vehicle will be procured for the field activities and used for those areas exhibiting high exposure rates or contamination levels (in particular, the hot cells and the pump room). Vehicle operators will receive training from the vehicle manufacturer on its use and maintenance, and training will be documented per PP 1120, "Administration of RI/FS Training."

The vehicle currently being considered for OHF D&D characterization will be a tether-controlled track vehicle with forward and reverse drive, capable of maneuvering at variable speeds with zero turn radius, and capable of climbing up slopes and over small obstacles (e.g., a 2-in.-diameter pipe). Its compact base (less than 1 ft wide and 2 ft long) will allow the vehicle to maneuver in constrained areas and be lowered through the cells' roof hatches. The standard manipulator system will consist of a mechanical arm with the capability to pivot at the shoulder, extend at the elbow, and bend at the wrist. Radiation measurement equipment can be held with a tong/gripper end effector or simply bolted onto a plate attached to the manipulator's wrist. The vertical reach of the manipulator system will be approximately 2-1/2 ft above the floor; measurements at heights above the reach of the remote-controlled vehicle must be performed by other means. The video system will consist of two TV cameras, one with pan and tilt capability, and two variable intensity lights on the front and back of the vehicle.

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.

A maximum of six corehole samples will be taken from the concrete floors, and up to four miscellaneous cores may be taken from such areas as walls and equipment pedestals (for the purposes of this report, miscellaneous cores are categorized as "opportunity" samples—see Sect. 5.7). Specifically, one core sample will be taken from the floor of the pump room in the pump house, and one core sample will be taken from the floors of each of the five characterization areas in Building 7852: engine pad, control room, mixing cell, pump cell, and well cell. No cores are planned for the valve pit because the pipe network there may make drilling access difficult. General coring areas will be delineated in the E/PP. Specific coring locations within the general areas will be selected based on initial site survey results; criteria considered will include dose rates, hotspots, presence of drains, presence/absence of coatings, cracks in concrete, interference from in-place equipment and shielding (e.g., lead around pumps and piping in pump house), and access.

According to ORNL drawings, the floors of the pump house and control room are 4 in. thick, that of the engine pad is 6 in. thick, and those of the cells are 8 in. thick. (Note: One Energy Systems representative reported that the floor of the pump room in the pump house may be dirt rather than concrete; this will be verified during the initial site survey.) The P-3 pump pedestal (1.5 ft high) and the two pump pedestals (1 ft 4-1/2 in. high) in the pump house are examples of potential locations for miscellaneous corehole samples. The ORNL design drawings specify that (28 days after pour) the concrete floors should have a minimum compressive strength of 3000 psi. Reinforcing steel bars were placed in the foundation, and welded wire fabric was placed in the floors. No notes were found in the ORNL drawings that specified application of any coating or sealant to the floors.

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. The concrete floor thickness, as estimated from the length of the extracted cores, will be reported in the field logbook. After sampling activities are completed, the coreholes will be filled with grout and the locations will again be photographed.

Because of the reportedly high dose rates in the hot cells, consideration will be given to performing the cell coring from the roof. Drill bit extensions would allow field personnel stationed on the roof to extend the drill bit through the roof hatch to a template attached to the cell floor. The purpose of the template is to fix the position of the bit until a bit track has been initiated in the concrete.

5.6 EXTERIOR AND SUBFLOOR SOIL SAMPLES

Soil samples will be collected to indicate the release of contaminants from the structure and to plan D&D activities. Each location will yield one soil sample composited over a 5-ft depth. A maximum of 11 soil samples will be collected from a maximum of 11 locations (see Fig. 5.1 for a map of the 11 proposed single-sample areas).

- Five locations will be sampled outside the D&D structures. Tentative locations are the east side of the pump house; the east and west sides of Building 7852; the area between the engine pad and the well cell; and the area between pump P-3 and water tank T-5. The west and south sides of the pump house, as well as the north side of the well cell, are inaccessible (or high-risk areas) for sampling primarily due to underground piping and conduits. Access to the north side of the pump house is not needed because three areal composited soil samples will be taken at that location as part of the WAG 5 RI (see Sect. 2._.2). The exterior soil samples (locations shown in Fig. 5.1) will be collected within approximately 5 ft of the D&D structures. Actual sampling locations will be determined by the Team Leader after the initial site surveys and photographed when sampling activities are completed.

