Decommissioning Plan
Battelle Memorial Institute Columbus Operations

DD-93-19
Revision 4

January 23, 2003
PLAN APPROVAL PAGE

Prepared By:

C. Jensen	*Date*
Functional Manager, Radiation Safety Officer	

This plan, DD-93-019, *Decommissioning Plan for the Battelle Memorial Institute Columbus Operations*, has been reviewed and approved by the following.

Approved By:

C. Jensen	*Date*
Functional Manager	
Radiation Safety Officer	

J. Poliziani	*Date*
Acting Radiological Technical Support Manager	

DRAFT
TABLE OF CONTENTS

Page

N. J. Gantos *Program Manager Decontamination & Decommissioning Project*	*Date*
M. Jackson *Independent Oversight*	*Date*
R. Friedman *Quality Engineering*	*Date*

TABLE OF CONTENTS

TABLE OF CONTENTS

Battelle Memorial Institute Columbus Operations Decommissioning Plan

1. General Information

Licensee Name: Battelle Memorial Institute
Licensee Address: 505 King Avenue, Columbus, OH 43201-2693
1425 Plain City - Georgesville Road, West Jefferson, OH 43162
License Number: U.S. Nuclear Regulatory Commission Radioactive Materials License SNM-7

On April 16, 1943, Battelle Memorial Institute, acting through what is now its Columbus Operations (BCO), entered into Contract No. W-7405-ENG-92 with the Manhattan Engineering District to perform atomic energy research and development (R&D) activities. From that time until 1988, BCO performed nuclear materials R&D work at these privately-owned facilities for the Manhattan Engineering District and its successor agencies – the Atomic Energy Commission (AEC), the Energy Research and Development Agency (ERDA), and the Department of Energy (DOE). BCO also performed commercial nuclear operations and work for other Federal agencies such as the Department of Defense (U.S. Air Force, U.S. Army, U.S. Navy) and the National Aeronautics and Space Agency Administration.

The BCO facilities, composed of 15 buildings and their associated grounds located at BCO's King Avenue Site, Columbus, Ohio, and West Jefferson North and South Sites, West Jefferson, Ohio, became partially radiologically contaminated as a result of the performance of such work. These facilities now require decontamination to original status (i.e., unrestricted use).

It has been agreed that DOE, as the successor to the AEC and the Government's earlier work, has predominant liability and responsibility for decontamination and decommissioning (D&D) of the BCO facilities. At the direction of the Assistant Secretary for Nuclear Energy (May 29, 1986 memorandum, Voight to Vaughan, approved by Vaughan, June 10, 1986), D&D of the BCO facilities described herein was accepted into DOE's Surplus Facilities Management Program as a major project, entitled the Battelle Columbus Laboratories Decommissioning Project (BCLDP).

Battelle also holds U.S. Nuclear Regulatory Commission (NRC) license number SNM-7. Battelle has continually operated in full compliance with this NRC license and plans to perform this decommissioning in compliance with NRC regulations. Accordingly, this decommissioning plan is being submitted to the NRC for review and approval. It does not constitute a declaration to terminate license number SNM-7. Battelle plans to continue to operate under the license conditions and to request renewal at the appropriate time.

2. Description of Planned Decommissioning Activities

2.1 Decommissioning Objective, Activities, Tasks, and Schedules

2.1.1 Need for Action

This Decommissioning Plan describes the planned D&D of fifteen buildings or portions thereof, and possibly underlying and/or adjacent soils, that became radioactively contaminated as a result of performance of work under the U.S. Government contract. The fifteen buildings were contaminated as a result of nuclear materials R&D activities conducted for the U.S. Government and commercial nuclear facility clients.[1,2] The Battelle-owned buildings are being decontaminated at this time to make them available for unrestricted use.

Nine of the buildings are located at Battelle's King Avenue site, Columbus, Ohio (Figure 2.1), and the remaining six buildings are located at Battelle's West Jefferson site, West Jefferson, Ohio (Figure 2.2). Portions of the King Avenue site have radioactively contaminated research facilities and equipment contained in buildings, which range in age from 30 to 60 years old, and are across the street from The Ohio State University. A moderate density residential area, the Olentangy River, and several commercial and industrial areas are within ½ mile of this site. The West Jefferson site consists of radioactively contaminated facilities, including a decommissioned reactor building, a chemical/nuclear laboratory, and a hot cell building that is highly contaminated. The D&D of the BCO facilities will enhance environmental quality and assure public health and safety.[3] Battelle will perform, manage, and/or integrate the necessary D&D activities in compliance with all applicable Federal, State, and local regulations. The Ohio Field Office of DOE shall maintain day-by-day operational cognizance of the D&D project.[4,5]

The NRC has reserved three statutory responsibilities:

- to conduct periodic inspections;
- to approve the release criteria used; and
- to certify the final releases.

The NRC has all rights of surveillance as agreed with DOE and Battelle[6] and as set forth in the SNM-7 license.

2.1.2 Objective

The overall objective of this D&D project is to return the fifteen contaminated buildings and surrounding grounds to Battelle, free from radiological restrictions (e.g., unrestricted release), at or below levels consistent with U.S. NRC[7] and DOE applicable requirements in a timely manner. These facilities are an integral part of the Battelle's ongoing R&D operations in Columbus. Several D&D alternatives were evaluated:

- Close Facilities and Continue Surveillance and Maintenance (S&M). This option involves leaving the facilities intact while continuing S&M[8], and activities that are directed at preventing radiation exposure to workers, the environment, and the public. Accordingly, closing the facilities and continuing S&M indefinitely does not remove radioactive material from the site in a timely manner. Therefore, it is not considered a feasible alternative for meeting the D&D objective of Battelle.

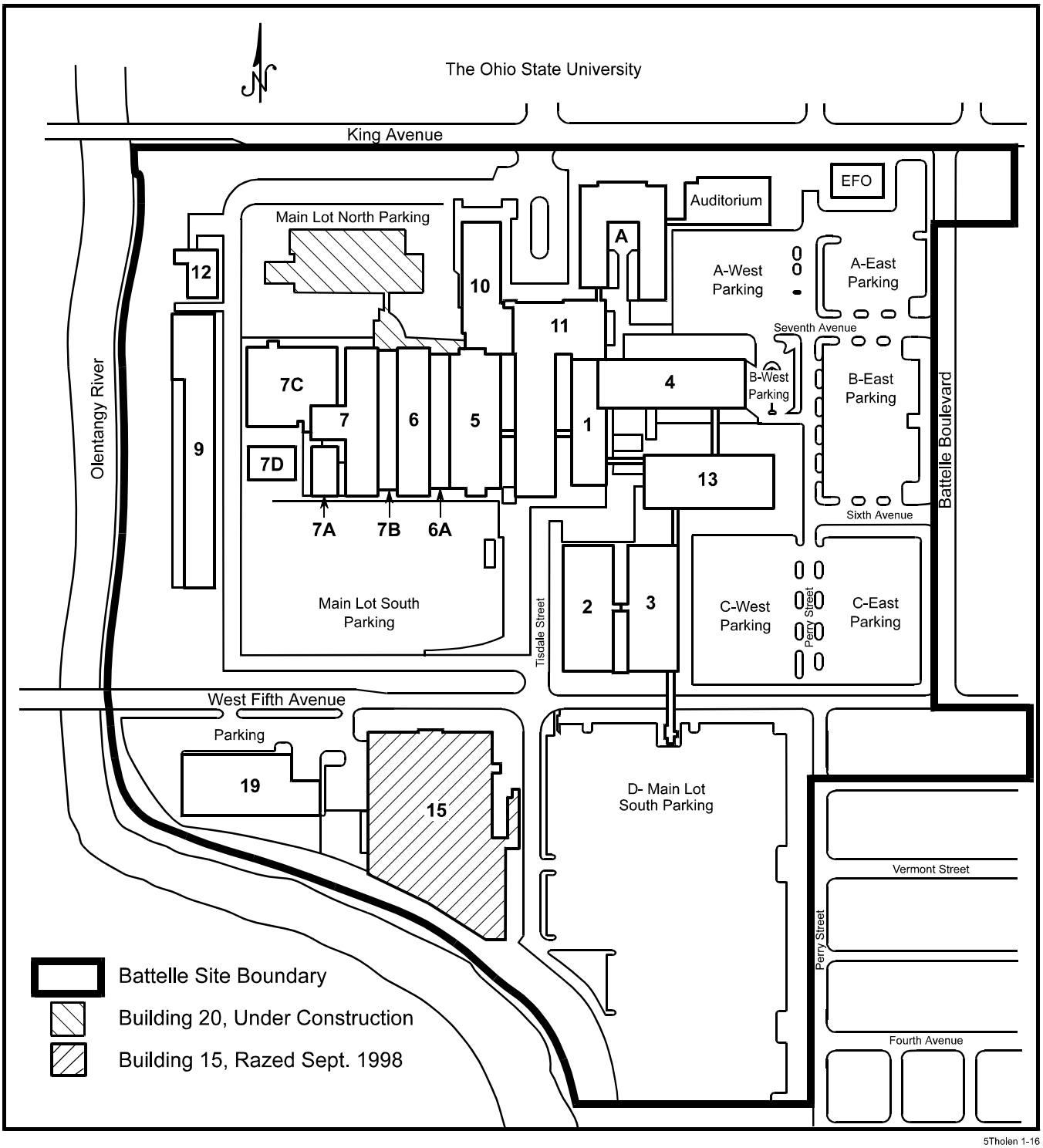

Figure 2.1
King Avenue Site

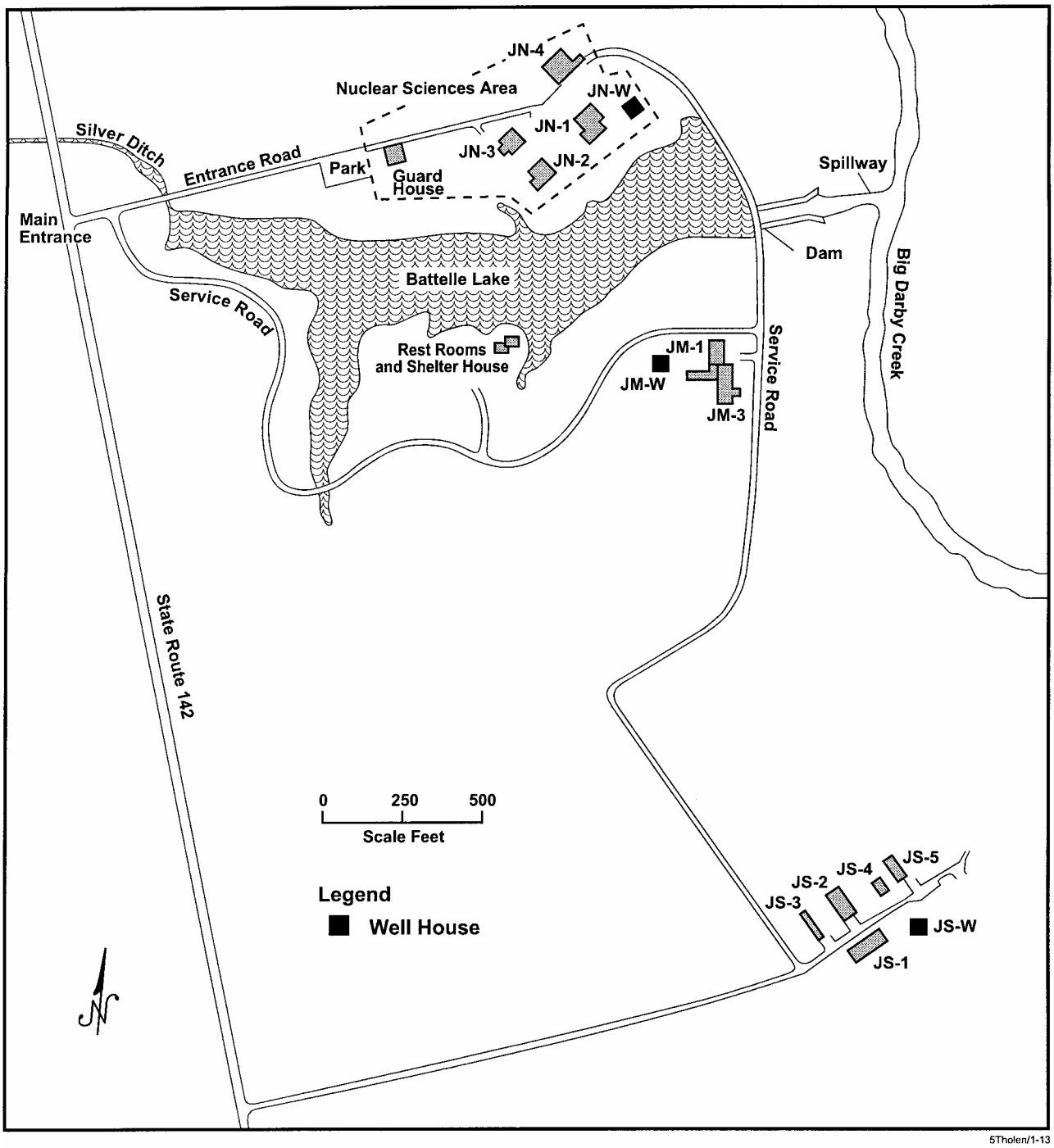

Figure 2.2
West Jefferson Site

- Close Facilities and No Further Action. The option of closing the facilities and doing nothing further is not appropriate for two reasons. First, it does not meet the objective of returning the facilities to use free from radiological restrictions, nor does it remove radiological material from the site. Second, the radioactive contamination remaining on site cannot be left unattended.
- Entombment. Entombment is the encasement of radioactive materials and components in a structure of concrete and steel. The structure must be sufficiently strong and long-lived to ensure retention of the radioactivity until it has decayed to levels that permit unrestricted use of the site. The entombment alternative is technically feasible, but it permanently precludes Battelle from using the affected facilities for alternative activities in pursuit of its business objectives. Because these facilities are an integral part of Battelle's R&D operations in Columbus, entombment is not considered to be a feasible alternative.
- Safe Storage Followed by Deferred Dismantlement. Safe storage involves activities required to place and maintain facilities in pursuit of its business that risk to public safety is within acceptable bounds and the facilities can be safely stored for as long as desired. This involves some facility and site preparation followed by a period of continuing care that includes security and S&M. Following the storage period, deferred dismantlement is initiated. Safe storage with deferred dismantlement is not the preferred decommissioning alternative for the BCO facilities because it involves long-term, i.e., higher total, radiation exposures (estimated to be six man-rem per year deriving from S&M activities during the safe storage period) and higher cost than immediate dismantlement. In addition, it delays returning the facilities to unrestricted use in a timely manner.
- Immediate Dismantlement/Decontamination. This decommissioning alternative involves D&D of all the facilities designated for decommissioning operations. This includes decontamination or removal from the involved facilities of all fluids, piping, equipment, components, structures, and waste having radioactivity levels greater than those permitted for unrestricted use of the property. This is the only alternative to meet the overall objective of the project to return the facilities to Battelle's use free from radiological restrictions, in a timely manner.

