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BENCHMARKING THE REMOTE-HANDLED WASTE FACILITY AT THE WEST VALLEY DEMONSTRATION PROJECT

Topical Report

By
Om P. Mendiratta
David K. Ploetz

September 2000

Work Performed Under Contract No. DE-AC24-81NE44139

Prepared by
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Assistant Secretary for Nuclear Energy

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Benchmarking

We should Compare
Ourselves
with the *Best*,
Learn from them,
and then *Change*
so that We become
Better than the Best.

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ABSTRACT

Facility decontamination activities at the West Valley Demonstration Project (WVDP), the site of a former commercial nuclear spent fuel reprocessing facility near Buffalo, New York, have resulted in the removal of radioactive waste. Due to high dose and/or high contamination levels of this waste, it needs to be handled remotely for processing and repackaging into transport/disposal-ready containers. An initial conceptual design for a Remote-Handled Waste Facility (RHWF), completed in June 1998, was estimated to cost $55 million and take 11 years to process the waste. Benchmarking the RHWF with other facilities around the world, completed in November 1998, identified unique facility design features and innovative waste processing methods. Incorporation of the benchmarking effort has led to a smaller yet fully functional, $31 million facility. To distinguish it from the June 1998 version, the revised design is called the Rescoped Remote-Handled Waste Facility (RRHWF) in this topical report. The conceptual design for the RRHWF was completed in June 1999. A design-build contract was approved by the Department of Energy in September 1999.

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EXECUTIVE SUMMARY

In support of the U. S. Department of Energy's (DOE) decontamination and decommissioning efforts at the West Valley Demonstration Project (WVDP) in West Valley, NY, DOE will construct a Remote-Handled Waste Facility for size-reducing and packaging high-activity radioactive waste for disposal. This report describes benchmarking of the WVDP RHWF through examination and comparison to other radioactive waste handling facilities around the world. Through benchmarking, West Valley Nuclear Services Co., DOE's prime contractor at the WVDP, has made value-added revisions to the RHWF.

The benchmarking process entailed the collection of data and the compilation and examination of similarities and differences between several radioactive waste handling facilities from around the world. Eleven proposed, under construction, or operational facilities were compared to the WVDP's proposed RHWF. However, due to the unique aspects of individual waste streams, differences in regulatory requirements, and widely-varying information available for different facilities, comparisons were not conclusive in all cases.

This report documents the facility comparison process. Throughout this report, differentiation is made between the original design and the redesign of the facility. The original conceptual design of the facility, dated June 1998, is referred to as Remote-Handled Waste Facility (RHWF). The benchmarking process resulted in a redesign of the planned RHWF. The redesigned facility (dated June 1999) is referred to as the Rescoped Remote-Handled Waste Facility (RRHWF). The RRHWF is based on the June 1998 design of the RHWF and incorporates the design changes based on the recommendations from the benchmarking and value engineering processes.

As a result of benchmarking, the confidence level associated with the cost estimates for the RRHWF has been improved. Independent reviews of the facility's cost estimates have resulted in validation of the cost estimates for the RRHWF. The RRHWF is estimated to cost $31 million, compared to $55 million for the RHWF.

The RRHWF will support continued environmental restoration efforts at the WVDP. It is scheduled to operate from 2003 to 2010 and will be used to remotely: unpack, characterize, size-reduce, and package high dose rate and highly contaminated radioactive waste for disposal.

The high dose rate and high contamination levels associated with the wastes destined for the RRHWF necessitated extensive planning and comparison efforts in the early design stages. As a result of the incorporation of benchmarking comparisons, a scaled-down, more cost-effective facility than was originally planned will be constructed at the WVDP. To improve the cost/benefit ratio for handling such wastes, existing facilities will be modified to size-reduce and package some wastes at their point of generation. Remaining wastes already in storage and similar type wastes generated as a result of anticipated decontamination and decommissioning efforts will be processed in the RRHWF. Approximately one-third of the waste to be processed at the RRHWF is currently in temporary storage awaiting processing. The remaining two-thirds will be generated during ongoing and future site closure activities.

Thirteen separate waste streams will be processed in the RRHWF. An additional 11 waste streams will be processed in existing facilities at the WVDP. Within the facility, waste will be sorted and segregated according to radionuclide concentrations. Although many of the waste streams may have radionuclide distributions similar to spent nuclear fuel or high-level waste, the majority of the waste packaged in the RRHWF is expected to be classified as low-level waste. Sorting and segregation activities in the facility are expected to reduce the amount of transuranic waste.

The facility will be a standalone structure, consisting primarily of three concrete-shielded radioactive work cells: Receiving Area, Buffer Cell, and Work Cell. Work will be performed at the direction of operators stationed in a shielded Operating Aisle where they will be able to view the Work Cell through three viewing windows and remotely operate equipment throughout the facility. Wastes will enter the RRHWF at the Receiving Area and be transferred through a Buffer Cell and into the Work Cell through a series of remote operations.

The rescoped facility's features include revising the Receiving Area crane from a 30-ton nuclear grade to a 20-ton commercial grade crane. The thickness of shielding walls has been reduced by the decision to design the facility for the processing of the majority of waste, and only using additional temporary shielding in the few instances it will be necessary. Adjustment in the waste processing plans has resulted in reducing the decontamination facilities required. In the RRHWF, waste decontamination will be conducted on a limited basis, not aggressively as planned in the RHWF.

Simplification of the waste processing plan has resulted in an overall scaled-down facility. Waste processing will be primarily restricted to sorting, sampling, segregating according to size and radioactive contamination, size reduction and limited decontamination, and packaging for off-site disposal. The associated support facilities; which include a contact maintenance area, a secondary waste collection area, truck load-in and load-out areas, heating, ventilation, and air-conditioning, and ventilation stack monitoring equipment; have all been reduced in size and complexity from the RHWF design by designing for a nominal waste stream instead of designing for extreme conditions.

The use of innovative technologies, a reduction in the number of waste streams destined for the facility, a reduction in the shield wall thickness without compromising As Low As Reasonably Achievable (ALARA) principles, and the replacement of the aggressive decontamination system with a simple water jet decontamination system, have increased efficiency and decreased costs without compromising the ability to process waste.

Design and construction of the RRHWF is expected to cost $31 million and take four years to complete. It is expected to process waste for 7 years, in two 8-hour shifts that operate 50 weeks per year. Groundbreaking for the facility is scheduled for October 2000.

1.0 BACKGROUND

The West Valley Demonstration Project (WVDP) is located at the Western New York Nuclear Service Center (WNYNSC), approximately 35 miles south of Buffalo, New York. The WNYNSC reprocessed over 600 metric tons of irradiated fuel between 1966 and 1972; this reprocessing operation also produced more than two million liters (600,000 gallons) of high-level wastes (HLW) stored in subsurface tanks. In 1980, Congress passed the West Valley Demonstration Act authorizing the Department of Energy (DOE) to carry out a high-level radioactive waste management project at the WNYNSC. As part of this demonstration project, low-level radioactive waste (LLW) and transuranic (TRU) waste produced by the solidification of the high-level waste is also to be disposed of. In addition, the DOE is authorized to decontaminate and decommission (D&D) the facilities used in connection with the Project.

Both as a part of facility operations and in support of site remediation efforts, contaminated materials/components have been removed from the process facility and placed into storage to await ultimate disposal. In addition, as D&D efforts intensify at the WVDP, additional materials/components will be removed from the facility for off-site disposal. Before these waste materials can be shipped for disposal, they must be properly characterized, processed as necessary, and packaged to meet both regulatory requirements for transportation and disposal site acceptance criteria. This will necessitate that the wastes be sampled and, if necessary, segmented to facilitate packaging in acceptable containers. Also, sorting and decontamination will be used to minimize the quantities of waste in categories whose disposal costs are projected to be many times that incurred to dispose of LLW. Any site involved in nuclear activities (DOE or commercial) will have similar needs in support of site remediation efforts.

The sorting, segmenting, repackaging, etc. of wastes in preparation for off-site disposal must be performed in either a new facility or an existing facility, modified to meet processing needs, that provides: suitable confinement (including a “nuclear grade” ventilation system) to prevent the spread of contamination, and shielding and remote-handling technologies to ensure radiation exposures to personnel are as low as reasonably achievable (ALARA). The facility where the wastes are to be processed must be sized to support the throughput requirements as well as accommodate waste packages of varying size and weight. The need for these capabilities is not limited to the WVDP.

In June 1998, the West Valley Nuclear Services Co. (WVNS) Remote-Handled Waste Project (RHWP) Team submitted to DOE a conceptual design package of a Remote-Handled Waste Facility (RHWF). The package consisted of two options: (1) a new, standalone facility as the preferred option, and (2) modification to the existing facility that involved retrofitting the Vitrification Cell, Equipment Decontamination Room (EDR), and Chemical Process Cell (CPC). The new facility option was estimated to cost $55 million, and the modifications to the existing facility option required facility operations through 2016; neither of the two options was acceptable to the DOE for immediate implementation. At WVNS management’s initiative, two major activities followed: (a) benchmarking the RHWF against facilities designed to perform similar tasks and (b) Value Engineering of the RHWF. The purpose of the two activities was to identify key variations between the RHWF and other similar facilities, as well as identify innovative technologies for processing waste that could lead to reduced facility cost and an improved processing schedule. As documented in this report, the Rescoped Remote-Handled Waste Facility (RRHWF) accomplishes these objectives; the facility incorporates innovative concepts, provides for use of both new and the existing facilities, and will cost only $31 million.

2.0 SCOPE OF EFFORT

The scope of the benchmarking effort was to collect, compile, and compare data from various radioactive waste processing facilities and present the results of the assessment and any resulting recommendations to management. The following activities were performed:

A. Identified candidate radioactive waste processing facilities within the DOE complex and elsewhere within the worldwide nuclear industry.

B. Identified the types of data to be collected from the other waste processing facilities for benchmarking against the RHWF at the WVDP. Developed a questionnaire to support the information collection effort and ensure uniformity in the data.

C. Collected process facility data. Listed pertinent features of other processing facilities for comparison with the RHWF at the WVDP. Determined similar features and/or differences. Examples of the types of information compiled were:

- Basic facility design (e.g., type of facility [contact-handled {CH}, remote-handled {RH}], facility size, and key similarities and differences)
- Feed waste streams (e.g., types of waste and throughput rates)
- Processing capabilities provided (e.g., sort, segregate, size reduce, volume reduce, characterize, etc.)
- Purpose/objective for selected processes
- Process flow and location of the processing areas.

D. Identified modifications to be made to the June 1998 conceptual design.

E. Provided results of the assessment and made recommendations to WVNS management.

The results of the above activities are documented in this topical report for potential use / reference by the DOE complex.

3.0 BENCHMARKING OBJECTIVES AND APPROACH

3.1 Objectives

The objectives of the benchmarking effort were threefold. First, provide a comparative evaluation of facilities with objectives similar to the WVDP's RHWF. The intent of this comparative evaluation was to determine if the basic concept originally proposed for the RHWF was consistent with similar facilities under development elsewhere. Second, determine the potential for identifying technologies, processes, and/or concepts used in the design of other waste processing facilities that could be integrated into the revised conceptual design of the RHWF. Third, and more importantly, re-evaluate the need for a single new, standalone facility vs. the use of multiple existing facilities.

3.2 Approach

The following approach was developed to conduct the benchmarking study. The plan identified activities, effort involved, and responsibilities. The plan covered the following five areas:

- Identify the RHWP scope of work and proposed plan
- Prepare a list of existing and proposed facilities to be included in the benchmarking study
- Develop a questionnaire to conduct inquiries and collect data for benchmarking
- Determine a format for the best representation of facility data and meaningful comparisons
- Prepare the benchmarking report and make recommendations to WVNS management.

The following is a brief description of the activities undertaken for accomplishing the above-listed topics:

3.2.1 Identify the RHWP Scope of Work and Proposed Plan

- List waste streams within the scope for the RHWP, including waste volumes, number of containers, storage locations, etc.
- Identify key parameters and characteristics of the waste forms, including nuclides, curie levels, hazardous constituents, physical form, etc.
- Determine processing needs and expectations, including regulatory requirements, project mission, and disposal options
- Summarize the waste data into presentable talking points.

3.2.2 Prepare a List of Existing and Proposed Facilities to be Included in the Benchmarking Study

- Prepare a list of facilities within the DOE complex
- Prepare a list of commercial nuclear facilities (including nuclear power plants) processing radioactive waste in the USA

- Prepare a list of foreign nuclear waste processing facilities through personal contact, by researching project historical documents such as Environmental Impact Statements (EIS) and long-range plans, and searching through electronic media resources, including the Internet

- From the above, compile a short list of the facilities to be contacted for the benchmarking effort.

3.2.3 Develop a Questionnaire to Conduct Inquiries and Collect Data for Benchmarking

An exhaustive questionnaire was developed to solicit inquiries from facilities under consideration for benchmarking. The questionnaire helped prompt inquiries in a systematic and effective manner. Use of a list reduced the need for subsequent followup inquiries. It also helped in determining early on: whether the facility qualified for benchmarking, innovative technologies were being deployed, or if there was some other feature of interest to the RHWP, for example, unique facility layout, central location of utilities, support services, etc.

The questionnaire underwent several revisions and expansion as the new information/features for inclusion in the comparisons were revealed in inquiries with the facilities. Another advantage of using the questionnaire was that it provided a standard format for documenting the data used/referenced in the benchmarking study.

3.2.4 Report Format and Presentation of the Comparisons

Early on it became apparent that the RHWF was unique in terms of waste streams, processing methods, and throughput, thus requiring limiting comparisons to key differences and exceptions. Also, condensing an enormous amount of design, budget, and schedule data into a concise, useful summary posed a formidable challenge. The benchmarking effort consequently focused only on features of particular interest or on those that had the potential for incorporation into the RHWP planning and execution.

3.2.5 Prepare the Benchmarking Report and Make Recommendations to WVNS Management

Significant diversity among the facilities that were evaluated and the unique engineering applications noticed at these facilities, led to two sets of recommendations:

- Determine how the RHWF compared with other facilities

- Evaluate what technologies, processes, and project management techniques used should be considered for use in the RHWF.

4.0 FACILITIES EVALUATED UNDER THE BENCHMARKING STUDY

The first significant task of this benchmarking study was the identification of facilities against which to compare the WVDP's RHWF. Different sites within the DOE complex were contacted regarding their Waste Management Plans. DOE's Ten Year Plans and other documents provided by the DOE Environmental Management (EM) Integration Group helped determine an individual site's schedules.

Once a site was known to have RH-transuranic (TRU), CH-TRU, or high-activity waste, the site representatives were asked an initial set of questions. These questions included: the type and quantity of waste at their site, the configuration (container type) and location (storage building, pit) of the waste requiring processing, and the plans for managing that waste. If the site had an existing waste processing facility or envisioned one in the near future, a more detailed survey that utilized a questionnaire specifically developed for this purpose was then conducted.

Follow-up to the surveys involved contacting Environmental Management (EM) Integration representatives, site waste management personnel, and manufacturing and construction subcontractors associated with the waste processing facility. Dialogue with representatives from waste examination entities and waste disposal sites helped provide additional details about particular equipment or processes.

The extent of data available for the facilities also determined whether the sites could be used for benchmarking the RHWF. It was discovered early on that only limited design and operational information was available on facilities within the DOE complex. Most of the other DOE sites plan on processing remote-handled waste in the out years. The survey was therefore expanded to include facilities outside the DOE complex on an international level.

4.1 Facilities Evaluated

Broad-based design information has been collected on four remotely operated waste handling facilities found to have strategies for processing remote-handled waste in a manner similarly to the RHWF:

- Advanced Mixed Waste Treatment Facility (AMWTF) at the Idaho National Engineering and Environmental Laboratory (INEEL) Site
- Transuranic Waste Facility (TWF) at the Savannah River Site
- Transuranic Waste Remedial Facility (TWRF) at the Oak Ridge National Laboratory (ORNL)
- Miscellaneous Beta Gamma Waste Store (MBGWS) at Sellafield, England.

Since initial publication of this benchmarking report, the Remote-Handled Waste Facility (RHWF) has undergone significant changes. A revised, standalone conceptual design for the RHWF that incorporated benchmarking recommendations was issued in June 1999. Thus, two conceptual designs were used for in-depth comparison with the above facilities:

- June 1998, Conceptual Design of the Remote-Handled Waste Facility at the West Valley Demonstration Project, West Valley, New York
- June 1999, Conceptual Design of the Remote-Handled Waste Facility at the West Valley Demonstration Project, West Valley, New York.

Note: To easily differentiate between the two conceptual designs, the second (June 1999) conceptual design is identified as the Rescoped RHWF (RRHWF) throughout this report.

Information was also obtained from other facilities, but was not sufficient to warrant inclusion in the comparative evaluation (matrix) found in this report. A summary description of these facilities is included in order to capture the information that was collected. Specifically, these facilities were:

- The Hauptabteilung Dekontaminationsbetriebe at the Karlsruhe Nuclear Research Center
- BNFL's Low-Level Waste High-Force Compaction Facility at Sellafield, England
- BNFL's Waste Treatment Complex
- Los Alamos' Transuranic Waste Size-Reduction Facility
- The Dekontaminationsbetriebe at the Juelich Nuclear Research Center
- The Siemens Service Center at Karlstein
- The Waste Receiving and Processing (WRAP) Facility at Hanford.