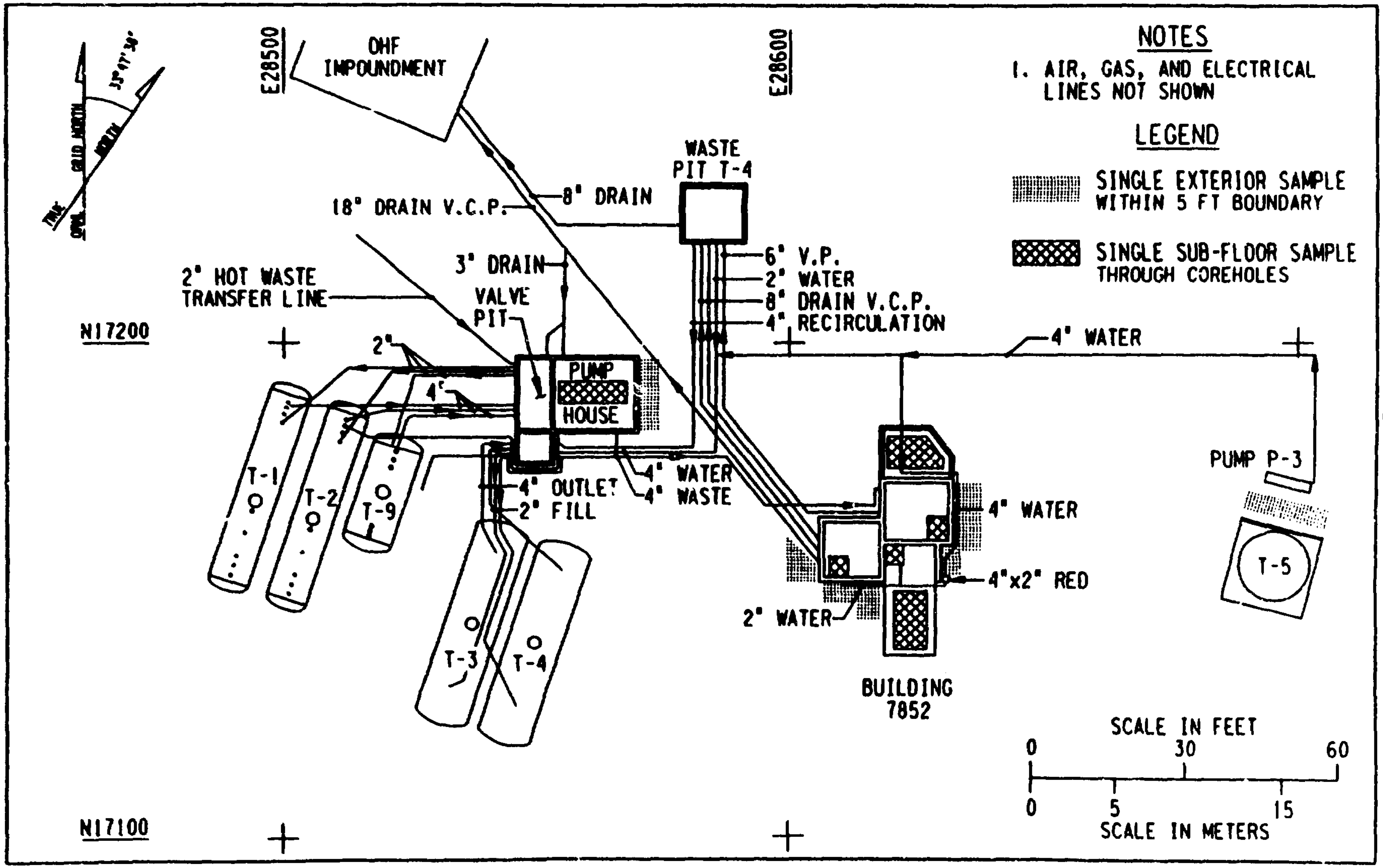

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Figure 5.1. Proposed soil sampling locations for OHF D&D structures.

- Six subfloor soil samples are planned (one through each of the floor coreholes drilled per Sect. 5.5). Tentative locations include one in the pump house, one in the control room, one on the engine pad, and one in each of the hot cells. The subfloor samples from the cells may be collected through the cell roof hatches using extensions in a manner similar to that for concrete coring.