Based on an evaluation of alternatives within the overall objective of returning the affected facilities to unrestricted use, immediate dismantlement was selected with the following technical objectives:

- Meet the requirements of the NRC regulations.
- Decontaminate or remove and dispose of all contaminated equipment and the contaminated portions of the buildings and grounds at minimum costs consistent with safety, health, security, and environmental considerations in accordance with all applicable Federal, State, and local regulations.
- Perform the decommissioning operations in accordance with ALARA (as low as reasonably achievable) principles.
- Perform the technical decommissioning operations within the budget and time allocations.

To accomplish the overall objective, the proposed activities and tasks of the D&D project will include the following:

- Conduct pre- and post- D&D radiological characterization surveys of each building and the surrounding areas.[9,10]
- Remove spent fuel fragments or fines, special nuclear and source material, low level waste, transuranic (TRU) waste, by-product material, and hazardous material required to prepare buildings for D&D.
- Plan, engineer, and procure equipment for the D&D tasks.
- Continue S&M of the buildings and site during D&D.
- Perform and/or manage D&D of fifteen buildings and surrounding grounds, as necessary.
- Perform the necessary environmental, safety, and health support functions in compliance with applicable Federal, State, and local regulations.
- Develop appropriate release criteria for NRC approval.
- Package and transport all D&D waste to an appropriate storage or disposal facility.
- Contract for independent radiological release surveys by an independent verification contractor (IVC).
- Complete restoration, as required, of buildings for structural integrity or safety. Restoration activities occur on radiologically released or releasable facilities and grounds and are not included in the financial assurance cost basis.

The type of operations required to achieve the above listed objectives will vary among the buildings and the areas surrounding the buildings involved, depending on the nature of the previous radioactive material operations. The concept of ALARA dose rates for the workers is an important part of this technical objective. The details of the ALARA program are described in Section 3.2. The objectives will be achieved by utilizing a suitable mix of experienced Battelle staff and subcontractors. Subcontractor assistance is described in Section 2.5. Battelle has a core of staff experienced in nuclear facility operations, D&D operations, waste management, radiation protection, occupational safety and health, health physics, and environmental protection. When subcontractors are required, they will be selected based on applicable prior experience using competitive cost considerations. The number and type of subcontractors utilized will be based on the type of workers required. All workers will be trained to carry out the decommissioning operations in a safe and cost effective manner. Training is further described in Section 2.4.

2.1.2.1 Release Criteria for Unrestricted Use

The objective of the decommissioning project is to decontaminate areas such that they are available for unrestricted use (e.g., without radiological restrictions). In order to clearly define the objective, the BCLDP has prepared two technical basis documents.

- Surface Release Criteria Technical Basis Document, and
- Volumetric Release Criteria Technical Basis Document.

These two documents provide the quantitative values for decommissioning objectives and discuss their technical basis. The documents also address how the project objectives meet the applicable NRC criteria, as well as DOE criteria for unrestricted release. The documents are presented in Attachments 1 and 2. Implementation of the release process consistent with these technical basis documents is governed by procedures also presented in Attachments 1 and 2.

2.1.3 Description

This section provides a brief historical perspective, the contamination categories of buildings, and a description of the overall plan to accomplish the activities and tasks proposed for D&D of the fifteen BCO facilities. The current status of the King Avenue and West Jefferson facilities is described in Section 7.0.

2.1.3.1 Brief History of Battelle's Nuclear Activities

Nine of the buildings involved in the D&D project are located at the King Avenue site. The nuclear research performed in the nine buildings included processing and machining of enriched, natural, and depleted uranium and thorium for fuel element fabrication and other uses. Radio-tracer studies, radiochemical analyses, and powder metallurgy studies were also performed. In addition, secure vault storage for accountable nuclear material was provided in one of the buildings.

The remaining six buildings are located at the West Jefferson research site in two areas: (1) the Engineering Area in the southeastern portion, and (2) the Nuclear Sciences Area in the northern portion.

The oldest and most contaminated building in the Nuclear Sciences Area is the Hot Cell Building (JN-1). This building began operation in 1955 and was used until 1988 for nuclear research studies. Work conducted there included evaluations of both power and research reactor fuels; post-irradiation examination of fissile, control rod, source, and structural materials and components; and examination of irradiation surveillance capsules. In addition, the facility has been the site of radiation source encapsulation and physical and mechanical property studies of irradiated materials and structures.

The two other buildings at the Nuclear Sciences Area are the former Critical Assembly Laboratory (JN-2) and the partially dismantled Research Reactor Building (JN-3). Both of these buildings are significantly less contaminated than the Hot Cell Building. The former Critical Assembly Laboratory was originally used for reactor critical assembly experiments, direct energy conversion experiments, experiment assembly, special nuclear materials handling, and plutonium research activities. Active nuclear experimentation in this building was terminated in 1970. A small Plutonium Laboratory previously located in this building was decontaminated and converted into the current Radioanalytical Laboratory. This building also contains administration offices and a former special nuclear materials vault.

The Battelle Research Reactor (BRR) was actively used from 1956 until 1974. It was then partially dismantled. The fuel, pool liner and core hardware were removed and most of the

building was decontaminated. The BRR license was then changed to a possession only license under SNM-7. Since then, it has been used for short-term waste storage and office areas.

The three buildings (JS-1, JS-10, and JS-12) at the Engineering Area, (where D&D was completed in 1990) were used for fuel element fabrication and ballistics studies. The Hot Isostatic Pressure Bonding Facility (JS-1) was used to fabricate military reactor fuel elements using the hot isostatic pressure fabrication technique. The other two buildings (JS-10, JS-12) were used for studies involving explosive forming and bonding techniques, and for ballistic studies using nuclear materials. These three facilities were never operated under the NRC license. They were independently verified, and returned to BCO for unrestricted use.

Section 3.1 provides more detailed radiological history information.

2.1.3.2 Assessment of Contamination Levels

The facilities undergoing D&D can be placed in three categories based on the history of operations and the levels of contamination present:

Category 1 – widely contaminated with low radioactivity levels;
Category 2 – high radiation fields and extensive contamination in hot cell areas and lower levels of contamination in operating areas; and
Category 3 – low-level contamination of isolated sections in otherwise uncontaminated facilities.

The building categories are shown in Table 2.1. Contamination levels and isotopes are shown in Table 3.1. Note that all fissile material, other than small laboratory samples or standards, has been removed from the Battelle sites.

Category 1. Category 1 defines contamination levels that vary from low to moderately high and that are widespread throughout the building. The buildings in this category are contaminated above background levels over wide areas of floors, walls, and ceilings and contain contaminated equipment. Four buildings (KA-1, KA-2, KA-3, and JN-3) have this level of contamination. A typical example of such a contaminated building is shown in Figure 2.3. Decontaminating this category of building will potentially require isolation of the building prior to initiation of operations. Only limited and controlled non-nuclear operations are now conducted in these buildings. All of the operations unrelated to decommissioning will be relocated and uncontaminated equipment will be surveyed and removed from the facility prior to decommissioning.

Category 2. Category 2 is the Hot Cell Facility, Building JN-1. This is the only Category 2 building to be decommissioned. The operating cells of this building have high radiation fields and extensive contamination on the ceilings, walls, and floors. The equipment inside the cells is also highly contaminated. Other areas in the building have low levels of contamination. Decommissioning of this building's hot cells will require some remote operations and extensive radiation protection precautions. Figure 2.4 shows the floor plan of this building.

Category 3. Category 3 includes buildings KA-A, KA-4, KA-5, KA-6, KA-7, KA-9, JS-1, JS-10, JS-12, and JN-2, which are only partially contaminated and most of the contamination is fixed.

Table 2.1
Battelle Buildings to be Decommissioned
Listed by Category of Contamination

	Building Number	Category[a]
King Avenue Site	Building KA-A	3
	Building KA-1	1
	Building KA-2	1
	Building KA-3	1
	Building KA-4	3
	Building KA-5	3
	Building KA-6	3
	Building KA-7	3
	Building KA-9	3
West Jefferson Site	Building JN-1	2
	Building JN-2	3
	Building JN-3	1
	Building JS-1[b]	3
	Building JS-10[b]	3
	Building JS-12[b]	3

[a] Category 1: Contamination level varies from low to moderately high and is widespread throughout the building.

Category 2: Highly contaminated in hot cells; low to moderate contamination in other work areas.

Category 3: Generally low contamination levels in small number of rooms.

[b] Buildings KA-9, JS-1, JS-10, and JS-12 have been completed.

Buildings JS-1, JS-10, JS-12, and KA-9 have been completed. Only controlled, non-nuclear research programs are currently being conducted in some areas of the Category 3 buildings adjacent to areas scheduled for decommissioning. Proposed decommissioning activities within or for these buildings include isolation of the areas to be decommissioned, and establishment of access control and administrative procedures to prevent the spread of contamination during decommissioning. A typical example of a Category 3 building is shown in Figure 2.5.

2.1.3.3 Planning and Assessment

Planning includes the preparation of project planning documents that will control and guide the decommissioning operations, preparation of documents to meet regulatory and institutional requirements, preparation of cost schedule and technical baseline estimates for the decommissioning operations, site characterization, the site, and performance of operations in preparation for decontamination. The Revised Current Year Work Plan is updated each year to plan the buildings or areas that will be remediated during the successive year. The review process that is completed before work begins in any building or area is described in Section 7 of this plan.

The **Site Characterization Plan (SCP)**[11] provides guidance for radiological characterization of buildings and the grounds surrounding the buildings to be decommissioned. The SCP sets forth the procedures for a detailed characterization. It includes the following subjects:

- Survey and Sampling Plan
  - Sampling approach for areas within, under, and around buildings
  - Sample analyses
  - Reporting procedures
- Responsibility for Site Characterization.

The **Area or Building Characterization Report** includes radiological and chemical survey data, prior to decontamination. It will be prepared for each building or area to be decontaminated. Upon completion of the final status survey, each area or building, including areas not decommissioned, will have a Final Status Report produced that documents residual radioactivity levels. Each area will also require an independent verification survey to confirm that release criteria have been met.

Surveillance and Maintenance operations are performed prior to, during, and after decontamination to assure that the contamination in the fifteen buildings remains controlled and is not inadvertently spread. S&M activities include:

- Environmental Monitoring – An environmental monitoring program is required to assure that radioactive contamination has not escaped to the surrounding environment. The environmental monitoring includes collection and analysis of water, air, soil, vegetation, agricultural crop, and sedimentation samples from areas surrounding the Battelle facilities.[12]
- Facility Surveillance and Maintenance – This includes regularly scheduled inspection and maintenance of health, safety, and radiation protection equipment and instrumentation. A detailed schedule of inspection and maintenance is followed. All S&M activities are conducted under an established nuclear quality assurance program. Emergency planning, training, and drills are also conducted as part of

Figure 2.3
Example of Category 1 Building

Figure 2.4
Example of Category 2 Building

Figure 2.5
Example of Category 3 Building

S&M.[13] Repair and replacement of equipment, air and water filtration, and clean-up of equipment are performed as required.

- Operational Health Physics – A program of health physics radiation monitoring is conducted, including training of site personnel, posting of contaminated areas, a detailed schedule of health physics surveillance monitoring, and personnel dosimetry. The health physics program is described in Section 3.3.

2.1.3.4 Decommissioning Operations

The sequence of D&D operations described in the following sections is based on the radiological survey information obtained at termination of research activities. This general sequence will be defined specifically in the individual building D&D plans as detailed radiological characterization information becomes available for each building. Each plan will describe the sequence of operations in predecessor-successor logic. The actual decontamination methods to be used and the rationale for selection, waste management, and other support functions will be described and schedules for completion of the work will be provided. More specific procedures and work instructions are developed for each task within the buildings (see Attachment 3). All of these documents are prepared and controlled according to QD-AP-5.1, "Preparation of Procedures"[14], QD-AP-5.2, "Work Instructions"[15], and QD-AP-6.1, "Document Control"[16], which conform to NRC requirements for preparation, management, and approval. Independent assessments are described in QD-AP-18.1[17] and QD-AP-18.2[18].

2.1.3.4.1 Category 1: Sequence of D&D Operations

The proposed general sequence of operations for decommissioning Category 1 buildings is as follows:

(1) Relocate the staff and non-nuclear operations from the building.
(2) Survey and remove uncontaminated items including office furniture and laboratory equipment from the building.
(3) Perform a detailed radiological and chemical survey of the building and the equipment in the building to identify contaminated areas and equipment. This information will be used to select the appropriate decontamination procedures for specific areas.
(4) Prepare a staging area for handling and packaging contaminated equipment and waste removed during the decommissioning operations.
(5) Remove contaminated furniture and equipment. Decontamination will be performed or the equipment will be disposed of as radioactive waste.
(6) Design and install access control areas including change rooms and showers as required.
(7) Seal all drains, vents, and other openings from the contaminated rooms to prevent the release of radioactive material during decommissioning operations.
(8) Remove exposed and contaminated plumbing, hoods, ducts, and electric equipment (including surface conduits and hanging lights) and dispose of as radioactive waste.
(9) Decontaminate the ceilings, floors, and walls using detailed decontamination procedures as prepared based on information from the radiological characterization surveys. The principal decontamination method will be wiping

and vacuuming and/or removal of surface layers from the ceilings, walls, and floors. Isolation will be provided to control the spread of contamination, as well as the use of dust and liquid collection equipment.

(10) Characterize and clean or remove all sumps, vertical and horizontal drain lines, and sewer lines.

(11) Perform interim radiological and chemical surveys to determine the depth to which material must be removed to achieve complete decontamination consistent with the release criteria and the release procedure.

(12) Perform a final status survey, including any building areas not covered in the D&D plan. Notify DOE that the building is ready for an independent verification survey when the radiological survey indicates that the building has been successfully decontaminated and the waste removed. The IVC who will perform an independent confirmatory survey is Oak Ridge Institute of Science and Education (ORISE).

(13) Restore the building when the building is certified for unrestricted use, free from radiological restriction. The restoration operations do not constitute a radiological hazard to the workers or the public.