Functionally, each facility is designed to receive TRU and/or LLW retrieved from on-site storage locations and process that waste so that it is in compliance with the appropriate disposal site's waste acceptance criteria. In some cases the waste, whether TRU or LLW, is contact-handled only (e.g., the Transuranic Waste Facility at the Savannah River Site [TWF]), while in other cases the facility may be required to process both contact- and remote-handled wastes (TWRF at ORNL and the RHWF at the WVDP). It was found that regardless of the designation of waste as contact- or remote-handled, the processing activities were performed remotely.

Each facility was designed to process waste. However, what is meant by the term "waste processing" differs for each facility; it can be as simple as emptying old containers and packaging the waste into new containers, or as complex as providing super-compaction, incineration, and vitrification. The facility descriptions documented in this report describe the level of waste processing performed at each facility.

Information on the facilities involved in the comparative evaluation is provided in Section 10.0, Appendices A through G, and the summary comparison is provided in Appendix H, Table H.1-1.

4.2 Features Evaluated

The facilities listed in the previous section have many features in common, as well as some major differences. This section lists features for comparison of the similarities and differences between the WVDP RHWF and each of the other facilities.

A major similarity of these facilities is that they were designed to receive remote-handled and/or contact-handled radioactive waste that is generated at or in storage at each site. Their primary function would be to process the incoming waste for ultimate disposal. However, even with this same objective, the facilities were found to have significant differences in design and cost.

When this effort was initiated, the intent was to determine the drivers governing the design of these types of waste processing facilities. Once these drivers were known, the information would be useful for comparison against the conceptual design for the WVDP's RHWF. The information would also be useful in determining if the RHWF's functionality and cost could be further optimized. A detailed list of these cost drivers is provided in Table 4.2-1.

Table 4.2-1 Typical Cost Drivers for Comparing Waste Processing Facilities

1. **Type of Facility**
   Remote-Handled
   Contact-Handled
   LLW Operations

2. **Purpose of Facility Operations**
   Waste Removal
   Decon Components for Reuse
   Regulatory Directive
   Contractual (volume reduction)
   D&D
   Integrated with Other Facilities

3. **Type of Waste Handled**
   RH-TRU
   CH-TRU
   LLW
   Mixed
   Other

4. **Facility Structure**
   Hot Cells
   Glovebox
   Modules
   Structural Steel Building

5. **Facility Integration**
   New Standalone with Integrated Support Services
   New Standalone with Separate Support Services
   New Standalone with no Support Services
   Use of Existing Facilities and Support Services

6. **Throughput**
   Large (>75K cu ft/yr)
   Medium (20 to 75K cu ft/yr)
   Low (5 to 20K cu ft/yr)
   As Needed (<5K cu ft/yr)

7. **Facility Mode of Operation**
   Continuous (conveyor/line system)
   Batch (1 container at a time)
   As Needed

8. **Facility Design Criteria**
   Site-Specific Requirements
   Multiple Operations/Activities
   Site Environmental Conditions

9. **Unique Safety Features**
   Fissile Material Accounting Instruments
   Radiological Control
   Explosion-Proof Chambers
   Hazard Monitoring & Mitigation Systems

10. **Processing Equipment/Technologies**
    Nuclear Grade Robotics (high cost)
    Industrial Systems (medium cost)
    Work Arounds (low cost)
    Simple Mechanical (sort and segregate)
    Complex Mechanical (compaction, shredding, cementation)
    Thermal (incineration, vitrification) and Complex Chemical

11. **Segmenting Technologies**
    Torch
    Saw
    Shear
    Other

12. **Material Handling Tools/Technologies**
    Remote Manipulators
    Power Manipulator

13. **Waste Characterization Equipment/ Technologies**
    Visual Examination
    Real-Time Radiography (RTR)
    Radiation Survey Meters
    Assay
    Smears and Swipes
    Sampling
    Other

14. **Secondary Waste Treatment System**
    Integrated w/Main Facility
    Separate Standalone Facility
    Portable Modular Units
    Outsourced Services

15. **Waste Characterization Services**
    Integrated w/Main Facility
    Standalone On-Site Facilities
    Portable Modular Units
    Outsourced Services

Table 4.2-1 Typical Cost Drivers for Comparing Waste Processing Facilities (cont.)

16. As-Received Waste Container Configuration
- 55-gallon Drum
- B-25® Box or Equivalent
- Waste Isolation Pilot Project (WIPP) Standard Waste Box (SWB)
- WIPP RH Canister
- Vessels/Equipment
- Other

17. Final Waste Container Configuration
- 55-gallon Drum
- B-25® Box or Equivalent
- WIPP SWB
- WIPP RH Canister
- Other

18. Final Waste Classification
- RH-TRU
- CH-TRU, Greater than Class C (GTCC)
- LLW
- Mixed (LLW and/or TRU)

19. Waste Disposal Locations
- On-Site
- WIPP
- Nevada Test Site (NTS)
- Other

20. In-Facility Transport Systems
- Conveyors
- Monorail
- Overhead Crane
- Jib Crane
- Fork Lifts

21. Waste Transport Systems & Modes
- Configuration:
  - Containers/Overpacks
  - Containerized/Flatbed truck
  - Casks/Flasks
  - Concrete Culverts
  - Other
- Mode:
  - Rail
  - Road
  - Other

22. Unique Regulatory Requirements
- Waste Generation
- Volume Reduction
- Waste Classification
- Waste Acceptance Criteria

23. Unique Operational Requirements
- Processing Approach:
  - Primarily Hands-On
  - Remote-Handled
  - Automated

24. Contracted Services
- Privatization
- Design/Build Contracting
- Incentive-Based Contracting
- Fixed-Price Contracting

25. Project Management
- Single vs. Multiple Contractors
- Integrated with Other Sites/Facilities
- Defined Project Management Plan (PMP)

5.0 FACILITY COMPARISONS

Comparison of the WVDP RHWF to Other Similar Waste Processing Facilities

This chapter provides a narrative comparison of the RHWF with other facilities selected for benchmarking. A subsection has been included to describe the Rescoped Remote-Handled Waste Facility (RRHWF). The modifications noted in the RRHWF resulted from earlier benchmarking efforts. Also, tables and graphs in this chapter provide comparisons with the RRHWF.

It should be noted that the dollar figures in this report represent qualitative values arrived at by: discussions with project personnel, a review of generic cost data available for public dissemination, public relations campaign literature by the projects, and upper tier documents such as an EIS and long-range plans. The dollar figures are represented in FY1998 dollars.

In the comparative subsections that follow, each comparison addresses the following nine topics:

1 - Facility Types
2 - Facility Integration
3 - Waste Types Form
4 - Facility Operating Mode
5 - Throughput
6 - Processing Methodology and Technologies
7 - Secondary Wastes
8 - Final Waste Classification
9 - Waste Disposal.

Subsection Numbering System: When a facility being evaluated could not provide data for a particular subsection in this report, that subsection was skipped, yet the subsection numbering scheme was kept intact. Stated another way, if data for Subsection 5, Throughput, was not available, Subsection 5 was then omitted. The next subsection, 6, Processing Methodology and Technologies, would be numbered as Subsection 6. For example, see Subsection 5.1.8 on page 12.

5.1 Comparison of the WVDP RHWF to the INEEL AMWTF

The comparative information presented below is summarized in Table 5.1-1.

5.1.1 Facility Types

A major difference between the WVDP RHWF and the INEEL AMWTF is that the RHWF was to process RH-TRU waste while the AMWTF will process predominantly CH-TRU waste. The RHWF therefore needed shielded cells with 3 zones of radioactive material confinement, while the AMWTF will need the same confinement capability, but need not be heavily shielded.

Both the RHWF and the INEEL AMWTF were to be new, standalone facilities at their respective sites. However, the RHWF was to be a much smaller facility than the AMWTF. The conceptual design of the RHWF was for a 57' x 101' process building and an attached 45' x 32' receiving area. The planned height was 35'. The volume of the RHWF was to be approximately 250,000 cubic feet.

In comparison, the AMWTF will be much larger. The AMWTF will be a two-story facility with maximum dimensions of 274' x 208' 6" x 42' high, with an attached penthouse with 19,000 ft^2 of floor space and about 18' high. The volume of this facility will be approximately 2,700,000 cubic feet (not including the volume of a separate support building), or more than a factor of ten times larger than the RHWF.

The difference in size is due mostly to the waste processing capabilities of each facility and the associated equipment needed (see Section 5.1.6). The AMWTF incoming waste stream will include significant amounts of combustible material that will be volume-reduced through incineration. The use of an incinerator necessitates an evaporator for treating the off-gas and a system for solidifying the ashes. None of this equipment was needed at the RHWF. Rather, the RHWF was principally for size reduction of large metal components in order to repackage the wastes for economical shipment and disposal.

Note: As of June, 2000 the AMWTF has been rebaselined to exclude incineration and vitrification.

The types of processing equipment in the AMWTF requires that the facility have two main processing sections while the RHWF had only one processing cell. In the AMWTF, one processing section is needed to house the incineration, evaporation, and vitrification equipment that will place a large heat load on the heating, ventilation, and air conditioning (HVAC) system.

Another difference between the two facilities is that the AMWTF will have a larger waste processing throughput than the conceptual RHWF (see Section 5.1.5).

The cumulative effect of these major differences is reflected in the significant difference in capital costs between the facilities. The RHWF was expected to cost $55 million while the AMWTF is currently estimated to cost $300 million.

5.1.2 Facility Integration

The RHWF was designed to be a new, standalone facility that included utilities and other support services. In contrast, the AMWTF has a separate, one-story facility, designated as the Utility Room, measuring 114′ by 64′. The AMWTF Utility Room houses support equipment such as process steam and humidification services including boilers, potable hot water boilers, process cooling water equipment, and the HVAC system.

One support activity that the RHWF did not include in the building was an analytical laboratory. A limited amount of sample preparation was to be performed in the RHWF. The RHWF did not duplicate other on-site facilities that were available for sample analysis. Should those existing laboratory facilities have been decommissioned, then their capabilities could have been integrated (moved) into an add-on module attached to the RHWF. At the AMWTF, the analytical laboratory will be located on the second floor and will include the equipment needed to fully support operations.

5.1.3 Waste Types/Form

The RHWF was designed to process RH-TRU waste and would have also processed CH-TRU, RH-LLW, and CH-LLW. The AMWTF is designed primarily for processing CH-TRU waste and will also process some RH-TRU and LLW. For the majority of the wastes expected at both facilities, the incoming waste containers consists of drums and boxes. Both facilities would also limit the incoming waste streams based on container size, weight, and radiation levels, although to significantly different values.

The differences in the sizes of the incoming boxes reflect that the RHWF was designed to remotely handle large plutonium uranium extraction (PUREX) process components (i.e., metal vessels, pumps, and piping) and segment them as needed. In comparison, the AMWTF is mostly limited to contact-handling and processing smaller size waste containers. The largest incoming waste boxes were significantly larger for the RHWF than for the AMWTF. The AMWTF limits boxes to 4' x 4' x 6', while the RHWF was sized to accept a dissolver box at 12' x 12' x 20' and a Waste Tank Farm (WTF) pump box at 4' x 4' x 50'.

Another difference in waste types processed at each facility is that the AMWTF will accept wastes from the INEEL site for processing while the RHWF had no plans to accept off-site wastes.

Both facilities were designed to accept similar types of waste: primarily dry active waste materials including metals, paper, old anti-C’s, rubber, plastic, wood, used process components, general debris, etc. The AMWTF is expected to process graphite, ceramics, bricks, and soils that would not have been present in the RHWF waste streams. The RHWF was designed to process minor amounts of ion-exchange resins.

5.1.4 Facility Operating Mode

A large difference between the operating modes of the two facilities is the planned utilization of the facilities. Because the AMWTF will contain an incinerator and a vitrification system, this facility is to be operated year-round. These types of systems are designed to operate 24 hours per day, 365 days per year to minimize the number of times that the equipment is heated-up and cooled-down. In contrast, the RHWF was sized to process the incoming waste streams using a standard 5 day work week (250 work days/year).

Another difference found was in the approach used to handle incoming waste streams. The AMWTF is designed with two parallel waste pretreatment lines. One of these lines is for opening incoming drums and the other is for opening boxes. In comparison, the RHWF had one incoming waste stream. However, the RHWF could accept any type of incoming waste container for processing at any one of the four work stations.

5.1.5 Throughput

The total and annual waste throughput for each facility is:

INEEL’s AMWTF	
Total Life Cycle Throughput 3,000,000 ft^3	Annual Throughput 231,000 ft^3
WVDP’s RHWF	
Total Life Cycle Throughput 102,000 ft^3	Annual Throughput 9,300 ft^3

In spite of the large differences in the total amount of waste planned to be processed and the expected annual throughput, the planned operating lives of these two facilities is similar. The AMWTF has an operating life of 13 years and the RHWF had a planned operating life of 11 years.

5.1.6 Processing Methodology and Technologies

Waste processing steps that are common to both facilities involve opening, sorting, segmenting, and repackaging. Both facilities use power manipulators and remote manipulators (MSMs) for these activities.

The differences in processing between these facilities are remote- versus contact-handling. The provisions for shielded enclosures/cells and remote handling of the waste help to reduce the total dose commitment to the worker, considering that CH-TRU waste could have associated radiation levels up to 200mR/hour.

Also, volume-reduction processes will be used at the AMWTF. Additional processing equipment at the AMWTF consists of an X-ray system for inspection of container contents, a shredder, a super-compactor, a sludge sampling station, an incinerator, an evaporator, a vitrification system, a vibro-chute, a shuttle trolley, and a special case waste glovebox. In comparison, a decontamination system was the only waste processing system that was to be provided at the RHWF that was not planned to be installed in the AMWTF.

5.1.7 Secondary Wastes

For waste processing activities involving sorting and segmenting of waste feed material, both facilities would generate secondary wastes such as worn out equipment (broken shears, dull saw blades, etc.). Both facilities also had secondary waste water that would be collected in tanks for processing, with the water being recycled in the facility.

The secondary wastes to be generated only at the AMWTF include the incinerator off-gas, the incinerator ashes, the scrubber solutions generated from the incinerator off-gas treatment system, and the discharge from the evaporators. In comparison, the secondary wastes generated only at the RHWF would have included the spent filter elements and expended ion-exchange media.

5.1.8 Final Waste Classification

This subsection omitted per subsection numbering system described in Section 5.0, Facility Comparisons, on page 9.

5.1.9 Waste Disposal

This subsection omitted per subsection numbering system described in Section 5.0, Facility Comparisons, on page 9.

Table 5.1-1. Summary of the Differences and Similarities Between the WVDP RHWF and the INEEL AMWTF		
Subject Area	**Differences**	**Similarities**
5.1.1 Facility Type	Total capital costs are $300M for the AMWTF vs. $55M for the RHWF	Both are standalone facilities
	Volume of the process building is 2,700,000 cu ft for the AMWTF vs. 250,000 cu ft for the RHWF	Both are designed with work cells isolated by three zones of confinement
	The AMWTF has two parallel, redundant HEPA filter trusses	
5.1.2 Facility Integration	An Analytical Laboratory within the AMWTF Facility. The RHWF depended on other on-site facilities for sample analysis	Both have TRU waste characterization equipment
	A separate building for process-related utility services at the AMWTF. No process services were required at the RHWF	
5.1.3 Waste Types/Form	The AMWTF processes CH-TRU waste vs. RH-TRU waste for the RHWF	Processed wastes packaged in drums and boxes
	The AMWTF processes a large amount of combustibles vs. mostly inorganic wastes at the RHWF	Facility processing limitations are based on container size, weight, & radiation level
	The RHWF was designed to handle large components and segment them as needed. The AMWTF processes relatively smaller size wastes.	Both process TRU waste in the form of metal, organic, and inorganic debris; both heterogeneous and homogeneous
	The AMWTF can handle 4'x4'x6' or smaller boxes vs. 12'x12'x20' or 4'x4'x50' boxes for the RHWF	
	Off-site waste streams that meet the size, weight, and dose rate limits could be processed at the AMWTF	
	The AMWTF will also process graphite, ceramic/brick debris, and soils	
5.1.4 Facility Operating Mode	24 hr/day 365 days/yr at the AMWTF vs. 5 days/week at the RHWF	
	Two waste pretreatment lines (one for drums and one for boxes) at the AMWTF vs. four work stations (for all types of containers) at the RHWF	

Table 5.1-1 (cont.)

Subject Area	Differences	Similarities
5.1.5 Throughput	231,000 cu ft per year of dry active waste at the AMWTF vs. 9,300 cu ft per year of dry active waste at the RHWF An expected total of 3,000,000 ft^3 of dry active waste for the AMWTF vs. 102,000 ft^3 for the RHWF	Operating life is approximately the same for both; 13 years at the AMWTF vs. 11 years at the RHWF
5.1.6 Processing Methodology and Technologies	Processing equipment at the AMWTF that is not installed in the RHWF: X-ray, shredder, super-compactor, grouting system for macroencapsulation, sludge sampling station, incinerator, evaporator, vitrification system, vibro-chute, shuttle trolley, and a special case waste glovebox* Processing equipment at the RHWF that is not installed in the AMWTF: decontamination system Power manipulators and MSMs are used to open containers, sort, size-reduce, and repackage waste	
5.1.7 Secondary Wastes	AMWTF-generated secondary wastes not generated at the RHWF include: incinerator off-gas, incinerator ashes, incinerator off-gas scrubber solutions, and evaporator-dried salts RHWF-generated secondary wastes not generated at the AMWTF include: spent filter elements and expended ion-exchange media from the treatment of secondary waste	Both facilities would generate spent cutting tools and equipment Both facilities would collect waste water in tanks for processing and recycle the processed water

****Note: As of June, 2000 the AMWTF has been rebaselined to exclude incineration and vitrification.***

5.2 Comparison of the WVDP RHWF to the SRS TWF

The comparative information presented below is summarized in Table 5.2-1.