Soil samples will be collected by a 2-in. Shelby tube, a 2-in. hand auger, or a core drill with a special 2-in. soil bit; 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. An E/PP that addresses safety concerns for penetrating soils with extensive underground piping will be submitted and approved prior to soil sampling activities. Generally, soil bores will penetrate a maximum of 5 ft into the soil; however, in areas with localized underground piping at known depths, penetrations may be disallowed, relocated, or limited to shallow soils above the piping.

5.7 MISCELLANEOUS GRAB SAMPLES

A maximum of 28 miscellaneous ("opportunity") samples will be selected by the Team Leader based on the inspection and ES&H survey information and collected by the field team. The sample selection criteria used by the Team Leader will include identification of hotspots, presence of residue or discoloration, evidence of leaks or spills, and presence or absence of coatings. Tentative locations for these samples include one from each of the four bulk storage bins, one from the valve pit, three from the pump room in the pump house, one from the engine pad, three from the control room, four from each of the three hot cells, one from pump P-3, one from water tank T-5, and two from miscellaneous areas such as the vacated blending and weigh-scale tank pads. The sample locations may be either interior or exterior to the structures mentioned. The miscellaneous samples may consist of extra core samples, extra exterior soil 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.

5.8 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 or analysis locations may be made at the time of sampling.

Table 5.1. Planned maximum number of OHF site characterization samples

Sample Collection Locations	Planned Analysis Locations					
	Field[a] (rad. screening)	CSL (rad. & VOC screening)	Off-site laboratory		ORNL[b]	
			Rad. only	Rad. & chem.	Rad. only	Rad. & chem.
Pump house valve pit	10W					1G
Pump house pump room	20W	2A		1S	1G	1C, 2G
Pump house - outside		1S				
Building 7852 - outside		3S				
Bulk storage bins		20W, 8A, 4G				
Water tank T-5 and pump P-3		10W, 1S, 1G		1G		
Control room		20W	1C, 1S, 2G	1G		
Mixing cell	20W	2A		1S	2G, 10T	1C, 2G
Pump cell		20W, 2A		1S	2G, 10T	1C, 2G
Well cell	20W	2A		1S	2G, 10T	1C, 2G
Engine pad		10W		1C, 1S, 1G		
Miscellaneous surfaces		10W	1G	1G		
TOTAL	70W	90W, 5S, 16A, 5G	1C, 1S, 3G	1C, 5S, 4G	7G, 30T	4C, 9G

Abbreviations: G = grab/miscellaneous sample; C = concrete core sample; W = wipe/smear; S = soil sample; A = grab air and air monitoring sample; T = TLD.

Notes:

- Numbers shown are estimates for planning purposes. Actual number of samples collected and analysis location may vary from that shown. Not included are those samples required for ES&H and QC purposes. One set of 4 QC samples will be required for every 20 samples (see Sect. 3.4.4).
- Concrete cores will first be slit-scanned (see Sect. 4.7.3) in the field and then a portion or all of the core will be shipped to the off-site laboratory or ORNL RMAL for further characterization.
- If the subfloor soil samples are extracted as a core (e.g., by a Shelby tube) rather than as bulk particulates by a hand auger, the soil core may be slit-scanned (see Sect. 4.7.3) in the field prior to shipment to the off-site laboratory or ORNL RMAL for further characterization. Outdoor soil samples will not be submitted for slit-scanning.

[a] Smears unacceptable to the CSL (if >5 mrad/h) will be screened in the field.

[b] Samples unacceptable for shipment to the off-site laboratory will be submitted to the ORNL RMAL for analysis. Any TLDs collected during site characterization will also be submitted to the ORNL RMAL.

5.8.1 Field Screening and Measurements

Radiological screening will be performed in the field for those smears with gross gamma activity exceeding the allowable 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.

Concrete cores (see Sect. 4.7.3) will be slit-scanned in the field before they are shipped to the off-site laboratory or ORNL RMAL for further characterization. The six subfloor soil samples, if extracted as a core by a Shelby tube rather than as bulk particulates by a hand auger, may also be slit-scanned (see Sect. 4.8) prior to shipment for further characterization. The five external soil samples (to be collected outside the D&D structures) will not be slit-scanned.