2.1.3.4.2 Category 2: Sequence of D&D Operations

The Hot Cell Building (JN-1) has been operated as a "closed system" with respect to release to the environment. Thus, all radioactive materials handled and processed in the building and the associated waste generated were retained in the building. The "closed system" feature will be maintained during the decommissioning operations. The following is the general sequence of decommissioning operations:

(1) Continue the current, complete environmental monitoring procedures including sampling of air, water, and soil throughout the decommissioning operations.

(2) Prepare a staging area for handling and packaging low-level contaminated equipment and waste removed during the decommissioning operations. High-level waste and transuranic waste will be packaged in the hot cell.

(3) Remove all storage racks and other underwater equipment in the fuel storage pool. Volume reduce the racks and equipment and dispose as waste.

(4) Clean the pool wall and floor surfaces with underwater vacuum cleaners.

(5) Reduce the volume of water in the pool using a water evaporation system. Dispose of the sludge residue by solidification.

(6) Remove all equipment and fixtures in the cells and in other contamination control areas of the building. Dispose of all waste generated.

(7) Remotely remove surface contamination from the inner walls of the hot cells to reduce the radiation field to a level that will permit entry by workers using the principles of ALARA.

(8) Dispose of all waste generated by the remote cleaning operations in the cells.

(9) Dismantle the hot cell rooms using methods that may include cutting, concrete breakers, core drilling, and other appropriate demolition methods. For these operations a separate exhaust system from the building may be installed. It will use high efficiency particulate air (HEPA) filters to restrict the release of radioactive material to within regulatory limits.

(10) Remediate sumps, vertical and horizontal drain lines, and sewer lines.

(11) Dispose of the waste from the cell dismantling operations.
(12) Clean the remaining rooms in the building using vacuum cleaning, wiping, and scabbling methods as required.
(13) Perform a final status survey of the entire facility and then notify DOE that the building is ready for an IVC survey when the radiological survey indicates that the building has been successfully decontaminated and the waste removed.
(14) Restore the building as required when a building is certified for unrestricted release for use without radiological restriction. The restoration operations do not constitute a radiological hazard to the workers or the public.

2.1.3.4.3 Category 3: Sequence of D&D Operations

The primary concern during decommissioning operations in Category 3 buildings will be to initially isolate the contaminated areas and prevent the spread of contamination to clean areas. The following is the general sequence of operations proposed for decommissioning Category 3 buildings:

(1) Relocate any staff and/or non-nuclear operations from the areas to be decontaminated.
(2) Relocate or isolate all activities from the clean areas adjacent to or near the contaminated areas.
(3) Establish access control areas near the contaminated areas. The access control areas will provide for change rooms and showers as required.
(4) Survey and remove uncontaminated items including office furniture and laboratory equipment.
(5) Perform detailed radiological surveys of the contaminated areas and the equipment in those areas. This will assist in preparing the specific decontamination procedures for specific areas.
(6) Prepare a staging area for handling and packaging contaminated equipment and waste removed during the decommissioning operations.
(7) Remove contaminated furniture and equipment. Decontaminate at a suitable location or dispose of as radioactive waste as deemed appropriate.
(8) Seal all drains, vents, and other openings from the contaminated areas to prevent the release of radioactive material during decommissioning operations.
(9) Remove exposed and contaminated plumbing, hoods, ducts, and electric equipment (including surface conduits and hanging lights) and dispose of as radioactive waste.
(10) Decontaminate the ceilings, floors, and walls, and using detailed procedures and using information obtained from the radiological surveys. The principal decontamination method will be vacuum cleaning, wiping, and removal of the surface layers from the ceilings, walls, and floors. Care will be taken to control the spread of contamination by isolation and use of dust and liquid collection equipment.
(11) Remediate sumps, vertical and horizontal drain lines, and sewer lines by decontamination or removal.
(12) Perform interim radiological surveys to determine the progress and depth to which material must be removed to achieve complete decontamination.

(13) Perform a final status survey, including areas of the building not covered in the D&D plan, and then notify DOE that the building is ready for an IVC survey when the radiological survey indicates that the area has been successfully decontaminated and the waste has been removed.
(14) Restore the building as required when the area is certified for unrestricted release, for use without radiological restrictions. The restoration operations do not constitute a radiological hazard to the workers or the public.

2.1.3.4.4 Soil Contamination

The soils near or under the buildings may be contaminated. The ground near and under the buildings, especially along buried sewer lines, will be surveyed to determine the presence of radioactive contamination greater than naturally occurring for the vicinity. All soil found to be contaminated above background will be evaluated to determine the appropriate remedial action consistent with the NRC-approved release criteria. Such action could include leaving the soil undisturbed, using in situ remediation, providing appropriate cover, or removal and shipment to a burial site. The areas affected by the soil removal will be restored as appropriate.

2.1.3.5 Environmental Safety and Assessment

Key environmental safety and health aspects of the D&D project have been assessed in the Environmental Assessment and Finding of No Significant Impact[3]. In this assessment, the potential for radiological exposure, impacts on human health and the environment, and non-radiological impacts such as chemical, physical, biological, and socioeconomic impacts focusing on transportation and employment have been considered in detail.

Estimates of potential exposures that may be experienced by D&D workers, Battelle staff, or the public were derived based on information available about the source term. The results showed that under normal operations, the exposure rates in all D&D areas will be well below the appropriate guidelines.[19,20,21] Even under accident conditions where all mitigative measures become inoperable, the estimated exposure was three orders of magnitude and five orders of magnitude below these guidelines for West Jefferson and King Avenue, respectively.

Additionally, other "worst case" scenarios were considered for release of radionuclides to the environment. Again, the conclusion was that such releases were extremely unlikely and that the environmental consequences of any release were insignificant. An ALARA policy has been adopted by Battelle for this project. In order to maintain doses as low as reasonably achievable, all preventive, administrative, and protective measures will be employed to the maximum practical extent. Additionally, monitoring of exposure rates, airborne concentrations, and surface contamination will be maintained in the work area, adjacent areas, and peripheral areas to evaluate the effectiveness of contamination controls and to detect and map trends. Such preventive and mitigative measures will also prevent and control contamination transported by air movement, as well as by other transfer vectors. Preventative measures to control airborne contamination include:

- Enclosure and isolation of the work areas
- Control of traffic and movement of equipment and materials in and out of the work area enclosure

- Ventilation of the work area to maintain a negative pressure with respect to surrounding areas and capture and remove a major portion of the aerosols from the exhausted air stream with standard HEPA filters
- Change areas for workers in the staging area
- Continuous monitoring and sampling of the air in the D&D areas and in the exhaust stream
- Use of personal dosimeters and breathing zone air samplers
- Use of local exhaust pick up for decontamination procedures such as certain kinds of abrasive blasting, scabbling, drilling, and spalling
- Use of a fine water spray to reduce the amount of dust that becomes airborne
- Use of remote manipulators in the decontamination process in the Hot Cells Laboratory
- Use of approved containers for waste transfers.

Decommissioning will be accomplished as described above to reduce risks and proceed in a safe manner.

2.1.4 Procedures

Battelle will conduct the decommissioning activities and tasks in accordance with approved procedures that satisfy the elements outlined in QD-AP-5.1, "Preparation of Procedures"; QD-AP-5.2, "Work Instructions"; QD-AP-6.1, "Document Control"; and the Quality Manual for the BCLDP. Second tier documents are prepared for each building for example, QAP-4.1,[22] QAP-7.1,[23] or QAP-11.0.[24] A quality plan may be incorporated into specific work plans as allowed by QD-AP-2.2[25], "Quality Planning." Third tier quality assurance is described in documents QD-AP-2.1 through QD-AP-19.1.

Administrative procedures, operating procedures, detailed technical procedures, work instructions, and work permits are used to control activities in the conduct of D&D operations. Examples of processes to be controlled are:

- Welding, cutting, and brazing
- Non-destructive examinations
- Chemical cleaning
- Grit and sandblasting
- Chipping and scabbling
- Concrete cutting
- Demolition processes
- Packaging radioactive wastes
- Packaging other wastes (non-radioactive).

Individual procedures have been developed and approved for controlling each process and/or special process. They include:

- Applicable codes, standards, and specifications
- Definition of responsibility
- Prerequisites including qualification and certification requirements
- Sequence of operations
- Acceptance criteria
- Record keeping requirements.

The procedures needed have been identified for the project and developed by the designated project staff. Documents are prepared in accordance with the quality procedures noted above. Documents are prepared and revised by task members, task leaders, technical personnel, and project management. All documents will be approved by Document Control and project management prior to release for use. The current index of project procedures/plans is included as Attachment 3.

2.1.4.1 Document Control

All procedures are controlled as described in QD-AP-6.1[16], "Document Control." The review, comment, revision, and approval process for the procedures is documented. Document Control assigns the approvals needed for controlled documents. These documents require at least two approvals in addition to that of the originator before implementation. They also require approval by Quality Engineering and Independent Oversight .

Project Records retains the original copy of the approval page, and is responsible for issuing copies of new and/or revised procedures to individuals designated by Project Management to receive them. Project Records maintains logs of document distribution. Project Records also publishes a monthly log of all active project procedures indicating their revision status and date of issue. This is distributed to predetermined, responsible personnel. All project personnel are required to have an approved procedure before work is started and to assure that they have the proper version of the document. All project personnel working with a Work Instruction (WI) are required to read and document by signature that they understand the WI being performed. For more critical procedures, they must demonstrate proficiency.

Methods for document revision and accomplishing activities under approved, temporary procedures are specified in QD-AP-5.1.[14] Advance copy procedures are issued for sixty days, but may be extended another thirty days. After the thirty-day extension, the Advance Copy expires and must be incorporated into an existing or new procedure. The Training and Records Coordinator is responsible for assuring that the advanced copy is terminated or incorporated into an existing or new procedure.

2.1.5 Schedules

Decommissioning activities for the Battelle nuclear facilities began in June 1988 with the initiation of planning and assessment.

Figure 2.6 shows the baseline schedule for decommissioning each of the remaining eleven buildings and the associated soils. Development of more detailed building-specific milestones is part of the D&D planning and Readiness Review process for the individual building. Buildings JS-1, JS-10, JS-12, KA-9, and KA-3 have been decommissioned. Each of the remaining eleven buildings will be decommissioned independently of one another. As shown in the project schedule (Figure 2.6), the activities for each building will be parallel. Figure 2.6 indicates that the critical path for the decommissioning activities runs through completion of the building that will require the most time, Building JN-1. Specific activities and milestones for decommissioning this building, as well as the other ten buildings, are being planned as part of the building-specific D&D/Readiness Review plans. Due to the nature of these buildings, and available funding, the D&D has been scheduled through 2005.

The current status of each of the buildings at the West Jefferson North site is described in Section 7.0 of this document.

2.2 Decommissioning Organization and Responsibilities

DOE has the lead responsibility for day-to-day management of this federally funded project. The NRC has responsibility for conducting periodic inspections; approving this Decommissioning Plan, the Financial/Assurance Plan, and the release criteria; and certifying the facilities for release. These D&D activities will be conducted and/or managed by Battelle under contract to DOE through its Ohio Field Office. The D&D project is referred to as the BCLDP. Battelle will function as the decommissioning operations contractor and will be responsible for all decommissioning operations, including procurement of appropriate subcontractors and integration of work performed. Battelle has the ultimate responsibility for complying with all the environmental, safety and health requirements of the U.S. NRC license SNM-7. The DOE organization chart showing the lines of authority and responsibility for the project is presented in Figure 2.7.

2.2.1 Department of Energy – Ohio Field Office

The DOE Project Manager (on site) is responsible for DOE oversight and field management of the BCLDP. As the DOE Contracting Officer's Technical Representative, he has technical and programmatic authority for overall project implementation. The DOE Contracting Officer is responsible for contract administration.

2.2.2 Decommissioning Operations

Battelle will manage, integrate, perform, and subcontract the decommissioning operations, as necessary, to ensure that all activities are performed within the requirements for occupational, radiological, and industrial safety; environmental protection; site security; cost and schedule baselines; and the technical objectives of the project, including the approved release criteria. Battelle activities will include preparation of detailed work procedures, engineering and design functions, decommissioning activities, property and waste disposal functions, and transportation of packaged waste material to a remote disposal site. In addition, Battelle will be responsible for all on-site work performance, including that of subcontractors. After the completion of decommissioning activities, a final status survey of all areas will be conducted to verify that

Figure 2.6
Baseline Decommissioning Schedule for BCLDP

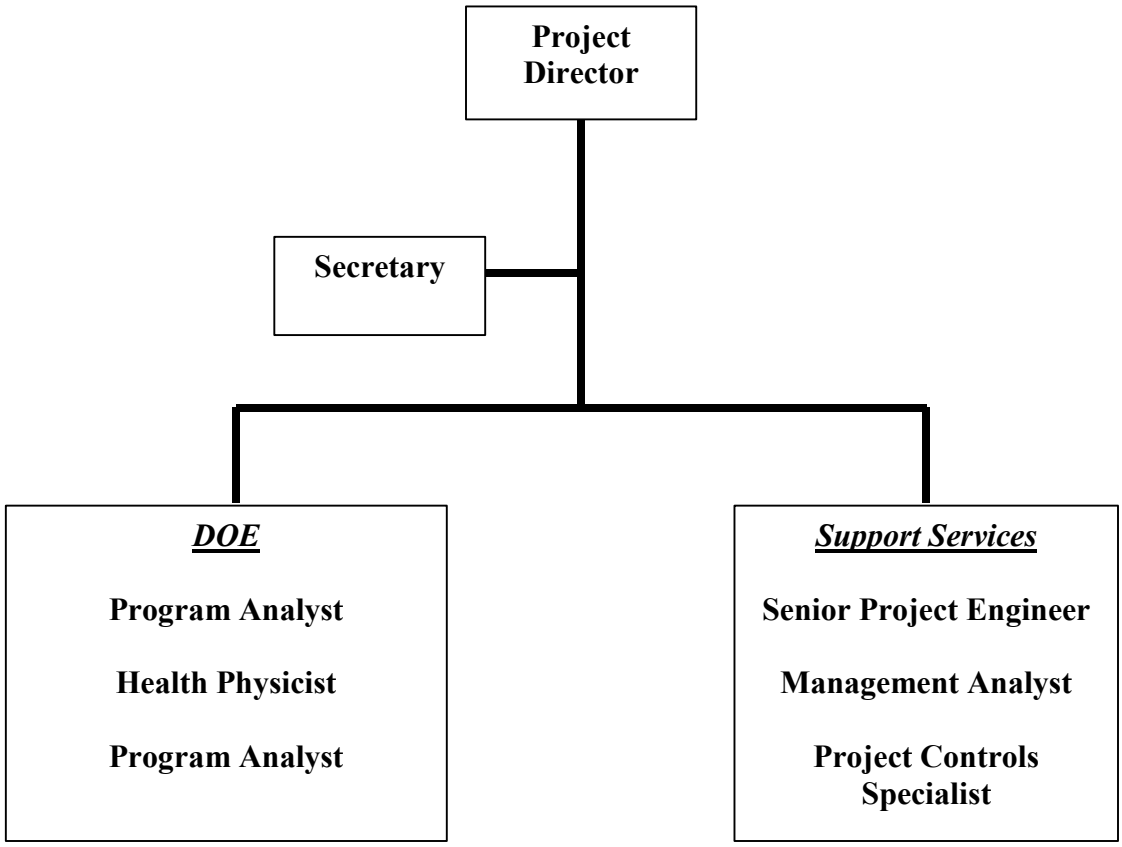

Figure 2.7
DOE Organization Chart for the BCLDP

decontamination is complete and that the facilities may be released without restriction. DOE will be notified and an IVC survey will be performed by ORISE under a contract with DOE-Headquarters (HQ) to verify that decommissioned facilities are suitable for release without radiological restrictions. A certification package will then be submitted to the NRC for its review and final certification of facility release.