5.2.1 Facility Types

A major difference between the WVDP RHWF and the SRS TWF is that the RHWF was to process RH-TRU waste while the TWF was to process only CH-TRU waste. The RHWF, therefore, needed shielded cells with 3 zones of radioactive material confinement, while the TWF needed the same confinement capability, but did not need to be heavily shielded.

Both the WVDP RHWF and the SRS TWF were to be new, standalone facilities at their respective sites. However, the RHWF was to be a much smaller facility than the TWF. The conceptual design of the RHWF was for a 57' x 101' process building and an attached 45' x 32' receiving area. The facility had a height of 35'. The volume of the RHWF was to be approximately 250,000 cubic feet.

In comparison, the TWF was larger. The TWF was to be a three-story facility with maximum dimensions of 174' x 274' x 45' (two stories or 33' above grade). The volume of this facility was approximately 1,400,000 cubic feet, or a factor of about five times larger than the RHWF.

Part of the difference in size was due to differences in the waste processing capabilities that each facility was to have and the associated equipment needed (see Section 5.2.6).

The two facilities had different layouts for the processing areas. The design of the TWF had multiple processing areas while the RHWF would have had one processing cell. In the TWF, two processing areas were to be hardened for safe handling, venting, and purging of waste containers that may have accumulated combustible concentrations of gases during storage.

Another difference in the facilities was the design of the HVAC systems. The TWF had two independent ventilation systems. One was specifically for the processing areas and the other was for the other radiologically controlled areas. The TWF had a separate Process Off-Gas System Building. In comparison, the RHWF had one system where the air flow was from an area of low potential airborne contamination to an area with a higher potential. The HVAC system was integrated into the facility.

The cumulative effect of these major differences was the significant difference in capital costs between facilities. The RHWF was expected to cost $55 million while the TWF was estimated to cost $228 million (1998).

5.2.2 Facility Integration

The RHWF was designed to be a new, standalone facility for most activities that would be needed to support its operation including a modest amount of office space and a breakroom area. In comparison, the TWF would have had a separate Solid Waste Support Facility that would have provided clean services such as a lunchroom, offices, etc.

One support activity that the RHWF did not include in the building was an analytical laboratory. The RHWF depended on other on-site facilities for its sample analysis. At the TWF, the Analytical Laboratory would have been included with the Health Physics area located inside the facility. However, the equipment needed for in-process characterization of TRU waste was not included in the TWF, but was to be provided in the RHWF.

5.2.3 Waste Types/Form

The RHWF was designed to process RH-TRU, CH-TRU, RH-LLW, and CH-LLW. The TWF was designed for processing CH-TRU and not for RH-TRU. For the majority of the wastes expected at both facilities, the containers would be drums and boxes. Both facilities would also limit the incoming waste streams based on container size, weight, and radiation levels, although to significantly different values.

The RHWF was designed to handle large, used PUREX process components (i.e., metal vessels, pumps, and piping) and segment them as needed. In comparison, the TWF was to be limited to processing relatively smaller sized wastes that were already size-reduced to fit into a drum or large plywood waste box. The incoming waste boxes would have been larger for the RHWF than for the TWF. The TWF limited overpack boxes to 12' x 18' x 7' and plywood waste boxes to 8' x 12' x 6', while the RHWF was sized to accept a dissolver box at 12' x 20' x 12' and a WTF pump box at 4' x 4' x 50'.

Both facilities would have accepted similar types of waste: primarily dry active waste materials including metals, paper, old anti-Cs, rubber, plastic, wood, used process components, general debris, etc.

5.2.4 Facility Operating Mode

One difference between facility operating modes was in the approach to handling incoming waste streams. The TWF was designed to repackage TRU wastes for disposal. The incoming waste containers would have been handled with a production line conveyor moving the waste from cell to cell. In comparison, the RHWF had only one cell equipped with four identical work stations where any type of incoming waste could be processed to completion.

The facilities also had different planned utilization. The TWF was to operate 24 hours per day with 65% availability. In contrast, the RHWF was to operate 5 days per week with 75% availability of the 4 work stations.

5.2.5 Throughput

The total and annual waste throughput for each facility was as follows:

SRS's TWF	
Total Life Cycle Throughput 480,000 ft^3	Annual Throughput 25,500 ft^3
WVDP's RHWF	
Total Life Cycle Throughput 102,000 ft^3	Annual Throughput 9,300 ft^3

The planned operating lives of these two facilities was also different. The TWF had an expected operating life of 18 years while the RHWF was to be in operation for only 11 years.

5.2.6 Processing Methodology and Technologies

Waste processing steps that were common to both facilities involve opening, sorting, segmenting, and repackaging. Both facilities would have used power manipulators and MSMs for these activities.

The differences in processing between these facilities were related to processing equipment at the TWF that was not, by design, to be installed in the RHWF. This equipment included a motor-driven shredder, telerobots, plasma arc cutting torches, and real-time radiography equipment. In comparison, equipment in the RHWF that was not in the TWF included a decontamination system, remote cutting saws and shears, a bridge crane-mounted power manipulator mounted on a telescoping tube, and power manipulators mounted on moveable jib cranes.

5.2.7 Secondary Wastes

For waste processing activities involving sorting and segmenting of waste feed material, both facilities would generate secondary wastes such as spent equipment (broken or dull cutting components, etc.). Both facilities also would have collected waste water in tanks. At the TWF, a small volume of secondary waste was expected since the only waste water was to have been incidental amounts removed from incoming waste containers that would have been solidified. At the RHWF, the decontamination system would have resulted in secondary wastes including spent filter elements and expended ion-exchange media.

5.2.8 Final Waste Classification

The final classification of finished TRU containers produced at the TWF was to be performed at a separate Waste Certification Facility elsewhere at the Savannah River Site (SRS).

At the RHWF, all sampling and analysis activities needed for waste disposal classification were to be accomplished prior to and during packaging.

5.2.9 Waste Disposal

The LLW, sorted out of the incoming wastes at the TWF, would have been sent to the on-site LLW burial grounds. All radioactive waste forms generated at the RHWF would have been sent off site for disposal.

Table 5.2-1. Summary of the Differences and Similarities Between the WVDP RHWF and the SRS TWF		
Subject Area	**Differences**	**Similarities**
5.2.1 Facility Type	Process cell was shielded at the RHWF, but not at the TWF Capital costs are $228M (1998) for the TWF vs. $55M for the RHWF Volume of the Process Building was 1,400,000 cu ft for the TWF vs. 250,000 cu ft for the RHWF Two independent HVAC systems, one for the Process Area and one for Radiologically Controlled Areas in the TWF Separate Process Off-Gas System Building for the TWF Nuclear-grade HVAC system integrated into the facility at the RHWF Two hardened areas and the ability to purge waste containers with nitrogen at the TWF	Both were standalone facilities Both were designed with work cells isolated by three zones of confinement, with air flow from cleaner to more contaminated areas
5.2.2 Facility Integration	Analytical laboratory within the TWF facility, but not the RHWF Separate Solid Waste Support Facility at the TWF for administrative functions TRU waste characterization equipment in the RHWF, but not the TWF	
5.2.3 Waste Types/Form	The TWF was to process CH-TRU waste vs. RH-TRU waste for the RHWF The RHWF was designed to handle large, used components and segment them as needed The TWF was designed to repackage TRU wastes contained in 55-gallon drums and large plywood boxes	Processed wastes were to be packaged in drums and boxes Facility processing limitations were based on container size, weight, and radiation level Both facilities would have processed TRU waste in the form of metal, organic, inorganic debris, and both heterogeneous and homogeneous solids
5.2.4 Facility Operating Mode	At the RHWF, processing work was to be accomplished at four identical work stations in the Work Cell The TWF was designed with a production line conveyor moving the waste from cell to cell 24 hr/day at 65% availability factor at the TWF vs. 5 days/week at 75% at the RHWF	

Table 5.2-1. (cont.)

Subject Area	Differences	Similarities
5.2.5 Throughput	25,500 cu ft per year of dry active waste at the TWF vs. 9,300 cu ft per year of dry active waste at the RHWF An expected total of 480,000 ft^3 of dry active waste for the TWF vs. 102,000 ft^3 for the RHWF Operating life of 18 years for the TWF vs. operating life of 11 years for the RHWF	
5.2.6 Processing Methodology and Technologies	Processing equipment at TWF that was not installed in RHWF: shredder, tele-robots, plasma arc cutting torches, real-time radiography Processing equipment at RHWF that was not installed in the TWF: decontamination system, remote cutting saws and shears, bridge crane-mounted PaR® arm, and jib-mounted powered manipulators	Remote-controlled manipulators used to open containers, sort, size-reduce, and repackage waste
5.2.7 Secondary Waste	Only a small volume of secondary waste would have been generated at the TWF RHWF-generated secondary wastes would have included spent filter elements and expended ion-exchange media from decontamination activities Processed water was to be recycled at the RHWF and water found in waste containers was to be solidified at the TWF	Both facilities would have generated spent cutting tools and equipment Both facilities would have collected waste water in tanks for processing
5.2.8 Final Waste Classification	Finished TRU packages at the TWF were to be sent to a Waste Certification Facility at SRS for final classification All sampling/analysis for waste classification/ certification was to be accomplished prior to and during packaging at the RHWF	
5.2.9 Waste Disposal	The LLW sorted out from TRU waste was to be buried at SRS All forms of waste from the RHWF were to be shipped off site for disposal	

5.3 Comparison of the WVDP RHWF to the ORNL TWRF

The comparative information presented below is summarized in Table 5.3-1.

5.3.1 Facility Types

The WVDP RHWF and the ORNL TWRF were designed to process RH-TRU and other types of waste and would need shielded cells with 3 zones of radioactive material confinement.

Both were to be new, standalone facilities at their respective sites and have separate construction access from the rest of the site.

There is a difference in capital costs between the facilities. The RHWF was expected to cost $55 million, while the TWRF is estimated to cost $101 million. This $101 million is the combined cost of $24 million for permitting and licensing and $77 million for construction and preoperational testing. These values are combined to provide the total capital cost since construction cannot begin without the necessary permits and licenses. The cost of the RRHWF is estimated to be $30 million.

5.3.2 Facility Integration

This subsection omitted per subsection numbering system described in Section 5.0, Facility Comparisons, on page 9.

5.3.3 Waste Types/Form

Both the RHWF and TWRF were designed to process RH-TRU waste as well as CH-TRU, RH-LLW, and CH-LLW. The TWRF is designed to process a large volume of RH-TRU sludge and LLW supernate. Both facilities would process dry active solids in drums and boxes. Both facilities would also limit the incoming waste streams based on container size, weight, and radiation levels that were likely to have similar values based on the sources of the ORNL wastes (i.e., wastes from reactor operations and fuel reprocessing).

The TWRF facility is also expected to treat some solid waste by repackaging it and compacting it as necessary to achieve a 50% volume reduction factor. This suggests that there would have been differences in the sizes of incoming boxes between the TWRF and the RHWF. The largest waste boxes coming into the RHWF would have probably been significantly larger than those for the TWRF. The RHWF was designed to handle large, used PUREX process components (i.e., metal vessels, pumps, and piping) and segment them as needed. The RHWF was sized to accept a dissolver box at 12' x 20' x 12' and a WTF pump box at 4' x 4' x 50'. In comparison, the TWRF may be limited to processing smaller size wastes that are already size-reduced enough to fit into a drum or large waste box.

Both facilities would accept similar types of dry active waste including metals, paper, old anti-Cs, rubber, plastic, wood, used process components, general debris, etc.

The TWRF may treat wastes from other DOE sites if the Waste Isolation Pilot Plant (WIPP) is open and no excessive storage time is required at the ORNL TWRF. The RHWF had no plans to accept off-site wastes.

5.3.4 Facility Operating Mode

Based on the waste streams to be processed, there would be a difference between facility operating modes. The RHWF had four identical work stations where any type of incoming waste container could be processed.

To accommodate the types of wastes coming into the TWRF, this facility will be designed as three distinct process operations: a subsystem to evaporate liquid waste, a system to compact dry active waste, and a system to macroencapsulate mixed waste materials.

5.3.5 Throughput

The total and annual waste throughput for each facility is as follows:

ORNL's TWRF	
Total Life Cycle Throughput	Annual Throughput
143,000 ft^3	44,150 ft^3
WVDP's RHWF	
Total Life Cycle Throughput	Annual Throughput
102,000 ft^3	9,300 ft^3

The planned operating lives of these two facilities is also different. The TWRF has an expected processing schedule of 2 years, while the RHWF was to be in operation for 11 years.

5.3.6 Processing Methodology and Technologies

Waste processing steps that were common to both facilities involve opening, sorting, and repackaging. For RH wastes, both facilities would use power manipulators and MSMs for these activities. For CH-wastes, the TWRF may also have gloveboxes for these activities.

The differences in processing between these facilities are reflected in processing equipment at TWRF that was not in the design of the RHWF. This equipment included gloveboxes for CH-wastes, an evaporator, a compactor, and a macroencapsulation system for mixed wastes. In comparison, the equipment designed to be at the RHWF that is not at the TWRF included a decontamination system, remote cutting saws and shears, a PaR®, and powered manipulators mounted on moveable jib cranes and on a telescoping tube mounted on the overhead bridge crane.

5.3.7 Secondary Wastes

The TWRF will generate an evaporator distillate as a secondary waste stream. At the RHWF, the decontamination system would have resulted in secondary wastes including spent filter elements and expended ion-exchange media.

5.3.8 Final Waste Classification

This subsection omitted per subsection numbering system described in Section 5.0, Facility Comparisons, on page 9.

5.3.9 Waste Disposal

This subsection omitted per subsection numbering system described in Section 5.0, Facility Comparisons, on page 9.

Table 5.3-1 Summary of the Differences and Similarities Between the WVDP RHWF and the ORNL TWRF		
Subject Area	**Differences**	**Similarities**
5.3.1 Facility Type	Total capital costs are $101M for the TWRF vs. $55M for RHWF	Both standalone facilities are designed to be constructed with separate construction access Both are designed with shielded work cells isolated by three zones of confinement, with flow from cleaner to more contaminated areas
5.3.3 Waste Types/Form	The RHWF was designed to handle large components and segment them as needed The TWRF is designed primarily to process a large volume of RH-TRU sludge and LLW supernate, and a smaller volume of solid TRU and mixed waste The TWRF may also receive wastes from other DOE complex facilities, while the RHWF would not	Designed to process RH-TRU, CH-TRU, RH-LLW, and CH-LLW Dry active wastes packaged in drums and boxes including metals, paper, rubber, plastic, etc. The facility dry active waste processing limitations were based on container size, weight, and radiation level
5.3.4 Facility Operating Mode	At the RHWF, most processing work for opening, sorting, segmenting, and repackaging was to be accomplished at four identical work stations The TWRF is designed as three process subsystems to evaporate liquid waste, compact dry active waste, and macroencapsulate mixed waste	
5.3.5 Throughput	44,150 cu ft per year at the TWRF vs. 9,300 cu ft per year of dry active waste at RHWF An expected total of 143,000 ft^3 for the TWRF vs. 102,000 ft^3 for the RHWF Proposed operating life of 2 years for the TWRF vs. 11 years for the RHWF	
5.3.6 Processing Methodology and Technologies	Processing equipment at the TWRF that would not have been installed in the RHWF: gloveboxes for CH-wastes, an evaporator, a compactor, and a macroencapsulation system for mixed wastes Processing equipment at RHWF that will not be installed in TWRF: a decontamination system, and remote cutting saws and shears	Remote-controlled manipulators used to open containers, sort, and repackage RH-waste
5.3.7 Secondary Waste	The evaporator distillate will be the predominant secondary waste stream generated at the TWRF The RHWF would have generated spent filter elements and expended ion-exchange media from processing large volumes of water used for decontamination	

5.4 Comparison of the WVDP RHWF to the MBGWS at Sellafield, England

The comparative information presented below is summarized in Table 5.4-1.

5.4.1 Facility Types

The WVDP RHWF was designed to process RH waste (both TRU and LLW) and the Sellafield MBGWS is designed to process intermediate-level waste. These wastes have similar dose rates and require shielded cells for remote handling. Also, the radioactive material requires confinement and isolation by controlled barriers within the facilities. Other intermediate-level waste items, such as ventilation filters and scrap metallic objects, are packaged and stored in the MBGWS. Note the most common types of intermediate-level wastes, such as fuel cladding, sludges, and resins that are encapsulated in cement, are not brought to the MBGWS. Since intermediate-level wastes come from the Sellafield reprocessing plant, they are similar to the RH wastes that were expected at the RHWF.