5.8.2 CSL Screening and Measurements

The CSL will be used to (1) analyze smears (see Sect. 4.1), (2) analyze grab air and air monitoring samples (see Sect. 4.11), (3) screen the external soil samples, (4) screen the miscellaneous grab samples collected from the bulk storage bins and water tank T-5, and (5) 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 (approximately 90) will be submitted to the CSL for the following radiological analyses:

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

Total gamma activity will be estimated from gamma spectroscopy results. Analysis for total radioactive strontium will generally be performed only on those smears with beta activity that cannot be significantly accounted for from the gamma spectroscopy results. Those smears with gross gamma activities that exceed the CSL allowed activity or exposure limit will be screened in the field.

Soil samples collected from outside the D&D structures, as well as miscellaneous grab samples from the bulk storage bins and water tank T-5, will be submitted to the CSL for radiological and VOC screening. If a positive VOC reading is obtained for the miscellaneous grab samples at the CSL, or if grab sample radiation is detected at levels significantly above background, these miscellaneous grab samples will be submitted under approval of the Technical Task Lead to the off-site laboratory or ORNL RMAL as appropriate for further radiological and chemical analyses. (Background levels are generally defined as gross alpha values <15 pCi/L for liquids and <10 pCi/g for solids, and gross beta values <30 pCi/L for liquids and <50 pCi/g for solids.)

5.8.3 Off-Site and ORNL 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.

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. The actual types of analyses performed at the ORNL RMAL will be determined by Energy Systems. In addition, ORNL will analyze TLDs, if any, in its dosimetry laboratory.

The subfloor soil samples, concrete cores, and most of the miscellaneous grab samples will be submitted for analyses to the off-site laboratory or the ORNL RMAL. All the submitted samples will receive radiological analyses, and a majority of the samples will also receive chemical analyses. The Technical Task Lead will determine during sampling those samples to receive chemical analyses.

Current planning assumes that the subfloor soil and concrete core samples collected from OHF "process" areas, where the potential for contamination is greatest, will receive chemical analyses (in addition to radiological analyses). These process areas include the valve pit, the pump room in the pump house, the three hot cells (i.e., the mixing cell, pump cell, and well cell), and the engine pad. The subfloor soil and concrete core samples collected from the control room will undergo radiological analyses only.

Current planning also assumes that in addition to radiological analyses, more than half of the miscellaneous grab samples submitted will receive chemical analyses; these samples will be selected by the Technical Task Lead taking into consideration such criteria as the field screening measurement results, presence of coatings or residues, evidence of suspected spills or leaks, and sample location.

Analytical methods for the OHF D&D samples are summarized in Table 5.2.

The proposed radiological analyses were selected on the basis of review of the OHF history and on prior site characterization activities (see Sect. 2.2). 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),
- uranium isotopics (U-232, U-233, U-235, U-234/-238),
- curium isotopics (Cm-242/243, Cm-244), and
- americium-241.

Table 5.2. Analytical methods for soil, concrete core, and miscellaneous grab samples

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
Curium isotopics (Cm-242/243, (Cm-244)	Radiochemical separation followed by alpha spectroscopy	EML AM-03	0.6 pCi/g, 1 pCi/L
Americium-241	Radiochemical separation followed by alpha spectroscopy	EML AM-03	0.6 pCi/g, 1 pCi/L
Plutonium isotopics (Pu-238, Pu-239/-240)	Radiochemical separation followed by alpha spectroscopy	EML Pu-02, Pu-10	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

Table 5.2 (Continued)

[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). Standard EPA methods do not exist for all radiological constituents and sample types (e.g., gross alpha/beta for soil samples). Laboratories therefore develop laboratory-specific SOPs that are based on appropriate or applicable methods.

[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).

Total gamma activity will be estimated from the gamma spectroscopy results.

In general, chemical analyses (EPA analytical support level IV) proposed for the off-site laboratory are

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

One exception is that VOC analyses will not be performed for concrete core samples obtained during site characterization. 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.

In some cases, sample volumes may be limited due to difficulty in sample collection or the availability of only small quantities of collectible material. Such limited sample volumes may be insufficient for the full suite of proposed radiological and chemical analyses. If the off-site laboratory cannot perform all the analyses requested because of limited volume, the priority of analyses will be (1) radiological, (2) TAL inorganics, (3) TCL SVOCs, (4) TCL pesticides/PCBs, and (5) TCL VOCs. This list of priorities is based on the past operational history of OHF and the nature of material processed in the D&D structures.