The project is managed by the Decontamination and Decommissioning Operations (DDO) Program Manager for the BCLDP, who ultimately reports to the Chief Executive Officer (CEO) of Battelle Memorial Institute. The DDO Program Manager is responsible for the safe completion of the decommissioning effort at both the King Avenue and the West Jefferson sites. Reporting to the DDO Program Manager are the Deputy Program Manager, Operations Manager, Health, Safety, and Environmental Affairs (HSEA) Manager, and the Independent Oversight Manager.

The organization chart for the BCLDP is provided in Figure 2.8. The positions shown in the chart are filled by Battelle staff or subcontractor staff, as needed, to ensure safe D&D operations. Battelle currently has dedicated staff assigned to the BCLDP who have a wide breadth of knowledge of nuclear and non-nuclear safety and well-tested abilities to identify and solve safety problems.

The CEO has assigned the duty to verify compliance with applicable Federal, State, and local regulations to Battelle's Vice President of Environment, Safety, Health and Quality (ESH&Q). The BCLDP Site Radiation Safety Officer (RSO) is appointed by the Battelle Vice President of ESH&Q and the DDO Program Manager in consultation with the BCO RSO, is responsible for and performs the day-to-day implementation of and maintains compliance with the Radiation Protection Program (RPP) and serves as the BCLDP interface with the NRC, i.e., all of the responsibilities formerly assigned to the RSO, with the exception of oversight activities.

The HSEA Manager/Site RSO verifies that the requirements of the radioactive materials license and the radiation protection program are implemented completely. The HSEA Manager/Site RSO has assigned the day-to-day duties as described in the license and the Radiation Protection Program[26] to the Radiological Field Operations Manager (RFOM) and the Radiological Technical Support Manager (RTSM). The BCO RSO has the responsibility and authority to order the cessation or modification of any activities believed to constitute a substantial safety hazard or involve an unacceptable potential for such hazard. The BCO RSO also provides oversight to BCLDP in matters concerning license conditions and the quarterly review of segments of the radiation protection program. The BCO RSO and Site RSO will communicate frequently and maintain such records as are deemed necessary to conduct their operations. The BCO RSO position is filled by an employee of Battelle and may not be filled by a contractor. Qualifications for the BCO RSO are:

- A Bachelor's degree in one of the physical sciences, biological sciences, or engineering disciplines;
- A minimum of five years experience in operational health physics;
- Eligibility for certification by the American Board of Health Physics;

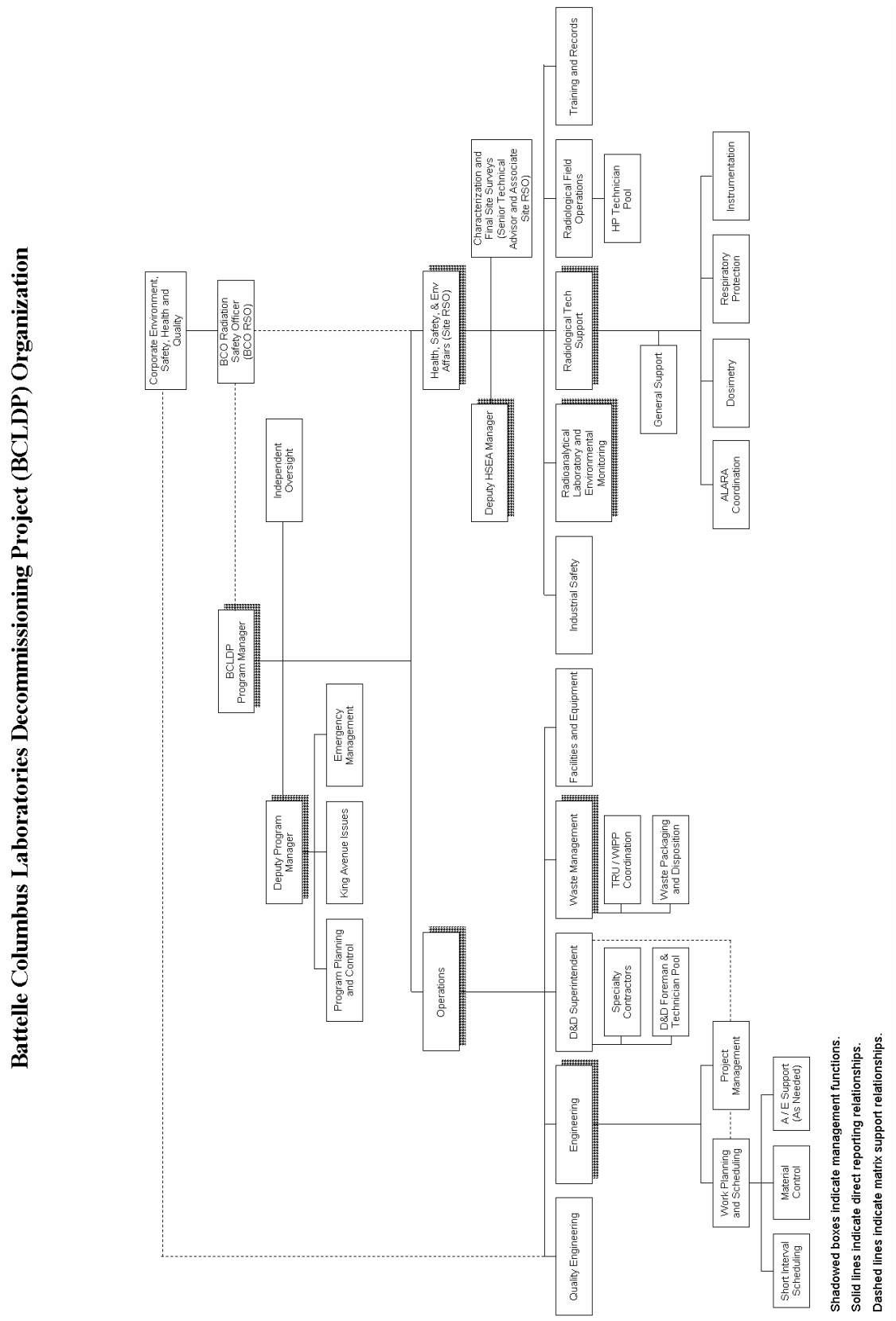

Figure 2.8
BCLDP Organizational Chart

- Demonstration of judgment and technical capability sufficient to conduct and review radiological safety operations
- Demonstrable management experience to apply practical experience to the operation of a radiation protection program.

The Operations Manager is responsible for deconstruction of buildings, environmental remediation of external areas, and waste management. The qualifications for the Operations Manager include:

- A Bachelor's degree in one of the physical sciences, biological sciences, or engineering disciplines
- A minimum of ten years experience in engineering or related disciplines.

The HSEA Manager is responsible for radiation protection, safety, environmental protection support, radioanalytical laboratory, records and training support, and characterization operations. In addition, the HSEA Manager serves as the Site RSO, implementing all of the functions formerly performed by the RSO, i.e., compliance, with the exception of RPP oversight activities. Site RSO functions are delineated elsewhere in this document and in the RPP Plan, DD-90-02. Minimum qualifications include:

- A Bachelor's degree in one of the physical sciences, biological sciences, or engineering disciplines
- A minimum of ten years experience in engineering or related disciplines with substantial experience on D&D-related projects
- Certification as a Certified Health Physicist.

The Site RSO will delegate authority for certain radiological field operations and other designated aspects of the RPP to the RFOM. The RFOM shall be responsible to the Site RSO for radiation protection issues and will provide continuing information to the Site RSO. Minimum qualifications include:

- A Bachelor's degree in one of the physical sciences, biological sciences, or engineering disciplines
- A minimum of five years experience in operational health physics, including experience in D&D involving large quantities of dispersible TRU and fission product radioactive materials
- Eligibility for certification by the American Board of Health Physics (ABHP).

The Site RSO will delegate authority for certain technical portions of the RPP to the RTSM. The RTSM shall be responsible to the Site RSO for radiation protection issues and will provide continuing information to the Site RSO. Minimum qualifications include:

- A Bachelor's degree in one of the physical sciences, biological sciences, or engineering disciplines

- A minimum of five years experience in operational health physics, with an emphasis on technical and licensing aspects as well as related experience on the D&D of facilities involving large quantities of dispersible transuranic and fission product radioactive material
- Eligibility for certification by the ABHP.

Quality Engineering is responsible for assisting BCLDP managers in establishing and implementing the Quality Program, which satisfies DOE contractual requirements including DOE Order 414.1A and NQA-1 (1989). Minimum qualifications include:

- A Bachelor's degree in one of the physical sciences, biological sciences, or engineering disciplines
- A minimum of five years experience in engineering or quality assurance programs.

The Independent Oversight Manager is responsible for assessing project activities and work conditions for compliance with external requirements on the project, e.g., regulations, licenses, contractual requirements, industry standards, and waste disposal facility acceptance criteria. Compliance with requirements is verified through performance of assessments and/or walkdowns, in accordance with Procedure RC-AP-1.0, "Environment, Safety, and Health Oversight." Minimum qualifications include:

- A Master's degree in a relevant physical science, biological science, or engineering discipline
- A minimum of fifteen years experience in the areas of licensing or regulatory compliance, with substantial experience on D&D-related projects.

2.2.3 Organization Communications

The BCLDP maintains effective communications among participants for routine matters and emergency conditions. The Project Plan[4] describes the organization and communicates responsibilities for DOE-HQ and the DOE Ohio Field Office, including the onsite Project Manager. The Project Management Plan[5] describes project administration and control. It provides more specific details of the daily operations of the project.

The Battelle emergency plan and procedures for King Avenue and West Jefferson North identify the types of emergencies that might occur and the immediate responses to be taken. The plan also presents the emergency communications procedures to be followed. This plan is being updated. Communications with local fire, police, hospitals, and ambulance services have been formally established; and a unified command structure has been created among these groups. An emergency hazardous material drill occurred in 1995 at the King Avenue facilities, and each year since 1992, a full-scale emergency drill has occurred at the West Jefferson facilities.

The BCLDP has developed the "Battelle Columbus Operations Emergency Action Plan," BCO-EP-024[13], which describes Battelle's emergency management program and the mechanism by which emergency resources are managed and mitigation strategies are implemented. It is

based on the Incident Command System (ICS), which recognizes authorities who assume responsibility for command and control of personnel, facilities, equipment, and communications. The structure of the ICS can be established and expanded depending upon changing conditions of an incident. As such, the system can be utilized for any type or size of emergency ranging from a minor incident involving a single event to a major emergency involving several events. The ICS promotes the timely combining of resources and integration of activities along functional lines at all levels, and, to the extent possible, across all hazards. It is designated to be used in response to emergencies caused by fires, floods, tornadoes, riots, hazardous materials, or other natural or human-caused incidents.

2.3 Training

2.3.1 Training Requirements

The BCLDP has adopted a policy that all personnel working on the project are required to have appropriate and verified training for the task assigned to them. The BCLDP Training Program Plan[27] outlines the training program requirements for employees, subcontractors, consultants, visitors, and others engaged in the D&D operations. This training program addresses health, safety, and environmental concerns for these workers and the public. It meets Environmental Protection Agency, Occupational Safety and Health Administration, DOE, and NRC requirements for handling D&D tasks in a safe and environmentally sound manner.

The training program is overseen and implemented by the Training and Records Coordinator, with required input from the managers responsible for the qualification and safety of their staff. This training program meets the requirements outlined in the following procedures: TD-AP-1.1[28], TD-AP-2.0[29], TD-AP-3.0[30], TD-AP-4.0[31], TD-AP-5.0[32], and PR-AP-17.1[33].

The BCLDP Training Program Plan details the minimum training requirements, the employee/visitor/subcontractor/consultant groups addressed, and the staff responsible for the successful implementation of the program. Finally, the plan discusses the training schedule, course evaluation process, and Training Information Management System, the system used to archive and track trainees' needs and accomplishments. Further details are provided in the Training Program Plan.

2.3.2 QA Training

All BCLDP personnel are given a quality indoctrination and training by the Quality Engineering Manager. The training is administered by means of classroom instruction, readings, and bulletins. The instructions are given to ensure adequate knowledge of the project requirements, familiarization with quality procedures, and documentation requirements. Project quality training is conducted as described in the Quality Manual, D&D Operations, and its revised segments.[34] Records of project personnel indoctrination and training are kept in the BCLDP project records file.

The quality requirements comply with DOE Order 414.1A and ANSI/ASME NQA-1.

2.4 Contractor Assistance

It is expected that Battelle will accomplish some of the decommissioning activities by using subcontractors. As discussed in Section 3.3, administrative controls are in place to ensure adequate health and safety protection during D&D activities employing subcontractor personnel. Placement of a contract is based on objective evidence of the subcontractors' capability and quality program, and/or successful past performance, documented evidence of qualifications and certifications of the subcontractor employees, and successful completion of the radiological safety training program. The evaluation is made jointly by the management requestor and Quality Engineering.

The subcontractor's suppliers of goods and services are subject to the quality group surveys to assure performance to project standards, as well as audits and surveillance of subcontractor's work on site. The subcontractor implements the elements of the BCLDP radiation protection procedures or the procedures proposed by the subcontractor are reviewed and approved by the Site RSO. The records of audits and surveillance will be kept in the project records.