The RHWF was to be a new, standalone facility at the WVDP site like the MBGWS is at the Sellafield site. The volume of the MBGWS Process Building is 1.4 million cu ft and 250,000 cu ft for the RHWF. The volume of the shielded process cells is estimated to be approximately 750,000 cu ft for the MBGWS and would have been 70,000 cu ft for the RHWF. The shield walls are 39" (1 meter) thick at the MBGWS vs. 24" thick at the RHWF.

The MBGWS has a separate shielded vault for storing 106,000 cu ft of boxed waste. No space was allotted for waste storage at the RHWF.

The difference in capital costs between facilities is: the RHWF was expected to cost $55 million while the cost for the MBGWS is $114 million (1998).

5.4.2 Facility Integration

This subsection omitted per subsection numbering system described in Section 5.0, Facility Comparisons, on page 9.

5.4.3 Waste Types/Form

The RHWF was designed to process RH-TRU waste and CH-TRU, RH-LLW, and CH-LLW. The RHWF was designed to handle drums, boxes, and other containers of waste. These wastes included large, used PUREX process components (i.e., metal vessels, pumps, and piping) that were to be segmented as needed.

The MBGWS is only for intermediate-level wastes. The MBGWS accepts waste only in a large disposable liner or smaller packages within a reusable liner. The liners are delivered in various standard-size shielded containers (flasks). The MBGWS does not process wastes but rather repackages and stores the waste.

5.4.4 Facility Operating Mode

Based on the waste streams to be handled, there is a difference between facility operating modes. The RHWF had four identical work stations where any type of incoming waste container could be processed. The MBGWS is designed with one distinct production line for opening flasks, sorting wastes, and repackaging wastes for storage.

5.4.5 Throughput

The total and annual waste throughput for each facility is as follows:

Sellafield's MBGWS	
Total Life Cycle Throughput	Annual Throughput
106,000 ft^3	5,300 ft^3
WVDP's RHWF	
Total Life Cycle Throughput	Annual Throughput
102,000 ft^3	9,300 ft^3

The planned operating lives of these two facilities is also different. The MBGWS has an operating life of 20 years (50 years for storage) while the RHWF was to be in operation for 11 years.

5.4.6 Processing Methodology and Technologies

The differences in processing between these facilities are related to the lack of processing at the MBGWS that does not include a decontamination system, remote cutting saws and shears, and powered manipulators.

5.4.7 Secondary Wastes

The RHWF's decontamination system would have resulted in secondary wastes including spent filter elements and expended ion-exchange media. The MBGWS has a much smaller volume of liquid waste that is generated from the more limited decontamination of processing equipment and shipping containers.

5.4.8 Final Waste Classification

This subsection omitted per subsection numbering system described in Section 5.0, Facility Comparisons, on page 9.

5.4.9 Waste Disposal

This subsection omitted per subsection numbering system described in Section 5.0, Facility Comparisons, on page 9.

Table 5.4-1 Summary of the Differences and Similarities Between the WVDP RHWF and the MBGWS		
Subject Area	**Differences**	**Similarities**
5.4.1 Facility Type	The projected capital costs for the MBGWS is $114M (1998) vs. $55M for RHWF The volume of the MBGWS Process Building is 1.4 million cu ft and 250,000 cu ft for the RHWF The MBGWS has a separate shielded vault for storing 106,000 cu ft of boxed waste. No space was allotted for waste storage at the RHWF The volume of the shielded process cells is estimated to be 750,000 cu ft for the MBGWS and 70,000 cu ft for the RHWF The shield walls are 39” (1 meter) thick at the MBGWS vs. 24” thick at the RHWF	Both are standalone facilities Both are designed with shielded work cells isolated by controlled barriers
5.4.3 Waste Types/Form	The RHWF was designed to handle large components and segment them as needed, while the MBGWS does not process wastes but rather repackages and stores it The RHWF was designed to process RH-TRU, CH-TRU, RH-LLW, and CH-LLW, while only intermediate level waste is accepted at the MBGWS The RHWF was designed to handle drums, boxes, and other containers, while the MBGWS only accepts waste in a liner	Both have fissile material characterization equipment Facility processing limitations are based on container size, weight, and radiation level Both accept dry active wastes
5.4.4 Facility Operating Mode	At the RHWF, most processing work was to be accomplished at four identical work stations for opening, sorting, segmenting, and repackaging The MBGWS is designed to repackage the waste in a single processing line	
5.4.5 Throughput	5,300 cu ft per year at the MBGWS vs. 9,300 cu ft per year at the RHWF The MBGWS has an operating life of 20 years for processing waste (50 years for interim storage) vs. 11 years for the RHWF	Total projected volume of waste to be processed/handled: 106,000 cu ft at the MBGWS vs. 102,000 cu ft at the RHWF

Table 5.4.1 (cont.)

Subject Area	Differences	Similarities
5.4.6 Processing Methodology and Technologies	The MBGWS is only designed to repackage waste and does not have: a decontamination system, remote cutting saws and shears, PaR®, or jib-mounted power manipulators needed for processing wastes at the RHWF	
5.4.7 Secondary Waste	RHWF-generated spent filter elements and expended ion-exchange media from processing large volumes of liquid decontamination solutions The MBGWS has a much smaller volume of liquid waste from decontamination of processing equipment and shipping containers	

5.5 A Summary of the Facility Comparisons with the RHWF

The comparisons of the four waste processing facilities described above with the RHWF are summarized in this section. Table 5.5.1 summarizes facility schedule for design, construction, and operations.

Table 5.5-1 Facility Schedule

	AMWTF	TWRF	MBGWS	TWF	RHWF
Design	2-1/2 yrs	2 yrs	U[1]	2-1/2 yrs	2-1/2 yrs
Construction	4 yrs	2 yrs	U	4 yrs	4 yrs
Operation	20 yrs	2 yrs	20 yrs[2]	18 yrs	11 yrs

1 U = Unknown
2 Processing segment has a 20-year operating life and the storage vault has a 50-year operating life

The basic data on the scope of these different facilities is also presented graphically in Figure 5.5-1, which shows the number of years of expected operation, the total amount of waste to be processed, and the corresponding throughput per year for each of the five facilities. The years of operation range from 2 years for the TWRF to 20 years for the MBGWS, with the RHWF near the center of this range at 11 years. The total expected throughput ranges from 88,000 ft^3 for the TWRF to 3,000,000 ft^3 for the AMWTF. The RHWF is near the lower end of this range at 102,000 ft^3. The annual throughput ranges from 5,300 ft^3/yr for the MBGWS to 231,000 ft^3/yr for the AMWTF. The RHWF is also near the lower end of this range at 9,300 ft^3/yr.

Figure 5.5-2 shows a "unit cost" comparison for the various facilities. The design and construction cost was divided by the total throughput for each of the facilities to determine the cost per cubic foot of waste processed, based on facility (not operational) costs. The results range from \$100/ft^3 for the AMWTF to \$1,150/ft^3 for the TWRF. The RHWF is near the middle of this range at \$540 ft^3/yr.

Figure 5.5-3 shows another "unit cost" comparison. The design and construction cost was divided by the annual throughput for each of the facilities to determine the cost per cubic foot of waste processed per year. These results range from \$1,300/ft^3/yr for the AMWTF to \$21,500/ft^3/yr for the MBGWS. The RHWF is \$5,900/ft^3/yr.

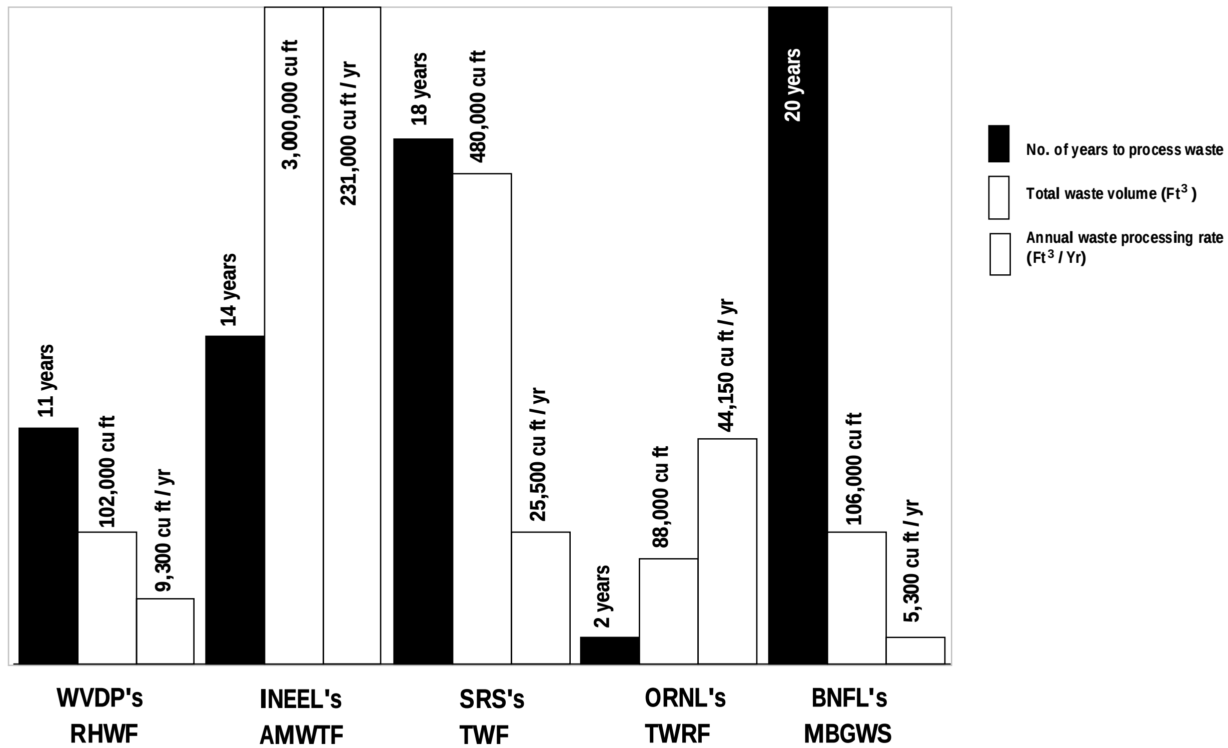

Figure 5.5-1. Comparison of Facility Operating Life, Total Throughput, and Annual Processing Rate

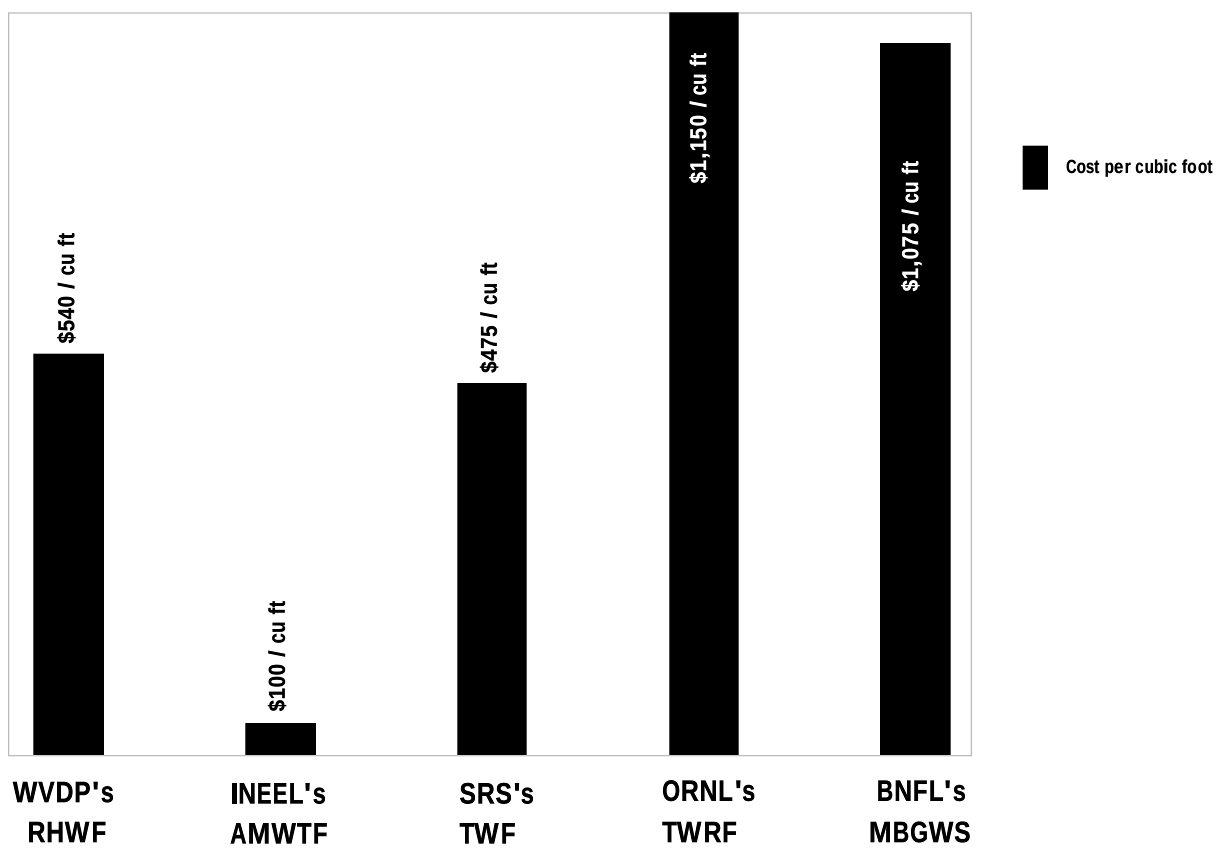

Figure 5.5-2. Cost per Cubic Foot of Waste Processed (Total Throughput Basis)

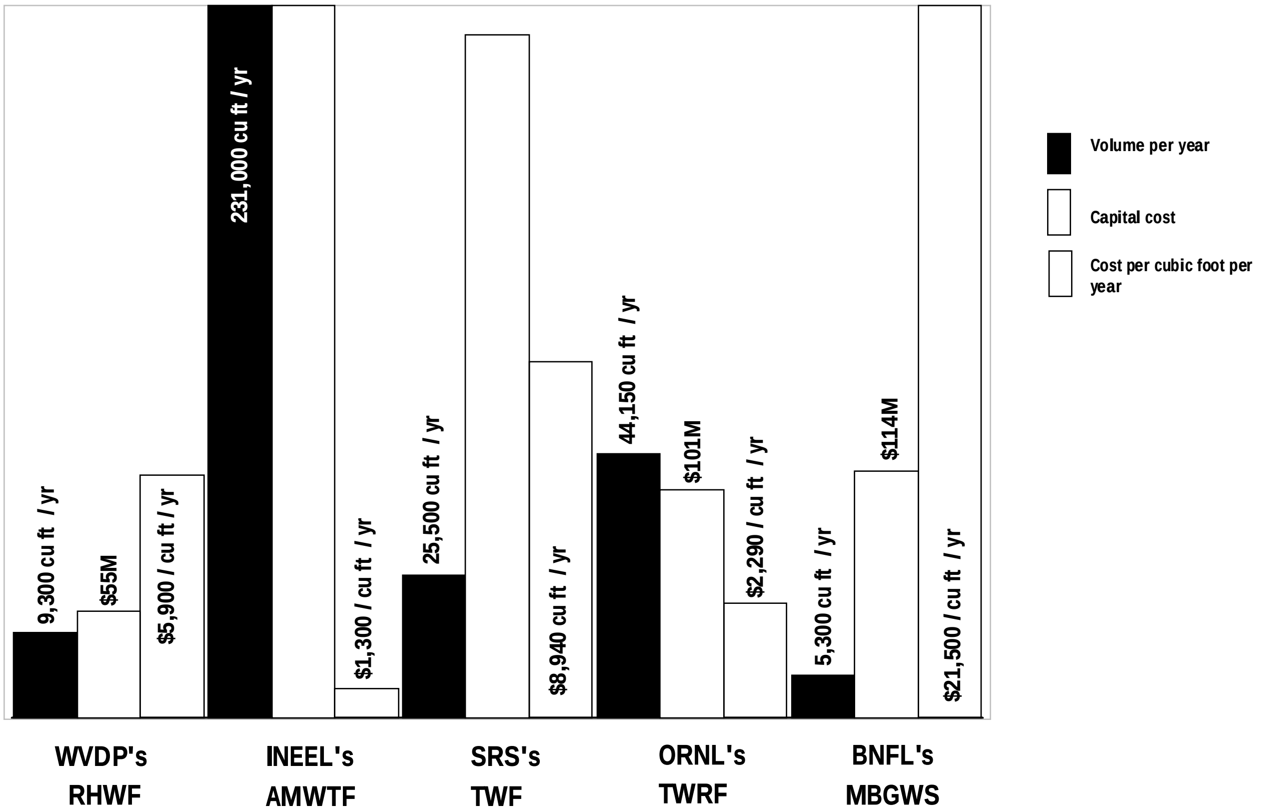

Figure 5.5-3. Cost per Cubic Foot of Waste Processed per Year (Annual Throughput Basis)

5.6 Observations from the Benchmarking Effort

An objective of this benchmarking effort was to perform a comparative evaluation of the RHWF at the WVDP and similar waste processing facilities within the DOE complex and elsewhere to determine if the basic design concept proposed for the RHWF was consistent with that used for the other facilities. The results of this effort are presented below. Another objective was to identify technologies, processes, and features used at the other facilities that could be integrated into the conceptual design of the RHWF and result in improved cost and schedule estimates over those presented in the June 30, 1998 conceptual design. Through each facility was uniquely tailored to its site-specific needs, a select number of engineering features were common to all facilities. These features are discussed below. Suggestions related to new technologies and processes that could be integrated into the RHWF are presented in Section 7.0.