6. 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).

6.1 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.

6.1.1 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.

6.1.2 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.).

6.1.3 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 and contamination levels and their spatial distribution in a given area.

6.2 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. An isotope's 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.

6.3 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 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.

6.4 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.

7. PLANNING AND SCHEDULING

The basic elements of the OHF site characterization 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 procedures before they are given access to the site.

The planning phase begins as the SCP is being prepared. Initially, existing ORNL data such as pictures and personnel interviews are collected and reviewed. Procurement activities leading to the purchase of a robot will begin; there is a potentially long lead time associated with delivery of a robot, so procurement activities must proceed as soon as the specifications have been determined.

The walkdown survey will take place as soon as possible and involves inspecting the conditions in and around the facility to determine the method of entry and identify potential obstacles that may have an impact on the field investigation. The information from the survey is utilized to develop the plan. A new HWP will not be required to perform the walkdown survey for this location because it falls within the boundaries of WAG 5.

When the SCP is submitted, preparation of the FWGs will begin. Following completion of the FWGs, they will be reviewed internally, revised, and submitted to Energy Systems. Permit requests to be submitted to Energy Systems include HWPs to allow entry into the buildings, and excavation/penetration requests associated with the corehole drilling and soil sampling that must be approved prior to execution of these activities.

When the FWG is complete, the QAA/QAAP will be developed and reviewed. A QAA/QAAP meeting will be held to review all plans, followed by a Readiness Review Meeting. These meetings will take place prior to execution of field work.

Field investigation activities will begin with a radiation survey and inspection, the results of which will be documented by ES&H. The survey will be followed by the collection of smears, air samples, photographs, corehole samples, soil samples, and miscellaneous grab samples. Samples collected will generally be screened at the CSL and analyzed at the off-site laboratory or at the ORNL RMAL, depending on the level of contamination. Results from the radiation survey and the CSL screening will be reported in a technical bulletin soon after that information is collected.

Data analysis and calculations will begin as soon as data become available from the CSL and will continue for approximately two weeks following receipt of all results from the off-site laboratory and the ORNL RMAL. Preparation of the draft Site Characterization Report may begin as soon as ample information has been received from the off-site laboratories to begin analyzing the data. Completion of the draft should take approximately four weeks following receipt of all analytical results. The draft report will be review internally, revised, and submitted to Energy Systems/DOE for review. The schedule assumes a one-month draft review cycle, followed by a two-week draft revision. The final draft report will then be submitted to Energy Systems for a three-week second review cycle. Final revision is assumed to take two weeks following receipt of final comments from Energy Systems/DOE. A schedule/logic diagram of activities is shown in Fig. 7.1.