The scope of the D&D effort requiring subcontractor assistance has been defined in the Subcontracting Plan.[35] A list of qualified bidders has been developed. In addition, the requirements of the BCLDP radiation protection program, specified in Section 3.3, Contractor Personnel, are imposed on subcontractor firms, their employees, and their sub-tier contractors.

3. Description of Methods Used for Protection of Occupational and Public Health and Safety

This chapter provides a description of the methods that will be used to ensure protection of workers, the public, and the environment against radiation hazards during decommissioning.

3.1 Facility Radiological History Information

Battelle has completed nearly 1,000 government and commercially sponsored research projects involving nuclear materials since April 1943. A description of these projects is compiled in the first references. The following section of this chapter is intended to provide an overview of Battelle's involvement in this nuclear work. More detailed information about the previous contamination status of the King Avenue and West Jefferson sites is presented in Section 3.1.2 below. The current contamination status of all areas is presented in Section 7.0.

3.1.1 Overview

Battelle's first studies related to atomic energy development began in 1942, with the fabrication of uranium, a metal whose properties had yet to be characterized. The scope of atomic energy research rapidly increased after 1954 when the AEC lifted restrictions on atomic energy R&D research/development. Battelle's accomplishments during the war years helped to make it possible to build and operate plutonium-producing reactors, not long after the feasibility of the chain reaction had been demonstrated. Several different types of reactor systems were being assessed by the early 1950s.

Nuclear-related research was greatly expanded at Battelle in the decade after World War II. Development work on extractive metallurgy and plant corrosion resulted in an ion-exchange process that is the basis for recovery of most of the world's uranium. Extensive work was performed on alloy and fabrication process development, corrosion chemistry studies, and engineering analyses for the Naval Reactor Branch via the Naval Reactor Program, beginning in the early 1950s. Reactor development was the main research theme throughout the first 20 years, and dominated Battelle's R&D program.

The very nature of research being performed made it mandatory that a remote-handling facility be built. Thus in 1955, Battelle expanded the existing nuclear facilities by building the first privately-owned nuclear research center in the world. This facility, the Nuclear Sciences Area, located at the north end of the West Jefferson site included a research reactor, critical assembly facility, hot cells, and later a plutonium laboratory which has since been fully decommissioned. At the south end of the West Jefferson site, several autoclaves were constructed for use in hot isostatic pressing, a Battelle-developed technique for fabricating nuclear reactor fuel elements. Experiments connected with the radiation stability of materials were conducted in the Hot Cell Facility. Evaluation of these experiments has formed the basis for developing better nuclear fuels, control rod materials, and reactor structural materials. An additional capability was added

to the Hot Cell Facility by adding a mechanical test cell to study the mechanical properties of irradiated materials. Typical areas of research have included:

- Post-irradiation examination of commercial pressurized water reactor and boiling water reactor fuel and control rod materials
- Nuclear fuel failure inspection
- Spent fuel shipping and storage container development
- Nuclear plant reliability analysis and qualification for NRC licensing
- Commercial reactor hardware testing and refurbishment

The above overview gives an indication of the scope of Battelle's government and commercially sponsored nuclear energy research programs.

3.1.2 Previous Contamination Status

Note: The current contamination status of each building is described in Section 7.

The original basis of the current assessment of the radiological contamination in the facilities at the King Avenue and West Jefferson sites was on a preliminary radiological survey performed in 1984. The survey results are summarized in Table 3.1. It lists known or suspected locations of contamination within each building, the types of operations performed, the estimated contamination inventory, and the types of isotopes involved. Detailed radiological surveys, decontamination, and IVC surveys have been performed on buildings JS-1, JS-10, JS-12, KA-A, KA-1, KA-2, KA-3, KA-4, KA-5, KA-6, KA-7, KA-9, KA-10, KA-11, KA-13, KA-15 garage and KA-19. Detailed radiological surveys are ongoing in buildings JN-1, JN-2, and JN-3.

Results indicate contamination in facilities/buildings which had been associated with handling nuclear material, with some contamination found in contiguous areas. Radioactive contaminants detected include TRU, mixed fission products (MFP), activation products, uranium, thorium, carbon-14, and cobalt-60. Most of the contamination at the King Avenue site is due to uranium, thorium, associated daughter products, and carbon-14. This status also applied to the South Area of the West Jefferson site, which has been decontaminated. The bulk of TRU, MFP, and activation product contamination is confined to the Nuclear Sciences (North) Area of the West Jefferson site.

The previous contamination status of each building is described in more detail below.

3.1.2.1 King Avenue Site

NOTE: For the current contamination status of each building as of May 2000, see Section 7.

Building A (Corporate Office Building). Previous operations in this building included the encapsulation of highly enriched uranium for advance test reactor fuel elements. The building decontaminated, several rooms are under evaluation, and approximately 200 linear feet of drain was substantially contaminated with uranium. Some areas of the building have now been line,

Table 3.1
Summary of Radiological Contamination in the Battelle Facilities

Building	Type of Activity/Areas	Use	Survey Instrument Reading (dpm/100 cm^2)	Estimated Contamination Inventory (Year of Inventory)	Radioisotopes	Location[a]/ Type of Contamination
A	Misc R&D/ First, fourth floors	Encapsulation of highly enriched U for ATR fuel elements: pilot plant operation	1.5 K – 200 K	10^{-6} Ci ('73)	U, Th, daughters	Drain system
1	Misc R&D/ First floor	Uranium ore processing; ore beneficiation studies	0.5 K – 10 K	0.3 Ci ('84)	U, Th, daughters	Drain system, equipment, exhaust stack and ducts, piping (sludge)
1	Foundry	Processing of ore (tons)	1 K – 15 K	2.0 Ci ('84)	U, Th, daughters	
2	Metal Working Lab	Ore processing (tons); metal working	1 K – 4 K	<1 Ci ('84)	U-238, daughters; U, Th, daughters	Trenches (debris), piping (sludge), equipment, debris, sludge
2	Welding Lab	Natural, enriched, depleted U welding and fabrication	3 K – 15 K	10^{-3} Ci ('84)	U, Th, daughters	Piping (sludge), trench (debris), equipment, stacks
2	Misc R&D/ Second floor	Heat treatment; electroplating	3.5 K – 5 K	10^{-3} Ci ('84)	U, Th, daughters	Debris/sludge, pipes (sludge)
3	U-235 Area	Receiving and distribution point for all unirradiated source & U-235 material	ND[b]	<1 Ci ('84)	U, Th, daughters	Pipes (sludge), floors and hoods
3	Melt Lab	U-235 materials (1954-1975) metallographic research; tons of source material	5 K – 50 K	<1 Ci ('83)	U, Th, daughters	Sludge; hoods, drain lines, trench (debris), equipment, stacks
3	Powder Metallurgy Lab	Natural U storage source processing	5 K – 30 K	<1 Ci ('83)	U, Th, daughters	Pipes (sludge); trench (debris), equipment, stacks
3	Misc R&D	Ceramics research; metallographic research using tons of source material	8 K – 200 K (localized)	<1 Ci ('83)	U, Th, daughters	Pipes (sludge) trench (debris, stacks
4	Radiochemistry Laboratory	Radiochemical analyses	ND	<1 Ci ('84)	U, daughters MFP	Residual activity in remaining sections of drain system
4	Misc Labs/ Second, fourth floors	Metallography; encapsulation facility	50 K (localized)	0.1 Ci ('84)	U, Th, daughters; MFP	Piping (sludge), trench (debris), equipment
5	Machine Shop	Machining and grinding of natural, enriched, depleted U; beryllium machining	1 K – 30 K	<1 Ci ('84)	U, Th, daughters; MFP	Trench (debris); drain lines, equipment
5	Coating Lab	Coating	6 K – 10 K	<0.1 Ci ('84)	U, Th, daughters; MFP	Piping (sludge); equipment, exhaust ducts, stacks
5	Misc R&D/ First, second floors	Americium processing; corrosion	2 K – 40 K	<1 Ci ('84)	U, Th, daughters	Piping (sludge)

Table 3.1
Summary of Radiological Contamination in the Battelle Facilities

Building	Type of Activity/Areas	Use	Survey Instrument Reading (dpm/100 cm^2)	Estimated Contamination Inventory (Year of Inventory)	Radioisotopes	Location[a]/ Type of Contamination
6	Misc R&D/ Ground, first floors	Alloy studies; chemical analyses; Co-60 irradiation	1 K – 14 K	<1 Ci (’93)	U, Th, daughters, Pu (TRU), Ce	Floor drains (sludge); drain lines, equipment, ducts
7	Misc R&D	Analytical chemistry on source materials; corrosion	1 K – 100 K	<1 Ci (’84)	U, Th, daughters	Drain lines (sludge), trench (debris), equipment, exhaust ducts
9	Misc R&D/ Ground floor	Handling of natural and depleted U; krypton studies	ND	<1 Ci (’84)	U, Th, daughters	Drain lines (sludge); trench (debris), equipment
JN-1	Hot cells	Fuel element development; examination of irradiated fuel; criticality experiments	ND	6,000 Ci (’89)	MFP; U, Th, activation products (AP); Co-60	Drain lines (sludge), closed tank (water), equipment
JN-2	Former critical assembly lab; Accountability Lab; Radioanalytical Lab	Fuel element development; U-235, plutonium storage; radio-chemical analyses	ND	<1 Ci (’84)	TRU, MFP, AP	Tanks (closed); stored water; drain lines (sludge); trench (debris)
JN-3	Retired research reactor	Reactor studies; material irradiation	ND	ND	TRU, MFP, AP	Piping, trench base of containment), external hold-up tank (water); external drain system; drainage system (sludge)

[a] Building surface contamination is common to all buildings

[b] ND = not determined

four floor drains, and approximately 100 square feet of concrete are known to be contaminated. Contamination is due to uranium, thorium and associated decay products.

Building 1 (Foundry). Uranium ore processing and ore beneficiation studies were performed in this facility, in support of feed material processing centers operated by other contractors for the AEC. A foundry and melting, cutting, and grinding facilities are located within this building. The second floor of this building was substantially contaminated, but most of the contamination now has been removed. Approximately 75 square feet on the second floor are still contaminated, together with the drain system. Other contaminated parts of this building include the foundry area, and both ground and third floors. Contamination is due to uranium, thorium, and associated decay products.

Building 2 (Metalworking Building). Building 2 was used for AEC research, including the electroplating of Hanford reactor slugs, heat treatment and fabrication of uranium and thorium alloys, rolling studies, alloy development, and fuel element fabrication. Most of the area contaminated by the electroplating activities has been cleaned. Radioactivity has been detected at several locations on floors and in trenches on one side of the building. A major portion of work in this building consists of decontaminating and/or removing 12 large metal working machines that include hydraulic presses, rolling mills, furnaces, and a power transformer. Contamination is due to uranium, thorium, and daughter products.

Building 3 (Materials Building). This building housed powder metallurgy, melting, metallographic, and ceramics research facilities using enriched, natural, and depleted uranium. Contaminated areas (uranium, thorium, and daughter products) are spread throughout this building, from the ground to the second floor, and include equipment, building surfaces, and drains. In addition, survey data indicated a relatively high concentration of uranium (10^{-3} μg/g) in sludge from a Building 3 sump.

Building 4 (Radiochemistry Laboratory). Building 4 contained a radiochemistry laboratory and an encapsulation facility for highly enriched uranium. The radiochemistry laboratory – floors, walls, ventilation system, and floor drains and drain lines – has been decontaminated. Areas of contamination still exist in the building ventilation system and parts of the drain system. They are contaminated with a mixture of uranium and MFP.

Building 5 (Machine Shop). This machine shop produced substantial work for AEC/ERDA/DOE programs. The work involved machining, grinding, and milling operations on depleted, natural, and enriched uranium. Part of the floor of the grinding room was replaced to remove contamination. Small areas of contamination also remain in the mezzanine and second floors. Areas of contamination also exist in the exhaust ventilation system, and drain system sumps.

Buildings 6 and 7 (Chemistry Buildings). Analytical chemistry activities in support of the DOE/Navy program took place in these buildings. The work involved alloy studies, corrosion research, and chemical and instrumental analyses. Low levels of contamination exist in the ground and first floors of Building 6, and in the first through third floors of Building 7. Contamination also has been detected in the drain system for these buildings. The contamination in both buildings is due to uranium and thorium.

Building 9 (Mechanical Engineering Building). Research programs were conducted in Building 9 for AEC/ERDA/DOE involving natural and depleted uranium. Minimal surface contamination remained in one area of the ground floor, and drain lines were slightly contaminated with uranium and thorium. A laboratory area on the mezzanine contained contaminated hoods and duct work, which were removed. This building has been decontaminated and released.

3.1.2.2 West Jefferson Site

NOTE: For the current contamination status of each building as of May 2000, see Section 7.

Building JN-1 (Hot Cells). JN-1 was constructed to support fuel development research for the AEC. The facility was initially used for hot cell examination of fuel specimens that had been irradiated in the BRR. Subsequent work involved examination of fuel from commercial power reactors in support of DOE programs. Due to the nature and extent of contamination within the hot cell area, a formal radiological survey has not been performed. Extensive contamination from TRU, MFP, activation products, uranium and decay products, and Co-60 exists throughout the hot cell laboratories.

Building JN-2 (Former Critical Assembly Laboratory). This building was used for a zero-power organic-moderated critical assembly and other criticality experiments. Subsequently, JN-2 housed a small plutonium laboratory, an instrument laboratory, and currently a radioanalytical laboratory for the D&D program. The building also contains a storage vault formerly used for storage of plutonium and highly enriched uranium. Contamination exists in those areas and in an underground storage tank and its associated hot drain system. The plutonium laboratory was decontaminated and converted into the radioanalytical laboratory.

Building JN-3 (Reactor Building). Building JN-3 housed a research reactor that was operated in support of fuel development programs for the AEC. This reactor was partially decommissioned in the mid-seventies and retired. Subsequently, the building was used to store waste generated from previous D&D activities in the JN-2 plutonium laboratory and another plutonium laboratory (JN-4) at the same site. TRU, MFP, and activation products are present, either as surface contamination, or in sludge/water/soil media in drain lines and around the containment building itself, as a result of former reactor operations.

3.1.2.3 Subsurface Soil Contamination at the West Jefferson Nuclear Sciences Area

Data presented in the Battelle annual site environmental reports[36] indicate that there have been no significant radionuclide releases to the environment from site activities. Furthermore, the ongoing environmental monitoring program indicates no significant site releases or migration of contamination.