5.6.1 Observations—Generic

The need to "process" both remote-handled as well as contact-handled radioactive waste exists throughout the DOE complex and elsewhere.

Facilities processing TRU waste were designed with three zones of confinement. To control radiation exposures to the operators, remote handling is used for both RH- and CH-TRU wastes. This helps implement ALARA and achieve their Project's goals.

The facilities did not perform aggressive decontamination of the waste. This process typically provided limited change in waste classification, added significantly to cost, and resulted in prolonged project schedules. Instead, the emphasis was to control contamination and exposure during the processing and packaging of the waste for disposal. As a result, aggressive decontamination was eliminated as a processing option in the RRHWF.

Most sites were to utilize standardized packaging containers, such as 55-gallon drums, standard waste boxes, 4' x 4' x 6' boxes, etc. This helped standardize packaging processes, shipping containers, and disposal areas.

Waste examination equipment and services were an integral part of the main facility/cell. The waste was to be examined and classified appropriately as it was being processed and packaged for shipment.

The benchmarking also found some divergence in the facilities evaluated. Divergences among the process facilities reviewed were typically related to those activities that involved direct interaction with the waste. These differences did not result from arbitrary decision-making, but were driven by the following factors:

- Physical Form of the Waste—Specifically what is meant here is the basic size and shape of the packages as they are received at the processing facility and more importantly, the size and shape of the material as it is introduced into the process cell/area.
- Processing Required to Reach the End-Point (final waste form)—All those activities that must be performed from receipt of the waste at the processing facility to closure of the disposal container into which the waste is packaged.
- Imposed Requirements—This involves contractual or regulatory requirements (for example: at least two sites required waste volume reduction be achieved by the facility operator) or site-specific factors (for example: the MBGWS has provided extensive space within the process facility for decontamination of the shipping cask or "flask").
- Facility Modifications—Modifications to existing contaminated facilities in radiological controlled areas are typically much more expensive than new construction. Implementing design modifications into a facility that is either still in operation or that is about to enter the D&D mode may result in unexpected schedule delays. Integrating additional waste processing into a preplanned facility D&D schedule is often a major and costly challenge.

5.6.2 Observations Specific to the RHWF

The overall design of the RHWF was controlled by two drivers, the physical form of the waste and the processing equipment required to reach the end point (final waste form). Recognizing this situation, it was concluded that the design of the RHWF effectively addressed the demands imposed by both the waste form and the defined processing requirements. The facility and its costs were limited to only what was needed to accomplish its design bases objectives.

The physical form of the waste was considered to be the major design driver for the RHWF. The form of the waste as it is received is a design basis feature that is somewhat common to all of the process facilities except the WVDP's RHWF. A review of the RHWF's design basis shows, for example, a facility designed to process waste packages ranging in size from a 55-gallon drum to a box measuring 4' x 4' x 50' and weights ranging from a few hundred pounds to well in excess of ten tons. The consequences of waste form variations were not limited to the receiving area of the RHWF; they were also accommodated in the process cell design.

The significance of this feature can not be overstated. Uniformity in feed simplifies the design effort since variations in the parameter's size, shape, and weight are limited. Process equipment and material handling equipment can be tailored to the waste rather than being designed to be able a handle a broad range of conditions.

The other sites included in this evaluation have wastes (e.g., size and radiation level) similar to those that drove the design of the RHWF. Those wastes, however, are not included in the scope of the facilities currently under design development. Development of facilities at other sites capable of handling wastes, such as those that were to be processed in the RHWF, will occur sometime in the future.

The processing required to reach the end-point is also important to facility design because it determines the process steps needed and the kinds of the processing equipment to be installed. The more processing steps needed, the more equipment required and the larger the facility to accommodate the equipment.

In comparing the facilities, the design of the RHWF could be considered to require a full set of processing steps including opening, sorting, segmenting, decontaminating, characterizing, and repackaging. Of these steps, the processing that most influenced the RHWF design was the need for segmenting large waste items to fit into waste disposal containers. The size of the vessels that needed segmenting caused the RHWF to be designed as a kind of "batch" processing facility because most of the steps could occur at the same work station.

For the other facilities, because the dry active solids wastes are already in a size suitable for repackaging and disposal, the "processing" steps are limited to opening, sorting, characterizing, and repackaging. The designs of the other facilities reflect a more continuous operation with a series of work stations, each specialized for a single operation. Thus, this tends to create a facility design with several similarly sized work cells.

The above discussion addressed those processing requirements imposed on the RHWF that were believed to have significantly influenced or controlled its design. There are, however, other findings related to: the remote processing of waste, the design of facilities, and uniquely related to the RHWF. These findings are:

- The need to process TRU waste exists throughout the DOE complex; however, the WVDP is the first to come forward with a design for processing large RH waste of the type generated during facility D&D. Almost all of the other facilities were designed to "process" previously packaged waste received in 55-gallon drums or 4' x 4' x 6' boxes.

- The approaches proposed for processing TRU waste differ according to the physical form of the waste and how to accomplish reaching the final end point

- The RHWF was a cost-effective approach for processing the WVDP's unique wastes. The RHWF was the smallest in size and the least costly of all of the facilities evaluated. However, funding constraints have caused WVDP personnel to look at ways of further reducing costs. The RRHWF, which resulted from this effort, is estimated to have saved $24 million in capital cost.

- The complexity of the RHWF was caused by large variations in the types of waste streams handled. The RHWF was designed to handle any type of solid waste. The new approach being implemented as part of the rescoping effort is to process only selected waste streams in the RHWF and process the remaining waste streams that drove up the cost and complexity in existing facilities.

- The size and form of the waste that the RHWF was designed to process is different and requires more work to prepare for disposal-ready form. This drove the design of the RHWF towards multiple work stations in the work cell for segmenting the waste, which were necessary to get the waste to fit into smaller boxes.

- There was minimum "volume reduction" in the RHWF

- Segmenting vessels and pipe to fit into standard waste boxes is a major driver towards facility design, as is the processing capabilities to meet throughput requirements. As part of the ongoing rescoping effort, the use of bigger boxes for disposal to reduce the amount of size reduction required was evaluated and adopted as a goal.

- The process technologies used in the facilities that were evaluated are proven, established technologies currently in use in the nuclear industry.

- It should be noted that one feature common to the facilities evaluated was that these facilities were all new, standalone facilities and not backfits into existing facilities.

6.0 INNOVATIVE CONCEPTS AND TECHNOLOGIES

Another objective of this benchmarking effort was to identify technologies, processes, and/or concepts used in the design of the other waste processing facilities that could be integrated into the conceptual design of the RHWF, and result in improved cost and schedule estimates over those presented in the June 30, 1998 conceptual design. It is believed that this phase of the objective was successful as a result of truly understanding the facility drivers and recognizing that changing the drivers can greatly influence facility design.

6.1 Innovative Concepts

The RHWF attempted to provide a facility that performed the role of a "universal processing cell," (i.e., the RHWF was designed to handle any type of remote-handled waste). There are other options available and these are:

Modify the Existing Concept to Remove the Major Drivers

Reduce the overall size of the new, standalone facility through the selective elimination of those waste streams that significantly influence building size and/or equipment requirements. This approach leaves the processing needs of the selected waste streams unaddressed. This is not an approach that provides total closure of the waste management issue at this time and defers total resolution of this waste management issue to a later date.

Integrate the Reuse of the Existing Process Facility into the Waste Management/Process Program

The objective here is to seek out areas within the existing process areas that as is, or through facility modification, could be used to process one or more of the waste streams that cannot be processed in a much scaled-down RHWF. This concept, however, involves cleanup and modification of radiologically contaminated facilities.

Combine the Two Options

This concept involves utilization of existing facilities for some of the waste streams and building a scaled-down RHWF for the remaining waste streams. This option would minimize the consequences of the challenges for processing waste in the existing facilities by reducing the number of waste streams that would be processed in the existing facility. At the same time, this option would reduce the scope of the RHWF design.

6.2 Innovative Approach to the Process Design

The following recommendations follow from the information collected through this benchmarking effort. The recommendations are presented as "best management practices" or "concepts worth considering."

6.2.1 Changing the End-Point

The question here is whether an objective of the RHWF should have been to segment all incoming dry active waste to the point that it can be packaged into boxes and 55-gallon drums.

It is recognized that the packaged waste must be in compliance with the receiving site's waste disposal criteria. That aspect of the final waste form (or end-point) cannot be changed. However, the issue being raised here is the size of the final waste container. The RHWF was designed with the capability to segment process components to such an extent that an entire vessel (e.g., dissolver) could be packaged in 55-gallon drums. This places a burden on facility sizing to meet throughput requirements as well as on the robustness of the processing (segmenting) equipment.

6.2.2 Decontamination/Water Wash

The cost to dispose of TRU waste is high, thus some of the TRU processing facilities have instituted requirements or provided incentives for the facility operator to reduce the volume of TRU waste to be disposed. TRU waste volume reduction can be accomplished in one of two ways: (1) physical volume reduction of the waste (e.g., compaction/supercompaction), or segment the TRU portion of the waste from the non-TRU waste, and (2) remove the TRU contaminant (decontamination) during the TRU waste designation. This approach does not eliminate TRU in that the TRU contaminants are collected and concentrated, but volume reduction will occur. The RHWF was the only facility to propose waste decontamination/washdown. Specifically, provisions within the RHWF were made for the following:

- Water wash all wastes
- High-pressure, water-based decontamination, including the option to add abrasives
- Use of contractor services for aggressive decontamination needs.

6.2.3 Elimination of Aggressive Decontamination Processes

Further dialogue with facility operators showed that these facilities were using only necessary and effective waste decontamination processes. A majority of the facilities did not require the waste to undergo aggressive decontamination because the benefits did not match the extra effort. Aggressive decontamination, even a water-based process, requires a complex, costly waste processing system that takes a lot of space in the facility/cell. This results in secondary waste, mostly in liquid form, and sometimes creates mixed waste. The RRHWF does not require a generic, water-based decontamination of the waste. The RRHWF focuses on sorting and segregation, and size reduction to make the waste suitable for packaging and disposal.

6.3 Innovative Technologies

Waste processing facilities in the U.S. and abroad have developed unique technologies and concepts to meet their site-specific needs. The technologies noted below were deemed unique or needed a second look for potential application at the RHWF. Please note that reference to a particular vendor and inclusion of their drawings and specifications, was based solely on the immediate availability of the product information for inclusion in this report. It was noted that typically more than one vendor was available to provide similar equipment or service.

6.3.1 Bagless Transfer System

A bagless transfer system eliminates the bag-in bag-out system currently in use at most facilities that process radiologically contaminated waste. The system not only eliminates bags (which in turn means additional waste), it reduces operator exposure because it is remotely operated and shielded. Due to the higher level of integrity of the drum and lids over thin plastic bags, the system provides inherent process safety. Instead of transporting contaminated waste in plastic bags from one location to another, the waste will be moved in strong metallic drums.

A typical bagless transfer system includes: an entry-exit port; a specially designed seal that allows the waste to pass through while maintaining a contamination control boundary; a mechanism to hold the drums in position; a system to transfer the drums; and a mechanism to install the lid(s). Variations in design include, gas-purged double lids, types of lids, and drum design. Figure 6.3-1 depicts a typical bagless transfer process.

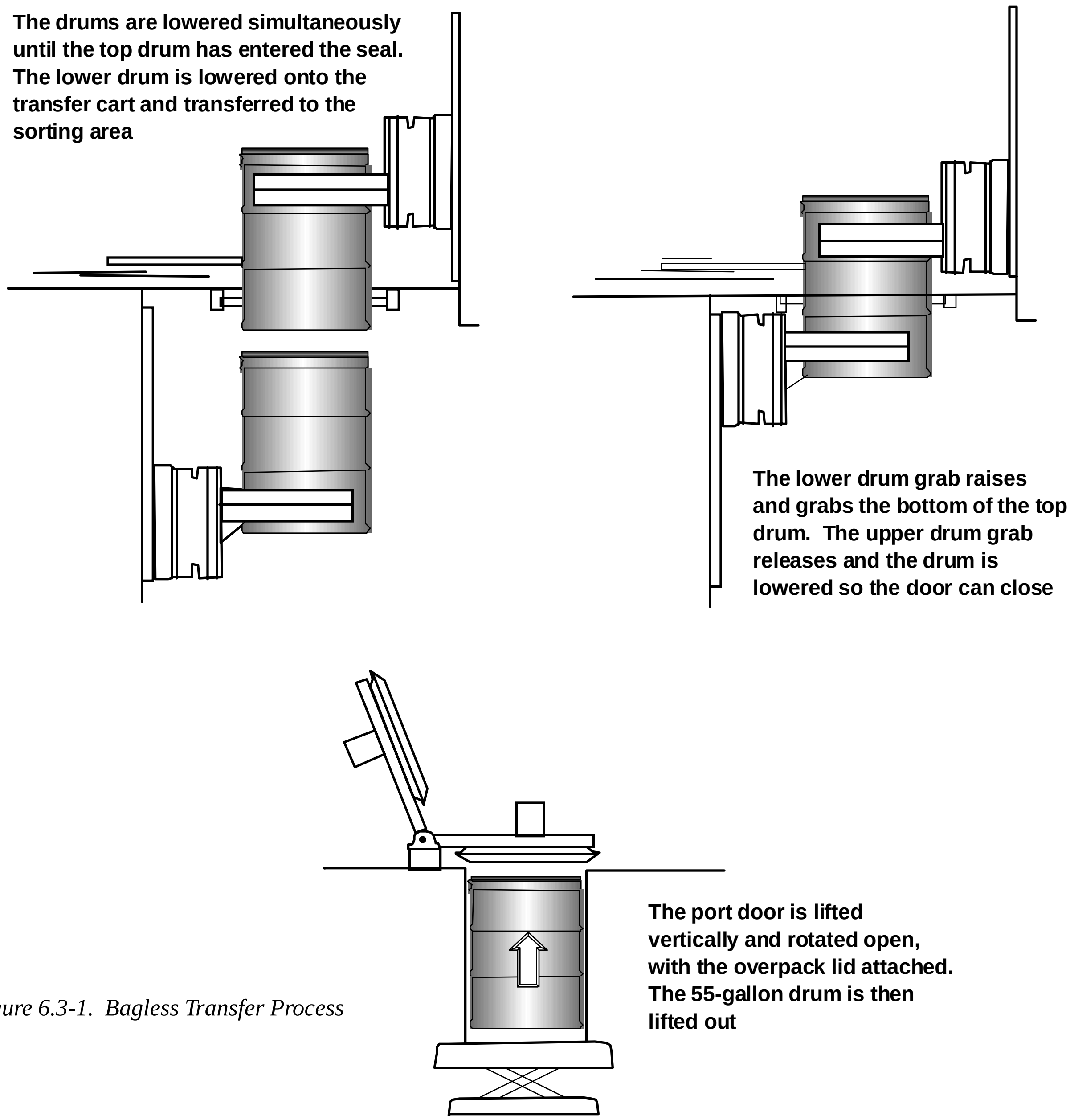

Figure 6.3-1. Bagless Transfer Process

6.3.2 Inflatable Seals

The loading dock in the waste receipt area of BNFL's Plutonium Contaminated Materials (PCM) Management Services at the Waste Treatment Complex (WTC) incorporates an inflatable weather shield that provides a seal between the transport vehicle and the building. The RHWF design provided for a totally enclosed truck bay with access by an overhead bridge crane. This was necessary to accommodate removal of the largest waste containers. Should those largest waste forms be eliminated, it might have been possible to use powered rollers inside an enclosed transport vehicle that would have allowed the waste to be transported onto a conveyor in the waste receipt area. This might have permitted the enclosed truck-bay to be eliminated and be replaced by an inflatable seal.

6.3.3 Passive Aerosol Generator

One of the waste streams to the SRS' Waste Tank Farm (WTF) included HEPA filters. It was proposed that the HEPA filters be dipped into a tank containing a fixative to coat the filters and prevent the release of respirable fines. The WVDP also has a significant number of HEPA filters that must be processed. One possible approach would be a variation of the SRS concept. Rather than dipping the HEPA filter, coat it using an Passive Aerosol Generator (PAG). This technology was going to be used to coat (fix contaminants) on the interior walls of a building undergoing D&D at the Fernald Site. The PAG was going to be demonstrated as part of Fernald's Large-Scale Technology Demonstration Program. However, the demonstration was canceled when it was found that the fixative was water soluble and could be removed if the walls had to be washed down.

The PAG system uses a fixative reservoir outside the area to be coated. The fixative is metered to an atomizer inside the structure that disperses the fixative as very fine droplets. The facilities' HVAC system disperses the fixative. What is envisioned here is a glovebox under which an opened HEPA filter container can be placed. The open container is raised up to seat against the bottom of the glovebox that has an opening large enough for the filter to be raised up into the glovebox. Once suspended in the glovebox, the PAG can be turned on and the filter coated. Once the filter is coated, it can be moved around without fear of contaminants being sloughed from it. The filter can either be placed directly into a Standard Waste Box (SWB) or processed to fit into a 55-gallon drum.