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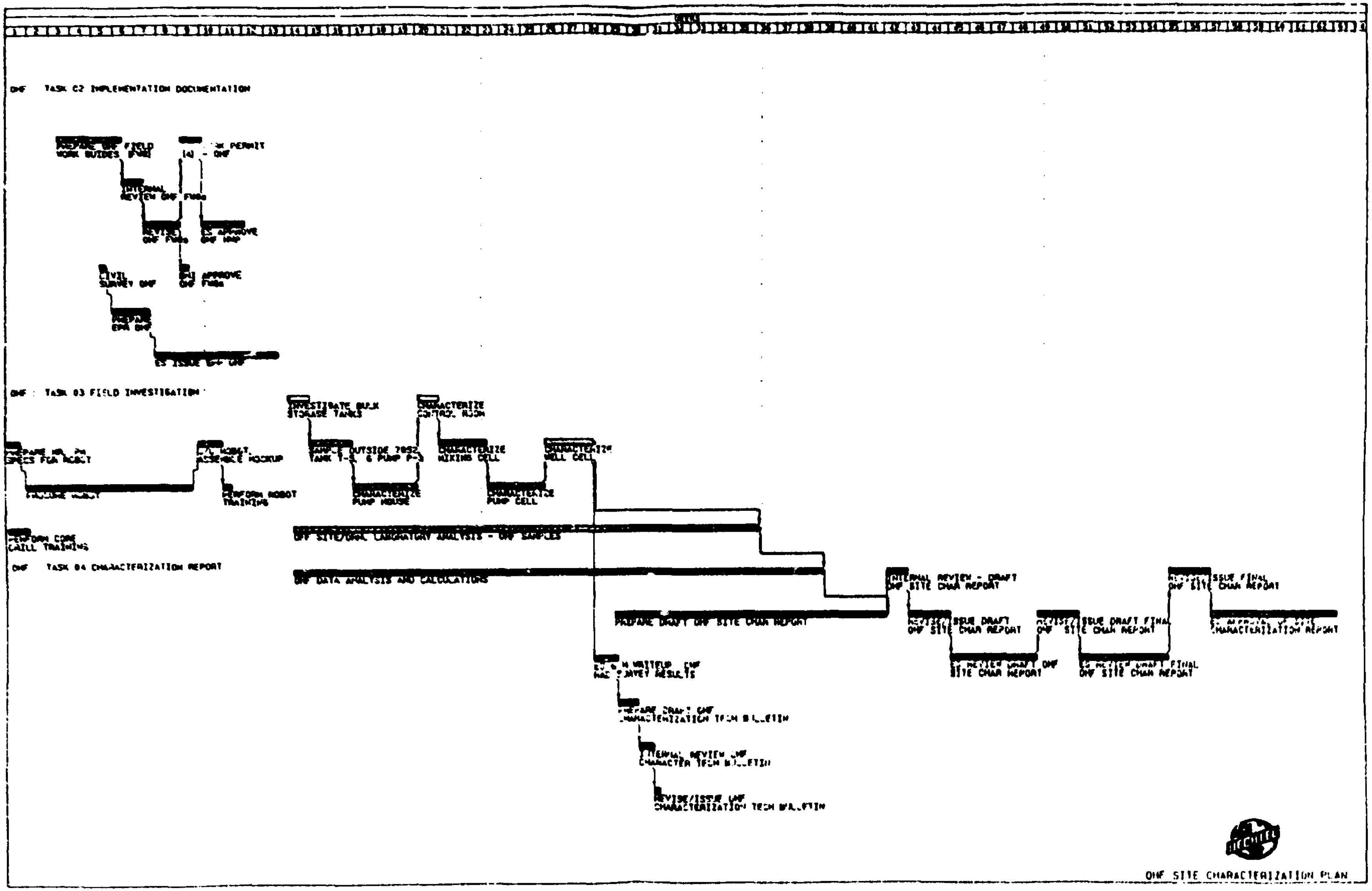

Figure 7.1. OHF characterization schedule.

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APPENDIX A

Hazard Analysis for the D&D Investigation of Old Hydrofracture Facility

A1. INTRODUCTION

The OHF facility and environs represent a unique challenge in safety and health protection requirements necessary for thorough characterization. The facility contains both high radiation and very high radiation areas in addition to known areas of very high radiological contamination.

Through ALARA planning and the use, where necessary, of remote technology, hazard exposure and the potential for release will be minimized.

A2. HAZARD ASSESSMENT

A2.1 EXTERNAL RADIATION EXPOSURE HAZARD

A2.1.1 Initial and Assumed Conditions

A variety of radiological surveys have been conducted in OHF since it became inactive. Those surveys are used as the basis of this assessment, and their results are included within other sections of this plan. The initial and assumed conditions are a summary of those past findings.

Building 7852 and the pump house remain in a highly contaminated state, and process equipment remains in these buildings. Available survey data for the building interiors indicate that the cells remain high radiation areas. Interviews with process and radiological controls personnel indicate that radiation exposure rates will be very high near some process equipment in the cells and pump house. General area exposure rates are known to be in the range of 75 mrad/h to >8 rad/h within the shielded areas of the facility. Hotspots and equipment may exhibit exposure rates in excess of 10 rad/h.

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

A2.1.2 External Radiation Exposure Controls

External radiation exposure will be controlled within administrative limits through the use of administrative, physical, and work task planning methods. In light of the anticipated high to very high radiation levels, alternative investigative techniques utilizing remote and semiremote technology are planned for areas where manned entry proves to be non-ALARA.