Radionuclide activities of soil/sediment samples collected by Battelle and Argonne National Laboratory during limited characterization studies, show that there are four small areas on the West Jefferson North site which have elevated activities of Cs-137 and Am-241. One area is in

two abandoned filter beds (Figure 3.1) which had been previously remediated, but not to current criteria. The second area is located near the sanitary outfall (Location #1 in Figure 3.1), which serves buildings JN-1 and JN-4 (the former plutonium laboratory). Low levels of MFP and TRU contamination have been identified along a narrow band that originates from this outfall. These areas had been remediated in the form of soil excavation, but were not submitted to the IVC. The extent of the remediation effort will be determined from the site characterization and excavation work.

3.1.3 Operational Occurrences

3.1.3.1 Procedure

In response to NRC Regulation 10 CFR Part 21, BCLDP developed a procedure for reporting of defects and noncompliance.[37]

That procedure requires any staff member recognizing a "deviation" that has radiological implications to immediately notify his or her Manager, who documents the deviation by initiating written notification (form DDO-001) to the Site RSO. Form DDO-001 serves as the official record for identified deviations. The notification remains open until the evaluation is completed and a determination resolved. The appropriate Manager and the Site RSO arrange for an evaluation of the deviation to determine present or potential radiological safety hazards. The evaluation must reflect a thorough and comprehensive investigation to determine if a substantial radiological safety hazard resulted or could have resulted from the deviation.

If the evaluation determines that a substantial safety hazard did result or could have resulted, the Manager immediately notifies the Site RSO in a written report that must include the following information:

- Identification of the facility, the activity, or the basic component that "fails to comply" or contains a defect
- Nature of the defect or "failure to comply" and the safety hazard that was or could be created
- The date on which the information of such defect or "failure to comply" was obtained
- Any advice related to the defect or failure.

The Site RSO will immediately notify the BCO RSO of the safety hazard or major noncompliance condition and notify NRC of a defect or noncompliance within two days following receipt of information confirming a defect or failure to comply. The initial notification report, along with the final evaluation report and supporting documentation, are maintained by the Site RSO and the Document Control Manager for corrective action tracking and inspection purposes.

3.1.3.2 Previous NRC Reportable Occurrences

Previous operational occurrences such as spills, releases, or other accidents, were evaluated according to the above procedure. Except for two incidents, the RSO found that the deviation did not constitute a substantial safety hazard and *was not* reportable to the NRC under

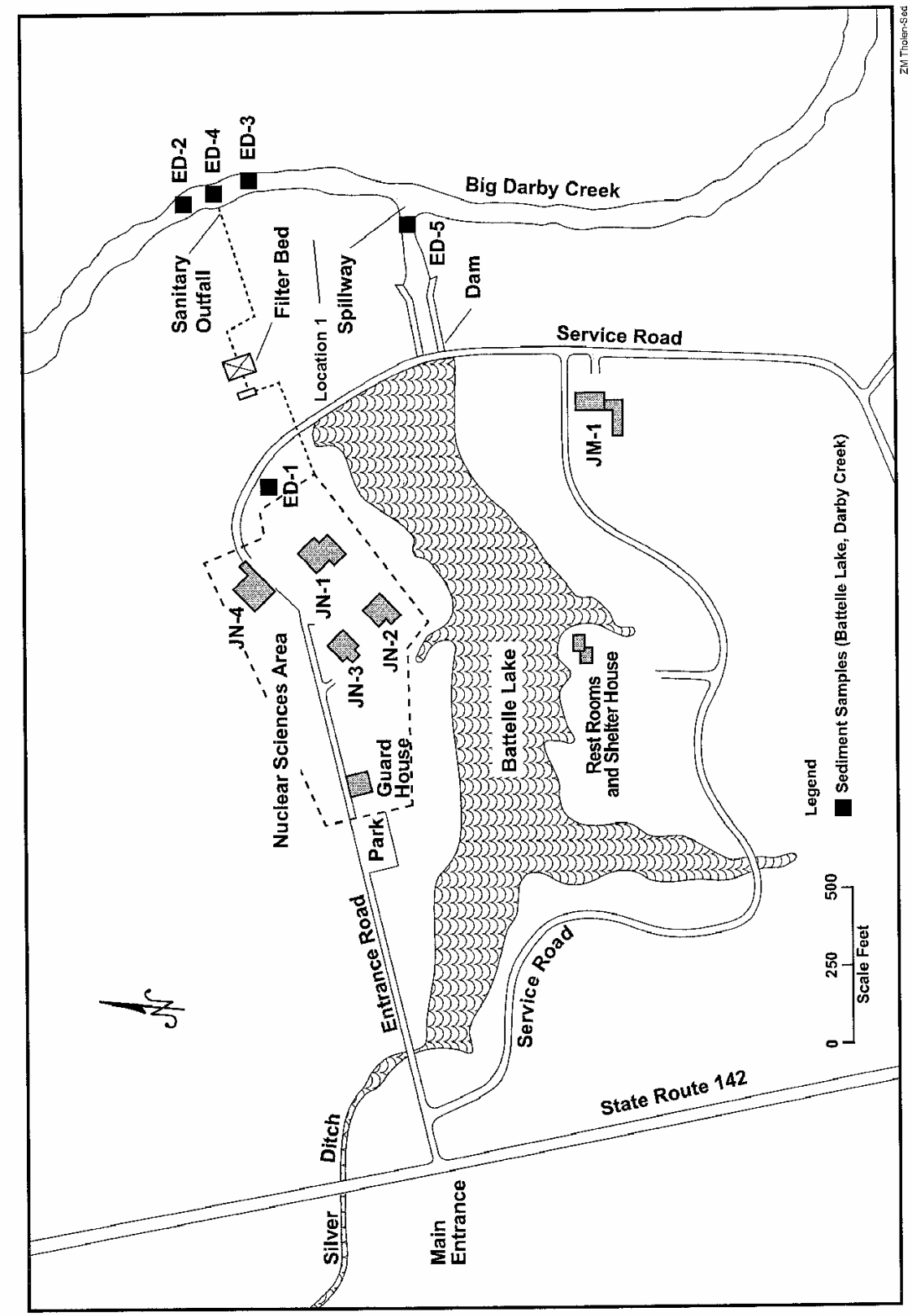

Figure 3.1
Environmental Monitoring at the West Jefferson Nuclear Sciences Area Showed Evidence of Soil Contamination in the Proximity of the Abandoned Filter Beds and Sanitary Outfall (Location 1)

10 CFR Part 21 and Battelle's license conditions. For each non-reportable incident, the RSO filed an internal memorandum that serves as the formal documentation of the evaluation and the final determination. All these memoranda are maintained in the Battelle RSO files.

None of these non-reportable incidents resulted in significant residual contamination since the contamination was largely removed following the occurrence.

In one of the two incidents reported to the NRC, the Security Access Control Center alarm panel at the West Jefferson Nuclear Science Area became inoperative at 5:00 p.m. October 17, 1977, and was not restored to operation until 8:00 p.m. on October 21, 1977. As a result of this outage, facility alarms at the Hot Cell Laboratory (JN-1), the former plutonium laboratory (JN-4), Vault Area (JN-2), and Retired BRR (JN-3) were not *continuously* monitored *during non-working hours*. The evaluation concluded that this outage could have constituted a substantial safety hazard since a condition such as fire, stack release, or criticality could have gone undetected for approximately one hour during non-working hours. A security guard makes hourly clock rounds at each of the above facilities.

As required, the Battelle Responsible Officer notified the NRC on November 11, 1977[38] within two days after receiving the results of the evaluation. Since no radioactivity was released during this occurrence, there is no residual contamination due to this specific incident.

The other noncompliance incident reported to NRC involved a release of airborne radioactive material within the Hot Cell facility and subsequent surface contamination. This occurred at the Hot Cell facility on May 3, 1980, during unloading operations of a failed spent fuel assembly received from the Connecticut Yankee Atomic Power Company. There was no release of radioactive material from the building. The data from bioassay procedures, including in-vivo counting, have established that resultant radiation exposures were well within prescribed standards as set forth in 10 CFR Part 20. Pulmonary depositions were a fraction of a percent of the permissible body burden.

An evaluation of this deviation in accordance with 10 CFR Part 21 procedures determined that this incident was reportable to the NRC as a defect in that it *could have* created a substantial safety hazard to staff in the area and the environment. Accordingly, the Battelle Responsible Officer notified the NRC on July 18, 1980[39], within two days of the evaluation. However, the surface contamination was largely removed following the occurrence and subsequent monitoring has shown no significant residual contamination.

3.1.4 Radiation Levels

The 1984 radiological survey of the facilities showed that, with the exception of the Hot Cell Facility (JN-1), the contamination was widespread but that the radiation levels were low, in the range of 0.1 to 0.2 mR/hr (beta-gamma). Although no measurements were made in the hot cells as part of the 1984 survey, the presence of radioactive materials currently stored in the cells and contamination from past operations indicates high radiation fields within the cells and in the controlled-access areas. The operating areas outside the cells have average radiation levels of less than 0.5 mR/hr. Table 3.1 shows radiation levels reported in the 1984 survey of the building.

Radiation levels will be continuously monitored and all operations will be performed in keeping with the ALARA considerations described in the next section during decommissioning operations in the hot cells and other buildings.

3.2 Ensuring that Occupational Radiation Exposures are ALARA

Ensuring that occupational radiation exposures, both internal and external, are as low as reasonably achievable is accomplished through an integrated radiation protection program at BCLDP. Project management, with a mandate and commitment from the Battelle Chief Executive Officer[40] and senior management, aggressively promotes a policy of ALARA among project staff. A thorough approach to ALARA is accomplished through a formal procedure-based program[41], including the appointment of an ALARA Coordinator. Project staff are encouraged to actively participate in the ALARA process through suggestions, review, and feedback networks of a formal and informal nature. Senior project management encourages an "open door policy" where an environment of self-appraisal is highly desired.

The goal of minimizing radiation exposure is based on the assumption that even small exposures involve some health risk. It is therefore incumbent upon staff and management to maintain individual and collective doses ALARA.

Reducing individual and collective radiation exposures to ALARA is a fundamental objective of a radiological protection program[42]. Reducing collective exposures (person-rem) is desirable because of the inferred connection between collective dose and the health and safety of the workers and the public. This connection has been presumed repeatedly in the guidance provided by such organizations as the National Council on Radiological Protection and Measurements, the International Commission on Radiological Protection (ICRP), and the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation.

Reducing individual and collective radiation exposures also improves other parts of a radiological protection program through better planning of work, training of workers, and tracking of exposures. Ultimately, these efforts benefit the safety and reliability of the project by improving the quality of work performed. They also are cost-effective because they often save time and money by reducing lost time incidents.

Minimizing radiation exposure is accomplished by preliminary planning and scheduling, by using proven and innovative engineering techniques, and by establishing and achieving radiation exposure goals. Preliminary planning and scheduling identifies those jobs that should be reviewed for radiation exposure reduction and allows time to develop methods, write procedures, and train personnel. Radiological engineering provides methods to reduce airborne concentrations, dose rates, or the time spent in radiological areas. Radiation exposure goals and annual ALARA performance goals are used as management tools for involving all project groups in actively reducing radiation exposures, as well as providing a means of assessing the effectiveness of radiation exposure reduction actions.

The project has established a formal ALARA program administered by the ALARA Coordinator. This program requires ALARA goals and objectives, pre-job and post-job reviews, and

performance tracking. Formal reports are issued to management to ensure proper review. These formal reports are implemented with several procedures, including, HP-AP-21.0[43], HP-AP-31.0[44], and HP-AP-08.0[41]. The Site RSO delegates administration of the Radiation Work Permit program[45], which applies specific ALARA requirements to each task, to the RFOM.

During jobs involving exposure to radioactive material, the ALARA Coordinator and Project Managers regularly observe work in progress to ensure that the planned exposure reduction techniques are implemented and to identify other ways to further reduce exposures.

It is the policy of the BCLDP that ALARA is an individual as well as a collective philosophy in which training equips the staff with the tools to have a successful program and management commitment promotes the use of those tools. Training is described in Section 2.3.

Supplemental implementation is accomplished through other administrative and operating procedures, training, oversight activities, and management direction.

3.3 Radiation Protection Program

(Please reference DD-90-02, Rev. 4, "Radiation Protection Program," for a complete description of the BCLDP program.)

BCLDP is committed to the safe use of radioactive materials at the King Avenue and West Jefferson sites during the decommissioning phase. The assignments for the DDO Program Manager, Site RSO, the RFOM, and the RTSM include the timely review of decommissioning techniques and verification that the controls implemented to reduce personnel exposures to radiation and radioactive contamination are reduced to ALARA.

The BCO RSO is appointed by the Battelle CEO and reports to the CEO through Battelle's Vice President for ESH&Q; the BCO RSO has direct access to the CEO when deemed appropriate. The BCO RSO is responsible for periodically assessing compliance with RPP requirements by performing oversight and assessment of BCLDP operations. The BCO RSO may stop any operations involving licensed activities that are unsafe or non-compliant with NRC requirements. The Vice President of ESH&Q and the DDO Program Manager will consult the BCO RSO in the assignment of managerial positions in the RPP. The BCO RSO is responsible for periodically assessing compliance with RPP requirements by performing oversight and assessment of BCLDP operations. The BCO RSO may stop any operations involving licensed activities that are unsafe or non-compliant with NRC requirements.

The BCLDP Site RSO is appointed by the Battelle Vice President of ESH&Q and the DDO Program Manager in consultation with the BCO RSO, is responsible for and performs the day-to-day implementation of and maintaining compliance with the RPP and serves as the BCLDP interface with the NRC, i.e., all of the responsibilities formerly assigned to the RSO, with the exception of periodic oversight activities. Site RSO functions are delineated elsewhere in this document and in the RPP Plan, DD-90-02. The Site RSO may stop any operations involving licensed activities that are unsafe or non-compliant with NRC requirements. The HSEA Manager is designated as the Site RSO, and may delegate responsibilities to the RTSM, RFOM.

The Site RSO has assigned specific day-to-day duties, as described in the license application and RPP, to the RFOM and the RTSM.