6.3.4 Use of Mobile/Transportable Systems or Components

The description of INEEL's AMWTF indicates the use of "modular" add ons to the facility to provide storage and staging areas. The concept of modular, mobile, transportable, and portable components has received a lot of attention both within the DOE complex and the commercial nuclear sector. (The differences between some of these descriptors are not certain.) Modular, mobile, transportable, portable currently known to be available are:

- mobile (skid-mounted) liquid processing systems of the type proposed for processing liquid waste at the RHWF
- modular process support areas such as those being proposed for the AMWTF
- assay systems
- real-time radiography (RTR) system
- laboratories
- drum characterization systems
- gloveboxes.

The design of the RHWF was reviewed in order to determine if the use of such systems or modules could improve the facility's design and/or capabilities. This evaluation was not limited to the independent RHWF, but included the possible use of these systems or components to support the option of waste processing being performed in existing facilities. In addition, due to the portability of these systems/components/modules, their evaluation addressed future site needs that parallel waste processing needs or capabilities. The economic benefits of addressing multiple site needs through the use of modular/transportable systems or facility could be significant. In fact, several of these innovative concepts and technologies have been adopted in the modified/rescoped design of the RHWF.

7.0 EVOLUTION OF THE RESCOPED REMOTE-HANDLED WASTE FACILITY

7.1 Introduction

Lessons learned from the foregoing benchmarking effort were applied to the redesign of the RHWF. Additionally, recommendations by a Value Engineering Team that included DOE representatives and industry experts, were considered in the facility redesign. These efforts led to a smaller, more economical, and more efficient version of the RHWF. The revised version is labeled Rescoped Remote-Handled Waste Facility (RRHWF) and is described in detail in the Appendices. Select distinctive aspects of the RRHWF are listed below:

1. The RRHWF will process 13 of the 24 waste streams that were in scope for the RHWP. The remaining 11 waste streams will be processed in existing facilities that will be modified to handle waste streams in their scope of work.

2. The RRHWF is much smaller than the original RHWF design due to: (a) reduction in waste streams to be processed in the RRHWF, (b) elimination of the aggressive and extensive decontamination previously planned for the RHWF, (c) utilization of innovative concepts and technologies already in use at other facilities around the world, (d) a rigorous evaluation of facility costs by independent financial experts, and (e) a much improved and efficient design that requires less workspace, a reduced number of workstations, reduced movement of waste from one location to another, and fewer waste processing activties.

3. The RRHWF has been strategically located to allow unrestricted access to the construction crew during the construction phase.

7.2 Comparison of the RRHWF with the RHWF at the WVDP

The RRHWF represents design improvements over the initial June 1998 version of the RHWF. Figure 7.2-1 provides a schematic of the RHWF, whereas Figure 7.2-2 is for the RRHWF, a June 1999 conceptual design. Significant changes to the initial (June 1998) design have been highlighted (shown as cross-hatched) in Figure 7.2-3. A detailed comparison of the two facilities is provided in Table 7.2-1. Of significance are the parameters representing facility volume, cost, and operating schedules.

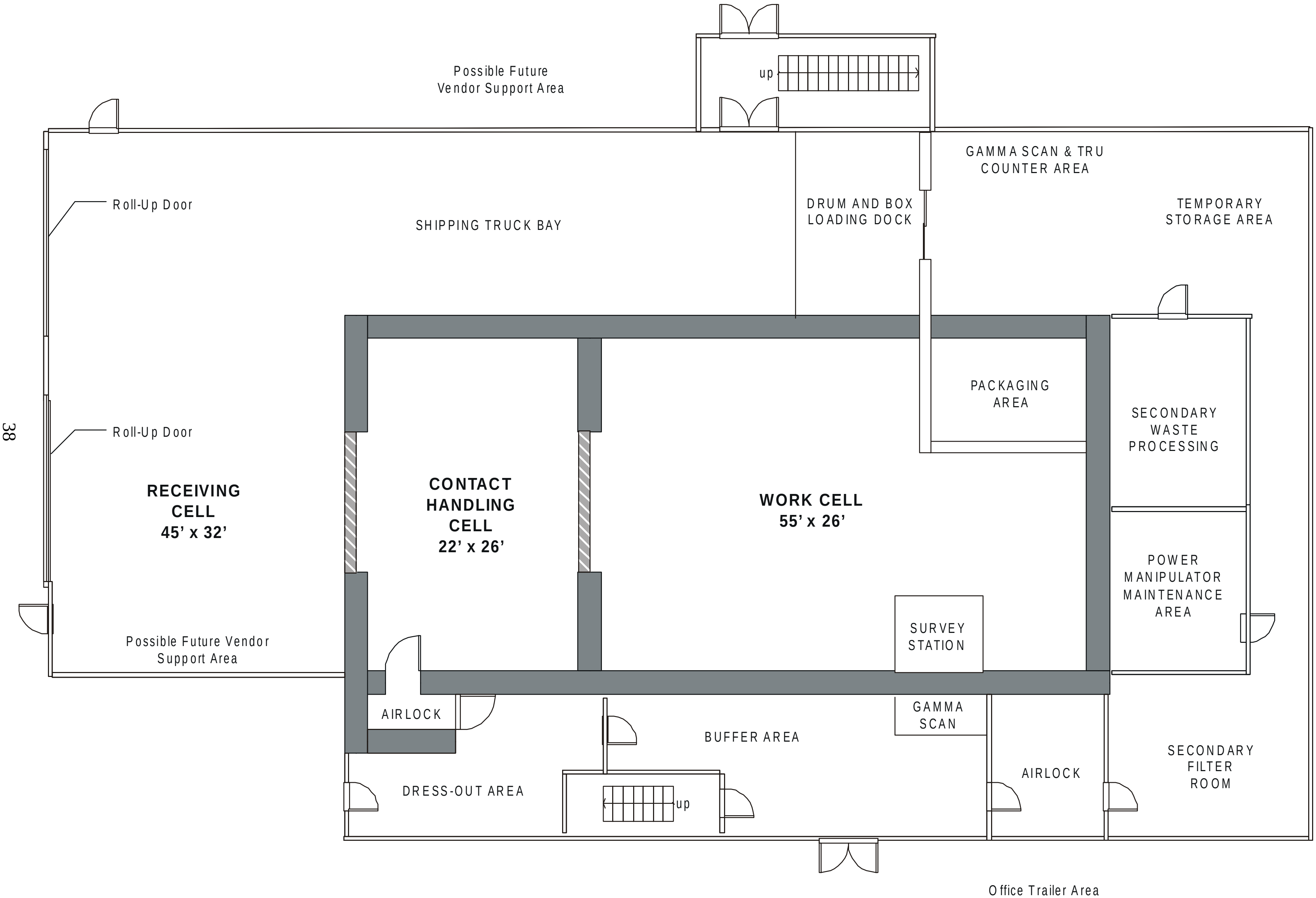

Figure 7.2-1. June 30, 1998 Conceptual Design of the Remote-Handled Waste Facility at the WVDP

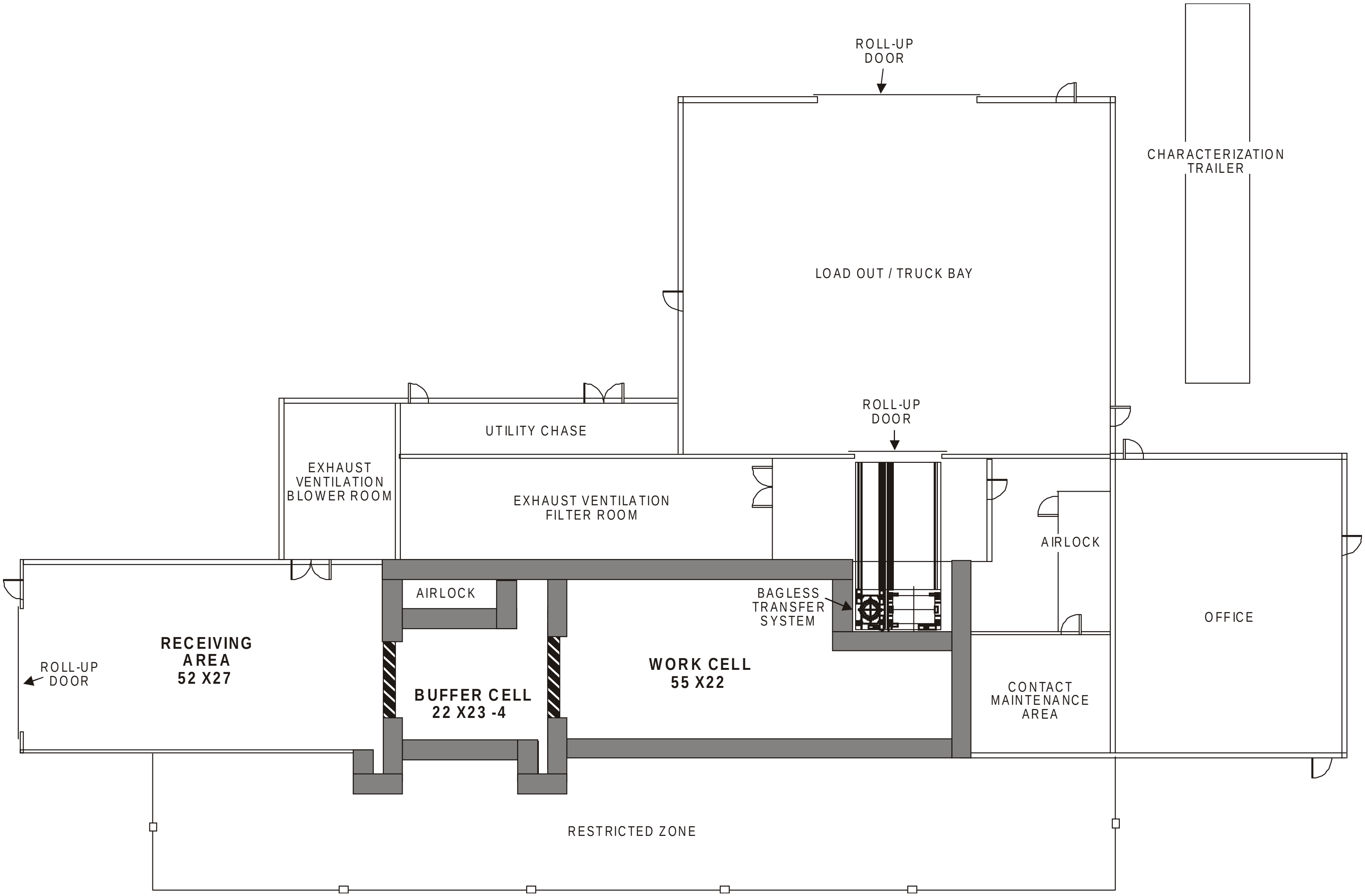

Figure 7.2-2. June 1999 Conceptual Design of the Rescoped Remote-Handled Waste Facility at the WVDP

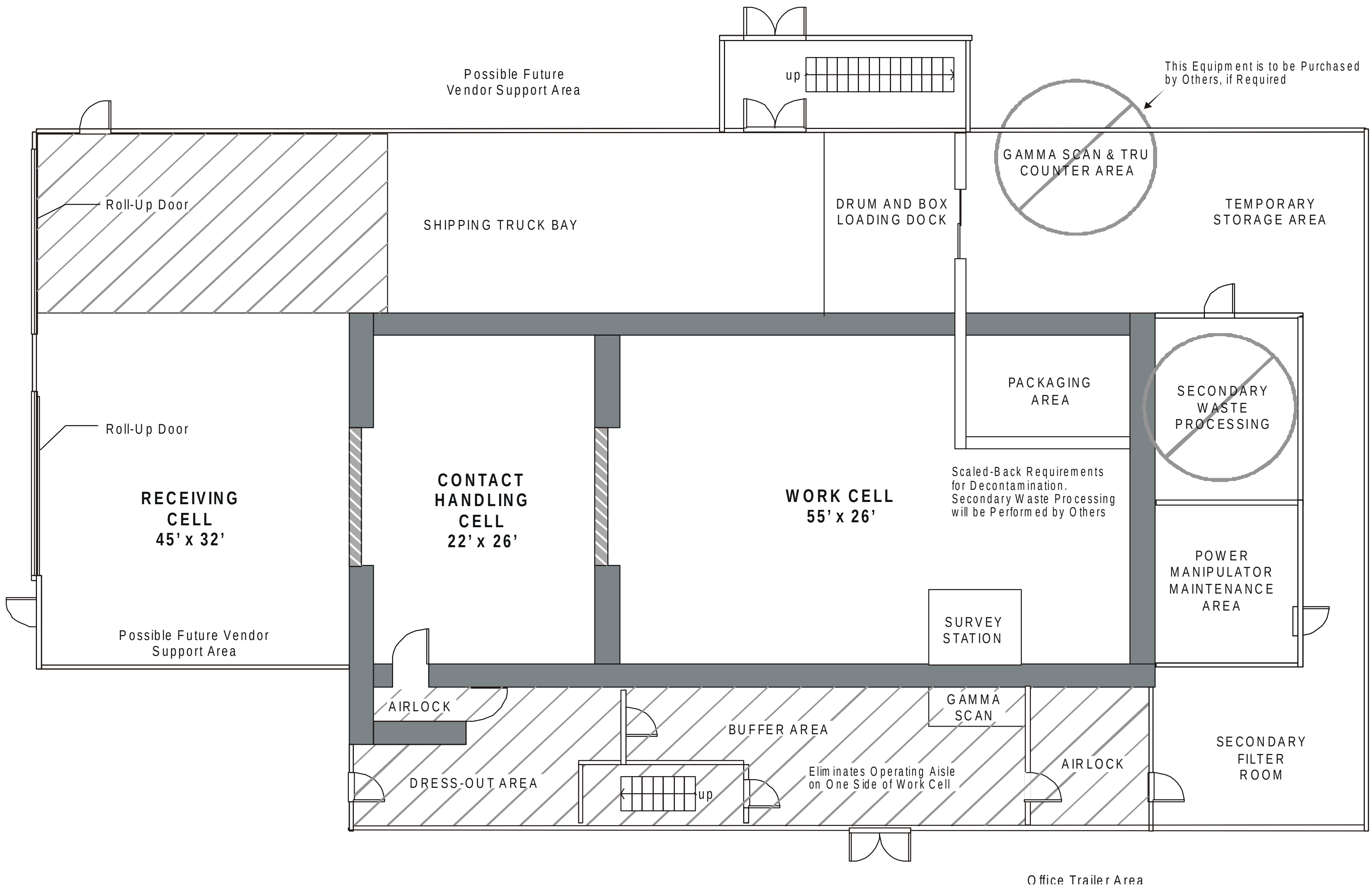

Figure 7.2-3. June 30, 1998 Modifications to the Conceptual Design of the Remote-Handled Waste Facility at the WVDP

Table 7.2-1. Summary of the Differences and Similarities Between the RHWF and the RRHWF at the WVDP		
Subject Area	**Differences**	**Similarities**
7.2.1 Facility Type	The projected capital costs for the RHWF was $55M vs. $31M for the RRHWF	Both are standalone facilities
	Constructed area of the receiving cell, buffer cell, and work cell for the RHWF was to be 3,442 sq ft; whereas, it is 3,127 sq ft for the RRHWF.	The three-cell concept was maintained in both facilities
	Volume of the shielded work cell for the RHWF was 48,620 cu ft vs. 44,770 cu ft for the RRHWF. Cell size reduction was achieved by eliminating two work stations and some of the complex processing activities.	Both were designed to have shielded work cells isolated by controlled barriers
	The shield wall was 24" thick for the RHWF whereas it varied 8" to 22" for the RRHWF. Shield wall thickness reduction was achieved by (i) eliminating access to the outside wall surface of one side of the Work Cell, (ii) local heavy shielding around the window area, (iii) design the facility to routinely processed waste, and (iv) handling higher dose wastes as a special case.	
7.2.3 Waste Types/Form	Due to only a select number of waste streams requiring processing in the RRHWF, the scope and complexity of the RRHWF, based on the size and type of wastes handled, has been reduced. Also, instead of designing the facility to handle the extremes in terms of size, weight, and dose rate of waste streams, the RRHWF is designed to routinely handle nominal waste types and unique, one-of-a-kind waste types as a special case.	Both facilities process RH-TRU, CH-TRU, and LLW which requires remote operations
7.2.4 Facility Operating Mode	The RHWF had four work stations; the RRHWF has only two	Both facilities were designed to run two eight-hour shifts per year for 50 weeks
7.2.5 Throughput	The RHWF was to process a total of 102,000 cu ft vs. the RRHWF which will process a total of 62,000 cu ft	
	Annual throughput for the RHWF was 9,300 cu ft vs. 8,900 cu ft for the RRHWF	
7.2.6 Processing Methodology and Technologies	Some of the complex processing methods (e.g., aggressive decontamination of all waste streams) planned for the RHWF have been eliminated, thus the RRHWF will perform simple sort and segregate, and size reduction operations. This has also led to the elimination or reduction of some of the heavy support equipment and utilities for the RRHWF	Remote-controlled manipulators will be used to open containers, sort, size-reduce, and repackage waste

Table 7.2.1. (cont.)