Initial entry will be semiremote, utilizing long reach instruments, probes, and tools to assess "as found" conditions. Where it is determined that general area radiation fields exceed 500 mR/h, manned entry will not be permitted and remote or semiremote methods will be used to accomplish mission objectives.

All areas within OHF have the potential for worker exposure to external radiation hazard. Building 7852 and the pump house represent a greater potential for worker exposure in excess of

ALARA goals. 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 nonpenetrating. Should initial conditions in excess of those listed be found during semiremote access of the building, no manned entry will be attempted and replanning for remote or other investigative methodology will be conducted. Should conditions permit manned entry, a combination of engineered controls (e.g., beta shielding of floors, and lead blanket temporary shielding of hotspots and equipment) and administrative controls (e.g., entry time limitations, conservative entry dose pull points, and area avoidance) 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.

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 (HWP). 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

The OHF mixing cell, pump cell, well cell, pump house, and valve alley are in a highly contaminated state. With some exceptions, all process equipment remains in the buildings. Survey data (previously presented in this plan) are available for these buildings. Interviews with process and radiological controls personnel indicate that contamination levels will be very high inside the cells. General area smearable contamination levels are in the range of 10,000 dpm/100 cm^2 to >100 mrad/h/100 cm^2. 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 cm^2.

The primary contaminants of concern are ^{90}Sr and ^{137}Cs. Known to have been present in the waste stream and tanks are ^{60}Co and $^{152/154/155}Eu$. Cobalt and the europium(s) have experienced significant decay since the termination of injection operations. Alpha-emitting radionuclides including ^{233}U, $^{238/239}Pu$, ^{244}Cm, ^{241}Am, $^{232/238}Th$, and ^{252}Cf were known components of the waste; however, survey results to date indicate that the alpha fraction of the loose surface contamination is quite low.

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.

A2.2.1 Internal Radiation Exposure Controls

The OHF cells are still maintained under negative pressure by local HEPA exhaust systems. Workers outside the cells are thus afforded a degree of engineered control against internal deposition. This in turn may be supplemented as necessary by local portable engineered controls (e.g., an air curtain at a cell access point) to improve environmental isolation. Cell entry will require combined administrative control and appropriate PPE to maintain potential exposures ALARA. Air monitoring by use of area sampler and breathing zone apparatus will be used to assess potential uptake. Initial planning will be based on maintaining worker inspired air at 10% of the DAC for ^{90}Sr (class Y). Should a radionuclide with a more restrictive DAC be discovered as a significant component of loose surface contamination, then planning will be modified to achieve 10% of the more restrictive DAC. In all cases the unity rule will apply to mixtures; however, initial planning will be based on ^{90}Sr as the sole component. 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 HWP. 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 concrete data are available concerning chemical contamination of OHF. 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—common process chemicals in fission product separations. Fly ash, portland cement, and high pH grout admixtures, as well as 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 2, 3, or 4 are anticipated as necessary and 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 HWP. 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

There are significant unknowns in terms of the soundness and condition of the external bin structures and the internal structures. With the exception of the bins, the main cell building is of substantial concrete construction and would be subject to minor deterioration since processes were halted. The cell building and pump house are known to have been 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, although this is qualitatively unlikely. 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 and above utilizes head, foot, and eye protection meeting or exceeding applicable ANSI standards.

The interior atmosphere of each building is of unknown composition; however, active ventilation systems are currently operating. The probability of an immediately dangerous to life or health atmosphere is qualitatively low. The OHF structures are considered permit-required confined spaces. Atmosphere testing using portable instruments is required, and initial penetration of cells or buildings will be in self-contained breathing apparatus unless 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 known electrical and stored energy hazards associated with these structures. Services are still active and all equipment will be considered as live.

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 HWP. 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

and

Contract-Required Quantitation Limits

for TCL VOCs, SVOCs, and Pesticides/PCBs

Contract Required Detection Limits (CRDLs) for TAL Inorganics

Metals	CRDLs* for Liquids (μg/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)

Volatiles	CAS Number	Quantitation Limits* Water ug/L	Low Soil ug/Kg	Med. Soil ug/Kg	On Column (ng)
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* Water ug/L	Low Soil ug/Kg	Med. Soil ug/Kg	On Column (ng)
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	606-20-2	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* Water ug/L	Low Soil ug/Kg	Med. Soil ug/Kg	On Column (ng)
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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