Functional responsibilities for day-to-day administration of the radiation protection program of the BCLDP have been delegated to the RFOM for most operational health physics procedures or the RTSM for most administrative health physics procedures. The Site RSO maintains direct responsibility for NRC reporting, the radiological awareness report program, radioactive source control, and program change assessments in a fashion similar to 10 CFR 50.59 (HP-AP-36.0)[46]. The BCO RSO provides oversight to BCLDP in matters concerning license conditions and the quarterly review of segments of the radiation protection program. The BCO RSO has the authority to stop work activities and verifies that activities are conducted safely and that personnel exposures are maintained to ALARA. The BCO RSO's responsibilities also include oversight of the implementation of the broad scope license, oversight of the BCLDP, and other applications of ionizing radiation conducted at Battelle.

BCLDP Site RSO may appoint an Associate Site RSO to act for the Site RSO during periods when the Site RSO is off site or otherwise unavailable for day-to-day direction of the Radiation Protection Program. The Associate Site RSO may fill in when the Site RSO is away for a short period of time. The Associate Site RSO has equivalent minimum qualifications, training, and experience as the Site RSO.

As stated earlier, the Site RSO has delegated authority for administration and implementation of radiological field operations to the RFOM, with periodic oversight by the BCO RSO. The RFOM is responsible for direct in-field coverage of radiological operations, surveys of working areas, posting and access controls, the issuance of Radiation Work Permits (RWPs), the evaluation of hot cells for downgrade or human entry, radiological control for the shipment of radioactive waste, or the storage of radioactive materials not currently in use.

The Site RSO has also delegated authority for administration and implementation of radiological administrative and technical programs to the RTSM. The RTSM is responsible for implementing the ALARA program, providing technical support to the BCLDP Operations groups, approving radiological volumetric releases, management of the Dosimetry Program, administration and implementation of the radiological instrumentation, respiratory protection, and personal protective equipment programs.

The HSEA Technical Advisor is a direct report to the HSEA Manager. The HSEA Technical Advisor will have qualifications similar to the Site RSO, will assist the HSEA Manager with management of the Radiation Protection Program, and may be named the Associate Site RSO.

Contractors performing radiological work shall comply with the requirements of this Plan, as captured in job-specific work documents. Contractors shall perform work under the BCLDP radiation protection program, using BCLDP implementing procedures. Their own implementing procedures may be used provided that they have been reviewed and approved by the Site RSO prior to commencing work. The Site RSO shall provide oversight of contractor personnel and activities to verify compliance with BCLDP requirements.

3.3.1 Radiation Exposure Control

The annual dose equivalent limits listed in 10 CFR 20.1201 apply to persons 18 years of age and older who receive occupational exposure to ionizing radiation. The numerical values do not represent dose equivalents above which injury will occur. Rather, they represent a dose that should not result in any significant deleterious effect or an unacceptable risk of delayed effects. Maintaining dose within the limits does *not* ensure that there is *no* risk to the individual. Therefore, management shall keep staff members' dose to a practical minimum.

BCLDP maintains an occupational radiation dose history file for all staff members. A staff member's radiation dose history file shall include occupational dose received at other nuclear installations. Both the calendar year and the lifetime radiation dose equivalent totals shall include that dose.

BCLDP annual administrative exposure limits for monitored personnel are:

- 2 rem total effective dose equivalent (TEDE)
- 20 rem total organ dose equivalent
- 6 rem lens of the eye dose equivalent
- 20 rem shallow (skin) dose equivalent
- 20 rem shallow (extremity) dose equivalent
- 500 millirem TEDE for the duration of pregnancy
- 100 millirem TEDE to members of the general public

The DDO Program Manager shall ensure that sufficient trained personnel are available to perform each operation such that NRC exposure limits are not exceeded. Persons under 18 years of age shall not be permitted unescorted access to radiologically restricted areas at Battelle facilities.

Exposure of an unborn child shall not exceed 500 millirem for the entire gestation period. Any employee, contractor, or visitor that has the potential for occupational exposure shall be informed of the potential effects on that may result to an embryo-fetus at low exposure levels. Individuals shall be encouraged to notify the Site RSO regarding "declared" pregnancies. Upon declaration, an evaluation shall be performed by the Site RSO to determine the potential for an employee to exceed the regulatory exposure limit during the nine-month gestation period. If the potential exists to exceed regulatory limits or if an employee's request for transfer is approved, the employee shall be transferred to a different job assignment. Declared pregnant females with the potential to exceed 100 millirem TEDE during a calendar year shall be monitored for internal and/or external exposure.

All employees with the potential to exceed 100 millirem deep dose equivalent within the calendar year shall be assigned a personnel dosimeter. Dosimetry will make personnel dosimeter assignments based on the potential of an individual receiving a dose during entry into radiation areas.

Dosimetry may change a staff member's dosimeter assignment during the year. Site RSO and line or project managers must review and approve the assignment change.

Dosimetry shall assign extremity dosimeters to staff members in accordance with HP-AP-1.0.

All employees with the potential to exceed 100 millirem committed effective dose equivalent from internal sources within the calendar year shall participate in a routine internal radiation monitoring program. The BCLDP internal monitoring program is consistent with Regulatory Guide 8.9[47].

The routine internal radiation monitoring program shall consist of:

- Personal air monitoring (e.g., breathing zone sampling)
- Direct bioassay sampling on a baseline, routine or special schedule to be determined by the Site RSO
- Indirect bioassay sampling at the beginning and end of employment and on a planned and periodic basis thereafter or
- A combination of air monitoring, direct bioassay and indirect bioassay.

BCLDP uses field measurement to assign worker dose. Examples of these field measurements may include workplace air sampling, nasal smears, and contamination surveys.

BCLDP may use indirect bioassay measurements, including *in vivo* measurements, urinalysis, and fecal analyses for radionuclides to confirm and assess internal doses.

Staff members shall provide samples for bioassay within 1 month of the originally scheduled date. Line or project managers shall restrict staff members overdue for sample submission from entering radiological areas.

3.3.2 Control of Work

Routine working conditions at Battelle that may cause an individual to incur a radiation dose of less than 100 millirem TEDE per calendar year may not require dosimetry. Control of work that may subject an individual to exposures equal to or greater than 100 millirem TEDE per calendar year shall be accomplished by:

- Establishing radiological standards and responsibilities
- Using line management, the RFOM, and/or the Site RSO to monitor performance of radiological work
- Training workers in recognition of radiation hazards and their responsibility to prevent their occurrence

- Providing personnel with radiation safety procedures and/or RWPs that include the radiological protection measures and controls necessary for safe completion of the job, or
- Performing mock-ups and/or dry runs of new or significantly modified radionuclide handling procedures.

Work will not be initiated in areas that may subject members of the general population to exposures equal to or greater than 100 millirem per year TEDE. An RWP shall be prepared for both routine and non-routine operations in radiological areas, in accordance with the Radiation Protection Plan and associated procedures.

Note: For purposes of this Plan, the term "non-routine" refers to radiological operations not covered by an existing procedure.

3.3.3 ALARA Program

All exposures shall be assumed to entail some risk to the employee. Line or project management shall adopt the following four principles to govern all work activities with the potential for exposure to radiation or radioactive materials:

- Activities and operations shall produce a positive net benefit.
- All radiation exposures shall be kept ALARA in light of economic and societal costs.
- Radiation exposures received by individuals should not exceed the administrative exposure limits described in Section 3.3.1.
- Radiation exposures received by individuals shall not exceed the regulatory limits specified by the US NRC in 10 CFR 20.

ALARA activities shall include the following:

- A program shall be established that integrates management philosophy and regulatory requirements, with specific goals and objectives for implementation included.
- The Site RSO in conjunction with the Operations Manager and ALARA Coordinator shall establish applicable and appropriate radiological goals to direct all levels of management and workers at BCLDP toward improvement in radiological performance.
- Pre-job planning, ALARA reviews, and ALARA audits shall be performed.

3.3.4 Contamination Control

Loose and fixed radioactive contamination shall be maintained at concentrations that are ALARA. Equipment, components, or surfaces where loose and/or total (loose plus fixed) activity in excess of the criteria contained in BCLDP Radiation Protection Program shall be classified as contaminated. Contaminated areas shall be clearly defined and posted.

3.3.5 Instrumentation

Instrumentation used by the BCLDP shall be of sufficient sensitivity and accuracy to assess radiation exposure levels found in BCLDP areas. Dose and exposure rate instruments should provide a response in units of exposure or dose rate. Other instruments shall be able to detect the presence of radioactivity on tools, equipment, clothing, and personnel at all levels typical of those in BCLDP areas. These instruments should provide a response in units of radioactivity (e.g., counts per minute). There will a sufficient quantity of radiation survey instruments to support on-going or planned operations.

Instrumentation shall be purchased, tested, and calibrated by methods that are consistent with ANSI N323A[48] recommendations. Calibration frequencies for instruments in the active inventory shall be in accordance with HP-AP-29.0[49]. Calibration and repair records shall be maintained.

3.3.6 Surveillance

Routine exposure rate surveys, contamination surveys, air monitoring, and other surveillance activities in all controlled areas and selected uncontrolled areas shall be performed in accordance with the BCLDP Radiation Protection Program, and applicable procedures.

3.3.7 Posting

Posting/labeling requirements shall be in accordance with 10 CFR 20, Subpart J, the BCLDP RPP, and applicable procedures.

3.3.8 Receipt and Control of Radioactive Material

Receipt and control of radioactive materials shall lie in accordance with 10 CFR 20, Subpart I, the BCLDP RPP, and applicable procedures.

3.3.9 Packaging and Transportation of Radioactive Materials

Shipments of radioactive materials are performed in accordance with approved procedures that are reviewed by the Site RSO. Material deemed radioactive by the Department of Transportation (DOT) to be shipped from Battelle shall be packaged, surveyed, labeled, and shipped in accordance with 10 CFR 71. The DOT defines radioactive materials as those that contain 2,000 pCi of radioactivity per gram. For series radionuclides (i.e., natural thorium or natural uranium), this includes the amount of the parent (i.e., ^{232}Th or ^{238}U), plus the amount of each of the radioactive progeny in the decay chain.

Prior to shipment of specifically licensed materials, the shipping department shall obtain confirmation that the receiver is licensed to receive the type, quantity, and form of radioactive material present in the shipment. Sealed sources shall be inspected and tested for construction defects, leakage, and removable contamination prior to shipment.

3.3.10 Radiation Protection Records

The Site RSO shall ensure that sufficient records are maintained sufficient to document implementation of this Plan and to demonstrate compliance with applicable US NRC license requirements. The following records shall be preserved and maintained until license termination, at which time the records shall be transferred to the US NRC:

- Individual employee records and analyses performed using employee exposure records
- Records of dose to members of the general public
- Records of waste disposal
- Records of Radiation Safety Training.

All other records shall be maintained pursuant to Battelle corporate policy and the advice of legal counsel.

3.3.11 Documentation

Health Physics Procedures (HP Procedures) shall be generated to guide the implementation of this Plan. HP Procedures shall be implemented as requirements. The preparation, distribution, and use of HP Procedures shall be controlled. All HP Procedures and BCLDP documents that define the radiation protection program are assessed by the Site RSO in a fashion similar to that described in 10 CFR 50.59, prior to implementation of the revisions. All HP Procedures shall be signed by the responsible radiation protection manager (e.g., RFOM and RTSM) in accordance with approved procedures and prior to their implementation. Approval signatures shall signify that the HP Procedure is adequate for its intended use, that it meets the requirements of this Plan, and that the provisions of the license are met. HP Procedures shall be reviewed periodically in accordance with applicable procedures.

3.3.12 Emergency Response and Notifications

For emergencies where radioactive materials may be involved, consideration shall be given to exposure to radioactive materials and ionizing radiation in addition to the other hazards present. If it is known or suspected that an internal or external dose limit has been exceeded:

- The Site RSO shall be notified immediately.
- The Site RSO shall evaluate the likelihood and magnitude of the exposure or contamination status, and shall implement appropriate follow-up actions as soon as possible after notification.
- The Site RSO shall notify the US NRC and the BCO RSO of events as required in 10 CFR 20 Subpart M and 10 CFR 30.50.

3.3.13 Periodic Program Review

All activities conducted as part of this Plan shall be subject to periodic reviews for continued applicability as required in 10 CFR 20.1101. Audits/assessments of the radiation protection program should be conducted by the BCO RSO (or designee) to determine compliance with applicable federal/state regulations, applicable license requirements, and this Plan. The following programmatic elements should be audited for compliance and continued applicability at a frequency of at least once per year:

- Radiation safety training
- Training of radiation protection personnel
- Documentation and records
- Exposure control
- Instrumentation and surveillance
- Sealed source and radioactive materials accountability
- Control of work
- Waste management/disposal
- Contamination control
- ALARA
- Shipping/receiving radioactive material.

3.3.14 Release for Unrestricted Use

The BCLDP Release Program is based upon the requirements of NRC Regulatory Guide 1.86[7]. The purposes of the release program are to specify the limits and methodology for release of materials from the controlled areas and minimize the potential for unintentionally releasing contaminated items to the uncontrolled areas.

Limits for the release of materials are discussed, along with the bases for these limits, in the following documents:

- "Release of Materials from Controlled Areas," HP-OP-011
- "Surface Release Criteria Technical Basis Document," DD-93-02 (Attachment 1)
- "Volumetric Release Criteria Technical Basis Document," DD-93-03 (Attachment 2)

3.4 Contractor Personnel

It is expected that Battelle will accomplish some of the decommissioning activities by using subcontractors. As discussed in Section 3.3, administrative controls are in place for both BCLDP personnel and contractors to ensure adequate health and safety protection during D&D activities. Placement of a contract is based on objective evidence of the subcontractors' capability and quality program and/or successful past performance, documented evidence of qualifications and

certifications of the subcontractor employees, and successful completion of the radiological safety training program. The evaluation is made jointly by the Project Management requestor and Quality Engineering.

3.5 Control of Radioactive Waste

Radioactive waste materials shall be controlled by the following:

- Preventing materials from becoming unnecessarily and/or excessively contaminated;
- Decontaminating and reusing radioactive materials such as tools and equipment;
- Monitoring materials for radioactivity and removing non-radioactive materials prior to disposal; and
- Using waste volume reduction techniques when practical.

Radioactive waste may be stored on site or disposed of by one of the following means:

- Transfer to an authorized recipient as provided for in 10 CFR 20.2001;
- Release into the sanitary sewer in conformance with 10 CFR 20.2003; or
- Any other means specifically approved in advance by the NRC.

Manifests, Certificates of Disposal, or other documentation to confirm transfer/disposal shall be maintained by Waste Management.