Subject Area	Differences	Similarities
7.2.7 Secondary Waste	The RRHWF generates very little liquid waste and smaller quantities of solid waste as compared to the RHWF	
7.2.8 Final Waste Classification		Analysis shows that final waste classification is expected to be similar for both the RHWF and the RRHWF
7.2.9 Waste Disposal		Both facilities package waste for off-site disposal

8.0 CONCLUSIONS

Benchmarking the facility at the WVDP with similar facilities around the world has led to a facility design that is (a) more compact in physical dimensions, (b) efficient in operations, (c) deploys state-of-the-art technology, (d) incorporates innovative concepts and processing techniques prevalent at other facilities, and above all, (e) will cost only $31M (in CY1999 dollars) compared to the previous design that was to cost $55M in capital costs.

The rescoped facility (RRHWF) has been conceptually designed, incorporating lessons learned from the benchmarking. The RRHWF has been approved for final design and construction by the DOE. A design-build contract, another unique concept, has been placed and is in the works. Reevaluation of the June 1998 conceptual design, aided by input from the Value Engineering Team and independent cost evaluations, has resulted in a facility design that reflects more streamlined operations and the elimination of uneconomical aggressive waste decontamination activities. The benchmarking has also enhanced safety features, especially in the area of criticality, spread of contamination, unwanted radiation exposures, and general operational concerns.

The new RRHWF incorporates design features that directly and significantly contribute to safe and efficient operations. The RRHWF was evaluated for potential risks, preventive measures, and mitigation features. The evaluation, documented in the Project Risk Management Plan, identifies multiple layers of preventive mechanisms and lists mitigation plans should an abnormal condition occur. In brief, the Rescoped Remote-Handled Waste Facility design and operations planning has enormously benefited from this benchmarking.

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10.0 APPENDICES

APPENDIX A. ADVANCED MIXED WASTE TREATMENT FACILITY (AMWTF) AT THE IDAHO NATIONAL LABORATORY AND ENVIRONMENTAL LABORATORY (INEEL)

A-1. The Facility

The Advanced Mixed Waste Treatment Facility (AMWTF) is located within the fenced area of the Transuranic Storage Area at the Radioactive Waste Management Complex in the southeast corner of the Idaho National Engineering and Environmental Laboratory (INEEL). The facility is designed to process contact-handled TRU waste. The AMWTF will receive, sort, characterize, treat, and package for off-site disposal approximately 2.3 million ft^3 (65,000 m^3) of radioactive waste currently stored at the INEEL's Radioactive Waste Management Complex (RWMC). The AMWTF will also be capable of handling an additional 0.7 million ft^3 (20,000 m^3) of waste generated at the INEEL during the AMWTF's first 13 years of operation. In addition to the sort/segmenting capabilities, the AMWTF will contain a super-compactor, shredder, incinerator, and vitrification system. To process the secondary liquid wastes, two evaporators are being provided. Information presented in this appendix was derived from References 1 and 2.

Note: As of June, 2000 the AMWTF has been rebaselined to exclude incineration and vitrification.

The AMWTF is to be a new, standalone three-story facility, with the process portion of the facility two stories tall. Its design includes several receiving/staging areas either adjacent to or inside the AMWTF. The AMWTF also houses the administration/personnel support areas, pretreatment areas, processing areas, and an analytical laboratory. Also provided are gloveboxes including a Special Case Waste (SCW) glovebox. The ventilation system HEPA filters are located inside the AMWTF, while the ventilation equipment is located in the roof penthouse. Figures A-1.1 through A-1.3 provide conceptual design details of the AMWTF.

The facility will consist of two individual buildings under one roof based on separating the thermal equipment that is rated over 400,000 Btu/hr (i.e., incinerator, melter, and evaporators) from the rest of the facility.

This is a privatization program where the costs incurred by the facility constructor/operator are recovered through a combination of: fixed priced efforts, lump sum payments made upon completion of specified activities (e.g., obtaining required permits and licenses), and unit fixed cost payments based on an agreed upon dollar payment per cubic meter of waste processed. The total costs to DOE for the AMWTF Project is $570 million. This includes permitting, design, construction, and interest during construction of the AMWTF as well as operation and maintenance (O&M) costs to process 3,000,000 cubic feet (85,000 cubic meters) of waste. Also included in this cost is profit to the constructor/operator for both phases of this project. It is estimated that $300 of the $570 million represents the charges to DOE for permitting, design, construction, interest during construction, and profit on the front-end of the effort, and $270 million covers O&M and profit on the back-end of the effort. This projected split in the allocation of cost is based on a cost breakdown presented in Reference 4 for a similar privatization program at Oak Ridge. The unit fixed price fee for the first 25,000 cubic meters is $2,557/m^3.

A-2. Status of Facility

Currently, this facility is in the Construction Permit Phase and its Draft Enviromental Impact Statement (DEIS) is currently undergoing a public review and comment period [August, 1998].

A-3. Facility Operation

Design, construction, and operation of the AMWTF will be by BNFL under a “privatized”, but noncommercial, contract. Privatization is a process that transfers the responsibility for the performance of specific activities to private entities (companies, corporations, etc.). The DOE still, for example, retains the environmental obligation to process waste as outlined in a Record of Decision or similar agreements. However, any fines and penalties charged to DOE for missed commitments or violations are transferred to the facility operator. Similarly, any costs incurred from permitting delays, equipment failures, etc. fall on the facility operator. As a result, proven reliable technologies familiar to the facility constructor/operator are usually selected.

In addition, privatization programs can, and typically do, include performance requirements in addition to schedule milestones. These can include, for example, that some minimum degree of volume reduction be achieved.

A-4. Schedule

Construction of the AMWTF began May 1999 and is scheduled to be completed by April 2002.

A-5. Waste Sources and Types

The AMWTF is described as having “…the capability to treat specified INEEL waste streams, with the flexibility to treat other applicable INEEL and U.S. DOE on- and off-site waste streams.” The “specified INEEL” waste streams are those wastes from the Radiation Waste Management Complex (RWMC). Thus, the primary objective is to “treat” or process the waste from the RWMC and once this task is accomplished use the AMWTF to process other wastes from the INEEL Site or from other sites within the DOE complex.

Specifically, the facility is designed to receive and process wastes packaged in drums and boxes. This facility is also designed to process both debris and non-debris wastes as defined by the Resource Conservation and Recovery Act. Thus, combining the range of waste materials and the use of standard containers, which it is designed to accommodate, it can be safely assumed that the AMWTF will have the capability to process wastes from various areas on the INEEL Site as well as from other sites within the DOE complex.

The AMWTF is designed to process 85, 000 cubic meters (or approximately 3 million cubic feet) of waste over a 13-year period of operation. This corresponds to an average annual waste throughput of 6,540 cubic meters or approximately 231,000 cubic feet.

The waste feed to the AMWTF has been categorized as follows:

Debris Waste

- Metal debris
- Graphite
- Organic debris
- Heterogeneous debris
- Inorganic debris
- Ceramic/brick debris
- Paper/rags/plastic/rubber

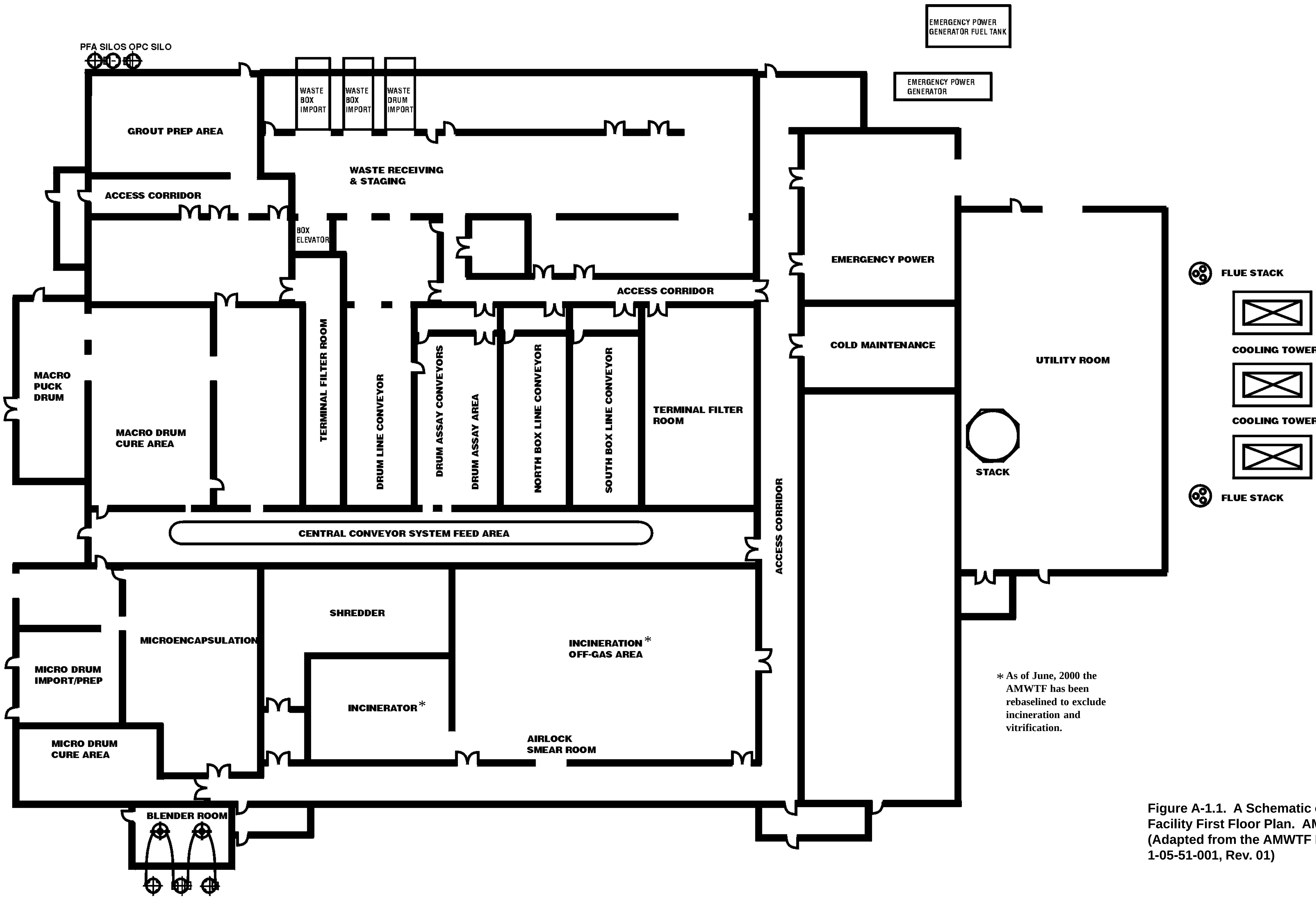
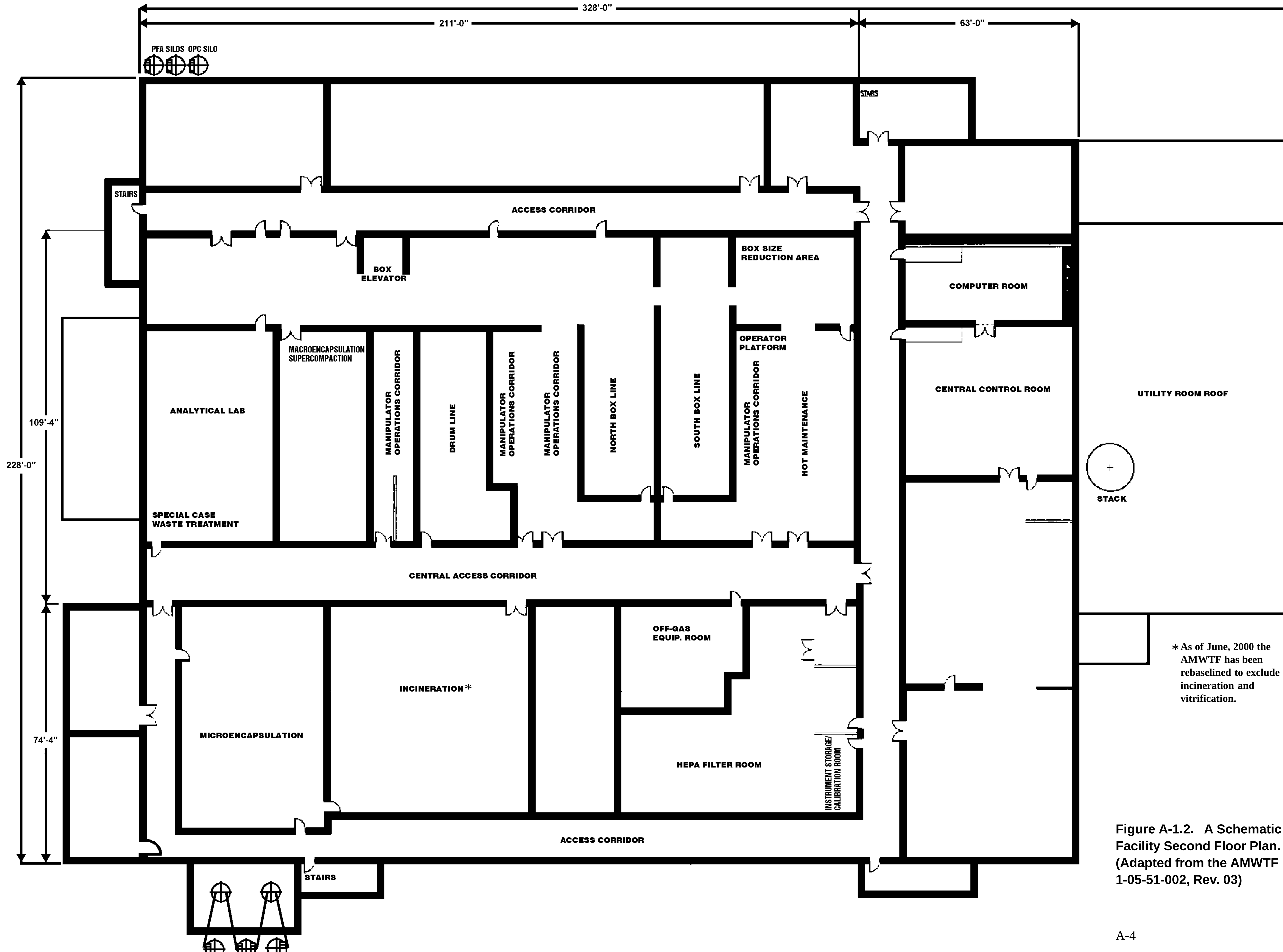


Figure A-1.1. A Schematic of the Treatment Facility First Floor Plan. AMWTF at INEEL (Adapted from the AMWTF Drawing Number 1-05-51-001, Rev. 01)



* As of June, 2000 the AMWTF has been rebaselined to exclude incineration and vitrification.

Figure A-1.2. A Schematic of the Treatment Facility Second Floor Plan. AMWTF at INEEL (Adapted from the AMWTF Drawing Number 1-05-51-002, Rev. 03)

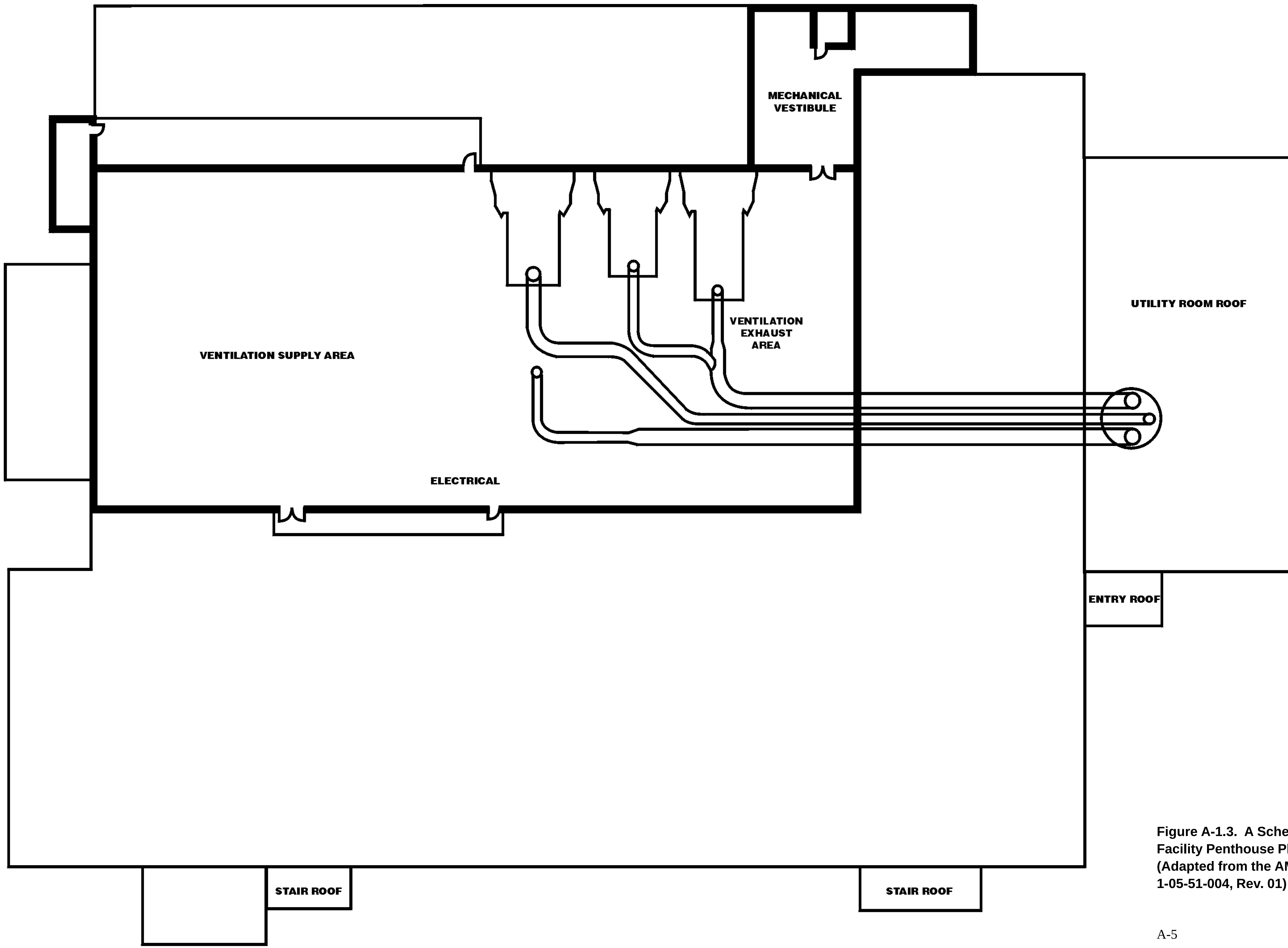


Figure A-1.3. A Schematic of the Treatment Facility Penthouse Plan. AMWTF at INEEL (Adapted from the AMWTF Drawing Number 1-05-51-004, Rev. 01)

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Non-Debris Waste

- Inorganic homogeneous solids
- Organic homogeneous solids
- Soils

A-6. Size of Facility

This is a three-story facility with maximum dimensions of 210' x 290' and 60' high. The process facility is housed within the first two floors. It is 42' high and includes process areas, staging areas, a central conveyor system, ventilation filters, an analytical laboratory, and administrative/personnel support areas. There is also a rooftop mechanical penthouse that is 1/3 the cross-sectional area of the first floor.