4. Planned Final Radiation Survey

Upon the completion of D&D activities in an area or building, a Final Status Survey will be conducted to verify that the decommissioning objectives have been met for all buildings, parts thereof, and associated grounds being released. The Final Status Survey will be conducted under a BCLDP WI and will be specific for each area/building. Where appropriate, based on process knowledge and/or characterization information, the Final Status Survey will be a statistical survey or percent survey of the D&D area, consistent with NUREG/CR-5849[50] and DD-97-02[51]. In all cases, it will utilize the same basic methodologies as the site characterization processes and equivalent personnel, instruments, procedures, grid patterns, fixed reference locations, radioanalytical supports, and management review will be utilized.

4.1 Release Criteria for Unrestricted Use

The objective of the decommissioning project is to decontaminate areas so such that they are available for unrestricted use (i.e., without radiological restrictions). In order to clearly define the objective, the BCLDP has prepared two technical basis documents:

- "Surface Release Criteria Technical Basis Document," DD-93-02, and
- "Volumetric Release Criteria Technical Basis Document," DD-93-03.

These two documents provide the quantitative values for decommissioning objectives and discuss their technical basis. The documents also address how the project objectives meet the applicable NRC criteria , as well as DOE criteria, for unrestricted release. The documents are presented in Attachments 1 and 2. Implementation of the release process consistent with these technical basis documents is governed by procedures listed in Attachment 3.

To guide the Final Status Survey, the BCLDP has prepared and issued procedure DD-CP-002, "Facility Post-Decontamination Final Status Survey for Baseline Areas." The latest revision of this procedure has been included as Attachment 4. The facility will meet the release criteria for unrestricted use as demonstrated by the Final Status Survey after decommissioning activities are complete.

5. Funding

Decommissioning of these facilities will be conducted under a cost share agreement with the U.S. DOE, under which DOE is contractually obligated to fund 100 percent of the pre-D&D S&M costs and 90 percent of all other D&D costs. Radioactive waste from the BCLDP will be disposed of at DOE-owned and/or DOE-approved disposal sites. The BCLDP is included in DOE's Environmental Restoration and Waste Management Five Year Plan[52] and DOE has approved the technical, cost, and schedule baseline for completion of all facilities. Decommissioning costs, including decontamination and waste disposal, are estimated to be $230 million dollars, of which $131 million dollars have already been spent through fiscal year 1995. Final cost estimates for each building will be developed as the building characterizations are completed. The Certification for Financial Assurance for the D&D project is currently being completed and will be transmitted to the NRC when finalized.

6. Physical Security Plan and Material Control and Accounting Plan Provisions in Place During Decommissioning

This section is no longer applicable to the BCLDP facilities. The requirements for maintaining the NRC-approved physical security plan and special nuclear control and accounting plan were removed when the special nuclear material inventory requiring these controls were shipped off-site.

7. Current Status of Decommissioning Activities

This section describes the current status of the BCLDP. It includes both building status and refers to changes to the radiation protection program found in Section 3.3. Note that it is Battelle's intent that this Decommissioning Plan in general be applicable to State of Ohio decommissioning activities, and in specific, the current decommissioning methodologies and limits.

7.1 General Information

Decommissioning efforts have been implemented at the West Jefferson and King Avenue facilities since 1986, after approval by the DOE and NRC. This section provides a brief description of the radiological status of the decommissioning effort. Battelle maintains a license from the NRC, SNM-7, and intends to maintain that license during the decommissioning effort.

7.2 Description of Decommissioning Activities

In Buildings KA-B (Auditorium), KA-1, KA-3, KA-10, KA-11, KA-13, KA-15, KA-15 garages, and KA-19 (except the Shipping and Receiving area), characterization and D&D have been completed, the Final Release Docket has been approved by DOE. These buildings have been unconditionally released by the NRC and released for unrestricted use by the BCLDP.

In Buildings KA-4, KA-5, KA-6, and KA-7, limited scope characterization, D&D, and final release has been completed and submitted to the IVC.

In Buildings KA-A and KA-2, characterization and D&D have been essentially completed. Characterization Final Status Reports have been approved by the NRC (except for one suite in KA-A).

Buildings JN-1, JN-2, and JN-3 are in active D&D.

Buildings KA-9, JS-1, JS-10, and JS-12 were previously decommissioned and released.

Remaining buildings are not within the current baseline of BCLDP.

At the direction of the DOE, Battelle is replanning the end state of JN-1, JN-2 and JN-3 to be demolition rather than restoration. This change has an impact on the general outline of the workflow of Section 2.1.2. The sequence of operations in Section 2.1.3.4 remains generally applicable, but specifics such as JN-3 remaining a long-term staging area is not currently in the planning.

As the BCLDP has matured, its staff gaining experience in general operations, it has been determined that the generation of building specific documents such as QAPs for Section 2.1.4 are no longer required. In similar logic, the extensive, formal review process of the Readiness Review as previously mentioned in Section 2.1.3.3 is no longer required or performed. A reduced scope of review is performed as documented in Section 7.2.1.

The schedules discussed in Section 2.1.5 are currently being replanned by the updating of the project baseline. Figure 2.6 was left in its original state, although Battelle acknowledges that the end date is closer to the 2005 in the text. This Figure will be submitted upon completion and acceptance by DOE-Columbus Closure Project of the updated baseline. Since the BCLDP is a 90% DOE funded effort and the wastes generated are DOE owned, DOE's plans, schedules and funding profiles have a significant impact on the decommissioning schedule.

The Draft Baseline Task Plan is included as Attachment 5. It is still in revision at this time.

7.2.1 Planning and Assessment

The planning process at the BCLDP requires a detailed review of each task to be performed before work begins and the approval of work instructions. Decommissioning each facility or major part is conducted as a separate effort. The effort-specific review package will be based on a review of the following subjects:

- Decommissioning Operations Objectives
- Site Radiological and Chemical Characterization Report
- Site Decommissioning Operations Release Criteria
- Site Decommissioning Operations Schedule, and
- Support Functions (QA, Health Physics, Radiological Safety Training).

Efforts-specific review packages include, but are not limited to:

- Waste Management Plan
- Industrial Safety Checklists
- Work Instructions, and
- Radiation Work Permits.

The assessment phase requires that all resources are available and the tasks can proceed. WIs are approved and the tasks are allowed to proceed. The formal review process, termed a Readiness Review has been modified as described above and is used for each task and work procedure, regardless of the scope.

7.2.2 Decommissioning Organization and Responsibilities

The organization assigned the BCLDP has changed since the last version of the Decommissioning Plan in 1993. A detailed description is provided in Section 2.2, with job descriptions for the positions responsible for implementing the elements of the decommissioning plan.

The DDO Program Manager serves as the principal person at the BCLDP site responsible for the completion of the Decommissioning Plan. The qualifications of the DDO Program Manager includes:

- A bachelor's degree in one of the physical sciences, biological sciences, or engineering disciplines; and
- A minimum of ten years experience in DOE project management of multi-million dollar remedial action projects and experience with radioactive processes.

The DDO Program Manager is supported by several functional staff groups to implement the Decommissioning Plan, including the:

- Site Radiation Safety Officer;
- Quality Engineering Manager;
- Radiological Field Operations Manager;
- Radiological Technical Support Manager; and
- Health Physics Technicians.

Each of these functions is described in Section 2.2 (Decommissioning Organization and Responsibilities) and Section 3.3 (Radiological Protection Program). The job descriptions and qualifications are provided.

7.2.3 Training

The requirements for training have not changed significantly since the previous version of the decommissioning plan. Training is provided as described in Section 2.3, regarding radiation protection as well as quality control. Personnel training is documented and maintained in project files.

7.2.4 Contractor Assistance

Contractors have a variety of assignments during the decommissioning efforts at the BCLDP. Their work is inspected by cognizant Battelle employees to verify that the elements of the decommissioning plan are satisfied. Additional information is provided in Section 2.4.

7.3 Description of Methods Used for Protecting Occupational and Public Health and Safety

The radiological protection program is adequate to evaluate and control personnel and public exposures to radioactive materials during decommissioning activities.

7.3.1 Facility Radiological History Information

The history of radiological information is provided in Section 3.1 of this Plan.

7.3.2 Ensuring that Occupational Radiation Exposures are as low as reasonably achievable

The management of the BCLDP is committed to reducing personnel exposures to radioactive materials to as low as reasonably achievable. BCLDP has established a formal ALARA program administered by the ALARA Coordinator. This program requires ALARA goals and objectives, pre-job and post-job reviews, and performance tracking. Information regarding the ALARA program is found in Section 3.2.

7.3.3 Radiological Protection Program

The current status of the BCLDP radiological protection program is described in Section 3.3. Control of radioactive materials and wastes may also be performed under the requirements of 10 CFR 30.12, 40.11 and 70.11 since they are in general, owned by DOE and Battelle is a DOE Prime Contractor.

7.4 Planned Final Status Survey

A final release survey is performed for the facility that was decommissioned or remediated. All documentation satisfies the NRC requirements described in NUREG-5849 and is sufficient to measure exposures and potential doses in excess of 100 millirem per year. A description of the final status survey is provided in Section 4 of this Plan.

7.5 Funding

The DOE provides the majority of the funding (>90%) for this decommissioning effort. It is estimated that there remains approximately $100 million in costs in this decommissioning effort. The BCLDP is currently undergoing a comprehensive re-baselining planning and scheduling effort. The NRC has recently approved the use of a Self-Guarantee Financial Assurance Mechanism to address Decommissioning Funding requirements. The funding arrangements are provided in Section 5.

7.6 Physical Security Plan

A physical security plan is not required for this effort. The requirement for the security plan was eliminated by the NRC after the bulk of the special nuclear material was shipped off site. Additional information is provided in Section 6.

ENDNOTES

[1] "The U.S. Government and Battelle – Partners in Nuclear Research. 1943 – Present", Report prepared by Battelle for the U.S. Department of Energy, October 1985.
[2] "Battelle-Columbus, 40 Years of Energy Research for the U.S. Government", Internal Report, Battelle Columbus Division, June 1984.
[3] "Environmental Assessment and Finding of No Significant Impact for the Battelle Columbus Laboratories Decommissioning Project", June 1990. DOE document.
[4] "Battelle Columbus Laboratories Decommissioning Project, Project Plan, Revision 1", July 1991.
[5] "Battelle Columbus Laboratories Decommissioning Project, Project Management Plan, Revision 1", October 1992.
[6] U.S. NRC, Letter Pertaining to Oversight Responsibilities and Authority on BCLDP, Charles J. Haughey, US NRC to Martin A. Langsam, DOE-CH, December 18, 1990.
[7] "Termination of Operating Licenses for Nuclear Reactors", NRC Regulatory Guide 1.86, June 1974.
[8] "Battelle Columbus Surplus Facilities Surveillance and Maintenance Program Plan, Revision 1", Prepared by Battelle Nuclear Services, October 1989.
[9] "Radioactive Contamination Monitoring Requirements for Facility Surface Characterization", DD-CP-004.
[10] "Facility Post- Decontamination Final Status Survey for Baseline Area", DD-CP-002.
[11] "Radiological Characterization and Final Status Plan for BCLDP West Jefferson Site", DD-97-02.
[12] "Environmental Monitoring Plan for the BCLDP Project", EM-QAP-1.0.
[13] "Emergency Action Plan", Battelle Columbus Operations, BCO-EP-024.
[14] "Preparation of Procedures", QD-AP-5.1.
[15] "Work Instructions", QD-AP-5.2.
[16] "Document Control", QD-AP-6.1.
[17] "Independent Programmatic Assessments", QD-AP-18.1.
[18] "Independent Activity Assessments", QD-AP-18.2.
[19] "Radionuclide Release into the Environment: Assessment of Doses to Man", ICRP Publication 29, International Commission on Radiological Protection, 1978.
[20] "Limits for Intakes of Radionuclides by Workers", ICRP Publication 30, International Commission on Radiological Protection, 1979-1982.
[21] "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings", 40 CFR Part 192, *Code of Federal Regulations*, July 1988.
[22] "Quality Assurance Plan for Decontamination and Decommissioning Operations in Building 6, 6G-NW Area", QAP-4.1.
[23] "Quality Assurance Plan for Decontamination and Decommissioning Operations in Building 3", QAP-7.1.
[24] "Quality Assurance Plan for Decontamination and Decommissioning Operations in Building A", QAP-11.0.
[25] "Quality Planning", QD-AP-2.2.
[26] "Radiation Protection Program", DD-90-02.
[27] "BCLDP Training Program Plan", DD-93-04.
[28] "The Personnel Training and Qualifications Records System", TD-AP-1.1.
[29] "Indoctrination, Training, and Qualification", TD-AP-2.0.
[30] "Qualification for Critical Procedures", TD-AP-3.0.
[31] "Health Physics Technician Training and Qualification", TD-AP-4.0.
[32] "Radiation Protection Training", TD-AP-5.0.
[33] "Operation of the Project Records Management System" PR-AP-17.1.
[34] "Quality Manual, Decontamination and Decommissioning Operations", DD-MN-01.
[35] "Subcontracting Plan"
[36] "Environmental Report on Radiological and Non-Radiological Parameters", Annual Report, Submitted by Battelle to the U.S. Department of Energy, September 1989.
[37] "Requirements for Reporting Information to the Nuclear Regulatory Commission", HP-AP-7.0.
[38] Docket No. 70-8, 10 CFR Part 21 Report, Letter to the U.S. Nuclear Regulatory Commission, November 11, 1977.
[39] Docket No. 70-8, 10 CFR Part 21 Report, Letter to the U.S. Nuclear Regulatory Commission, July 18, 1980.
[40] E-mail notice from Carl Kohrt, Battelle CEO, to Battelle Staff, ALARA Program, dated June 18, 2002.
[41] "ALARA Program", HP-AP-08.0.
[42] Nuclear Regulatory Commission, 10 CFR 20, "Standards for Protection Against Radiation".

[43] "Radiological Awareness Reports", HP-AP-21.0.
[44] "ALARA Reports", HP-AP-31.0.
[45] "Issue and Use of Radiation Work Permits", HP-AP-1.0.
[46] "Control of Radiation Protection Program Documents", HP-AP-36.0.
[47] Regulatory Guide 8.9, "Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program"
[48] ANSI N323A-1997, "Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments".
[49] "Control of Radiological Measuring and Test Equipment and Instruments (RMTEI)," HP-AP-29.0.
[50] Nuclear Regulatory Commission, Manual for Conducting Radiological Surveys in Support of License Termination, NUREG/CR-5849, June 1992.
[51] "Radiological Characterization and Final Status Plan for BCLDP West Jefferson", DD-07-02.
[52] 1996 Baseline Environmental Management Report (BEMR), in final preparation.