The staging/storage areas are BNFL-designed modules. They can be added on as needed to augment a facilities' process or storage area. The selections of drums for direct feed to the super-compactor will take place in these modules. The concept of using semi-portable modular structures (modules and gloveboxes) as extensions to the main plant is being followed through. These gloveboxes and modules provide for waste container sorting, staging, and simple processing, and examination of the waste gloveboxes being designed for the project. The mechanical range is 10' to 12' wide x 20' long. Multiple attachments of 10' x 10' to make L-shaped configuration are also being developed. The gloveboxes and the modules are/can be equipped with mechanical/electrical waste handling systems. The bigger structures can accommodate a 5-ton, trolley-mounted overhead crane and have access for forklifts and jib cranes. Additional information on these modules is being collected. Typically, they have their own ventilation systems with HEPA filters. They are also designed to be hooked up to auxiliary services and power.

The first floor has approximately 60,000 ft^2, but much of the first floor will be open to the roof structure with mezzanine levels or intermediate equipment access platforms. Thus, the usable area of the second floor is less than that of the first floor. The area occupied by the penthouse is approximately 20,000 ft^2. The volume of the facility is approximately 2.9 million cubic feet.

A-7. Ventilation System

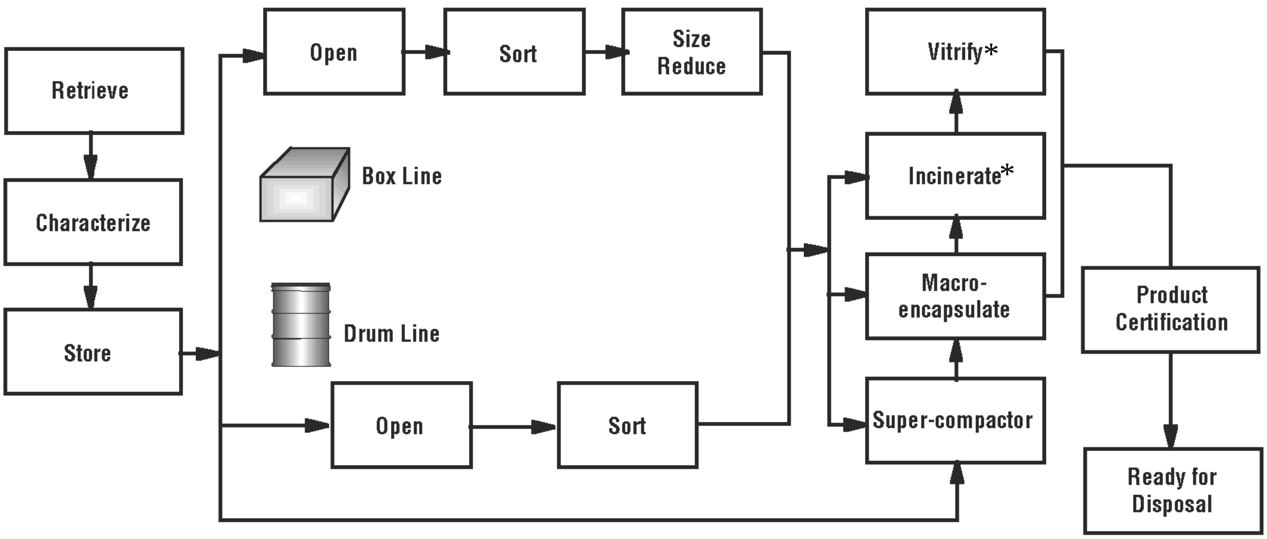
The process part of the AMWTF is divided into three confinement ventilation zones to minimize the potential of airborne releases to the environment. Air within the AMWTF will generally flow from outside through the clean areas into Zone 1, then into Zone 2, and finally into Zone 3. Under normal conditions, uncontained waste will be located only in Zone 3 areas. Zone 1 and 2 areas will remain clean (uncontaminated) and accessible to workers under normal operating conditions. Subchange rooms with interlocked doors (only one set of doors can be opened at any time) will allow personnel and supplies to pass from one ventilation zone to another without disrupting the air flow in toward Zone 3.

The HVAC system will be located in the rooftop penthouse while the HEPA filter rooms will be located within the process facility itself. The main facility stack will be a windscreen enclosing eight individual flues measuring 19' x 19' and will transition into a round duct 10' in diameter. The top of the stack will be approximately 90' above grade.

A-8. Methods of Waste Processing

There are two waste pretreatment lines, one line designed to handle drums and the other to handle boxes as shown in the simplified AMWTF process flow diagram in Figure A-8.1. The pretreatment lines are designed for continuous versus batch processing. Each pretreatment line is located within a concrete cell lined with stainless steel and equipped with a packet X-ray to confirm container contents. Power manipulators and MSMs will be used to open containers, and sort, size-reduce, and place the removed waste into transfer containers for downstream treatment.

Figure A-8.1. Simplified Process Flow Diagram for the AMWTF at INEEL



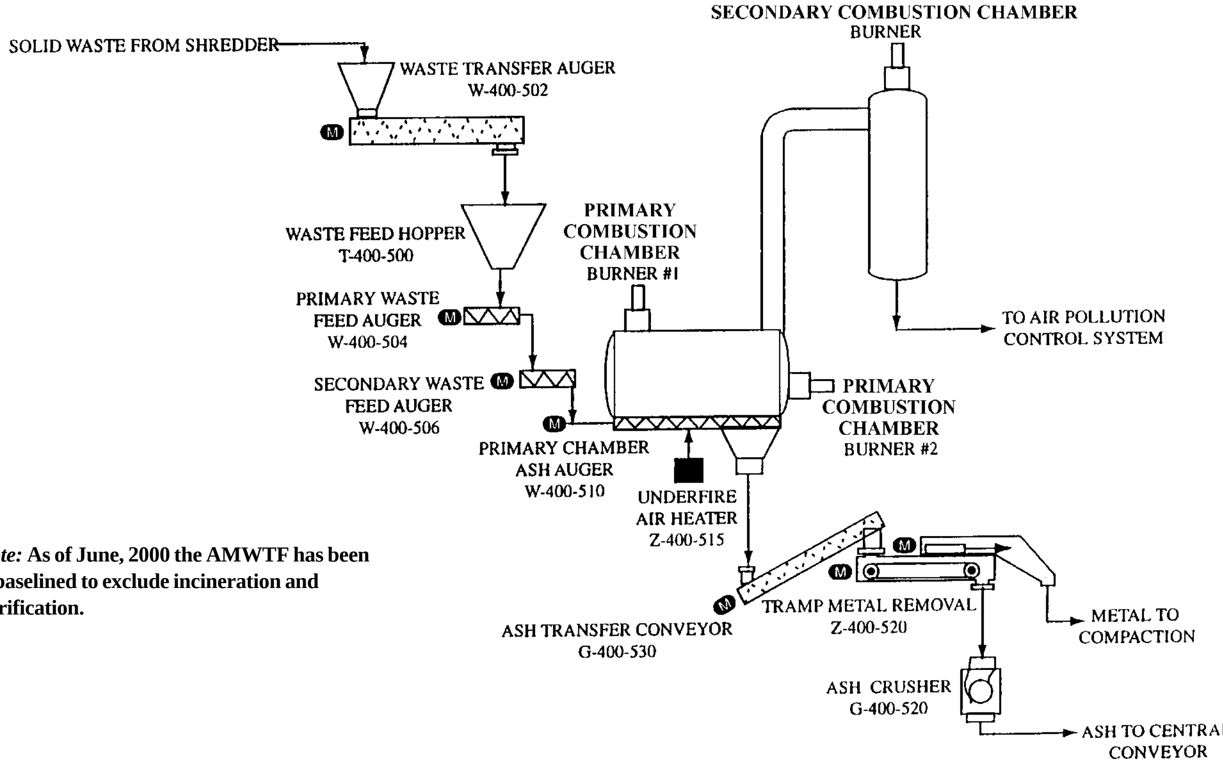
* As of June, 2000 the AMWTF has been rebaselined to exclude incineration and vitrification.

Debris drums will undergo pretreatment to remove problematic/special case waste (SCW), e.g., liquids and elemental mercury. Problem drums will be opened and sorted to remove problematic/SCW or processed to remove free liquids. Drums free of SCW will be fed directly to the super-compactor; while non-debris drums will be sent to a sampling station and then transferred to the incinerator. (Note: As of June, 2000 the AMWTF has been rebaselined to exclude incineration and vitrification.)

All waste boxes will be opened to remove drums and larger items for transfer to other stations such as the drum line, size-reduction/sorting area, etc. for pretreatment. The remaining waste will then be transferred to the size-reduction/sorting area via a combination of a vibro-chute and an incline. The sorted waste will be moved to an export station via a shuttle trolley. At the export station MSMs will load the waste to transfer containers with sliding lid covers. When a transfer container is at the correct fill level and weight, the lid is closed and the container is routed to an assay cell before being processed.

Sorted debris waste from the pretreatment cells or direct feed drums will be processed through a super-compactor that uses a die to maintain a uniform geometry for the final product which is placed into an overpack. When the capacity of the overpack is reached, it will be grouted to macroencapsulate the waste. Super-compaction and macroencapsulation constitute the primary treatment technologies needed to meet the Resource Conservation and Recovery Act (RCRA) Land Disposal Restriction (LDR) requirements for wastes that are not treated thermally (incineration and vitrification). To this point, the approach to waste processing provided by British Nuclear Fuels Ltd. (BNFL) is very similar to the waste processing concepts implemented at their Sellafield Site in England.

Figure A-8.2. Incinerator Schematic for the AMWTF at INEEL



Note: **As of June, 2000 the AMWTF has been rebaselined to exclude incineration and vitrification.**

Non-debris waste and shredded combustibles are incinerated (see Figure A-8.2). Incinerator feed will include, but not be limited to, inorganic homogeneous solids, organic homogeneous solids, and soils. The incinerator is a dual-chamber, auger hearth system. The incinerator off-gas will be processed through a scrubber system. The ash by-product from the incinerator will be fed, along with glass-making products, into a vitrification system (see Figures A-8.3). The melter is a joule-heated melter, similar to that used in the glass industry. The melter is projected to discharge approximately 6.8 tons of product per day. Problematic wastes are processed on a case-by-case basis based on waste type in the SCW glovebox. Empty drums and boxes are size-reduced for disposal as LLW.

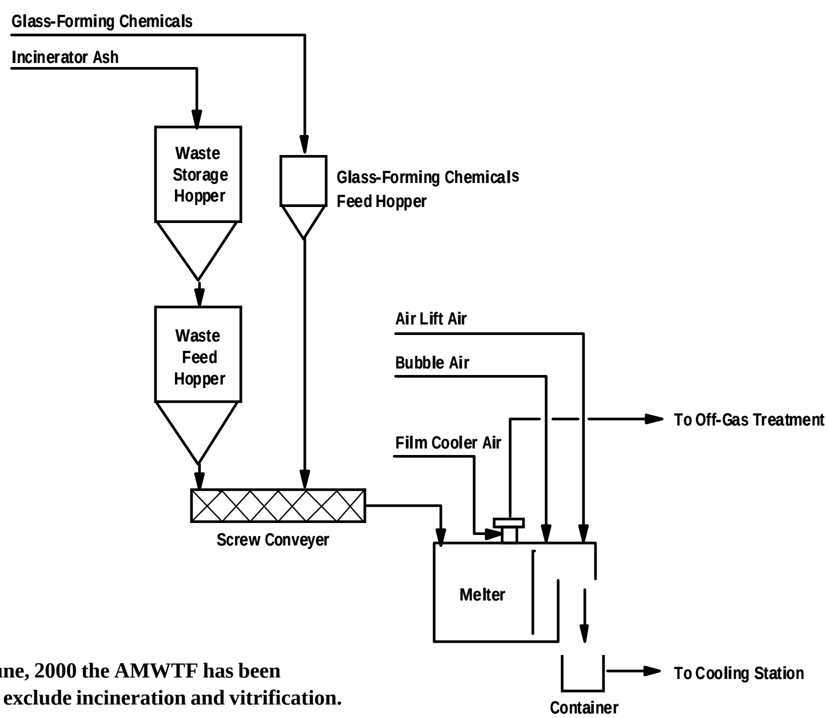


Figure A-8.3. Vitrification System Schematic for the AMWTF at INEEL

Note: **As of June, 2000 the AMWTF has been rebaselined to exclude incineration and vitrification.**

A-9. Analytical Laboratory

The Analytical Laboratory will be located on the second floor of the AMWTF. The Laboratory will be equipped with scales and balances, a muffle furnace, an energy dispersive X-ray fluorescence (XRF) spectrometer, a pH meter, a gas chromatograph, a flame atomic analyzer, a graphite furnace atomic analyzer, an inductively coupled plasma atomic emissions spectrometer, and other equipment dictated by operational needs.

A-10. Secondary Waste

A preponderance of the secondary waste generated at the AMWTF will be spent incinerator off-gas scrubbing solution. Another secondary waste source will be non-organic liquids from other areas of the plant. The secondary waste system is designed for batch operations, with two identical processing subsystems consisting of a collection tank and evaporator. One tank will be processed through an evaporator as the other tank is being filled.

The evaporator will produce a dried salt that will be conveyed to a container that is further overpacked prior to being transferred from the AMWTF. The evaporator distillate will be recycled.

A-11. Facility Duty Cycle

The facility duty cycle has been identified as follows:

- 24 hrs/day - 330 days/yr
- 24 hrs/day - 365 days/yr, Vit melter
- However, to allow maximum operational flexibility, the permit application has assumed year-round operations, 365 days or 8,760 hours per year vs. 330 days or 7,920 hours per year.

A-12. Support Facility Description

The AMWTF’s Utility Building will be approximately 70' x 100' x 28' high and located 70' from the AMWTF. This facility will house the:

- Process steam & humidification boilers
- HVAC and potable hot water boilers
- Process cooling water equipment.

A-13. Contractual Incentives

The privatization contract does provide for incentive payments based on achieving volume reduction of the waste sent off site for disposal.

APPENDIX B. TRANSURANIC WASTE FACILITY (TWF) AT THE SAVANNAH RIVER SITE (SRS)

B-1. The Facility

The Transuranic Waste Facility (TWF) Project at Savannah River Site (SRS) was to have been located in the H-Area, south of the Solid Waste Support Facility and the Consolidated Incineration Facility. The TWF was to retrieve and transport contact-handled waste stored at the SRS Burial Ground to the TWF where the storage containers were to be remotely assayed to determine the TRU waste content following which the waste was to be sorted, segmented (as needed), and packaged in either 55-gallon drums for placement in standard waste boxes or packaged directly into standard waste boxes. Waste found to be LLW by way of the waste assay system was to be overpacked in a new 83-gallon drums for disposal at the SRS. Information presented in this appendix was derived from Reference 3.

The focus of the TWF was to be strictly on TRU waste. The assaying of the waste feed was expected to generate two effluent streams from the facility: TRU waste and LLW. Because some of the waste has been in storage for numerous years, hydrogen buildup may have taken place in the storage drums. To account for this possibility, the capability to vent and purge the feed drums was provided in the conceptual design. The purge was to be done by nitrogen gas. Also, the facility was designed with two hardened (explosion-resistant) areas.

Major equipment in the TWF was to include bridge cranes, monorails (20-ton), transfer cars, conveyors, fork lifts, two drum transfer casks, a motor-driven shredder, an assay system for 55-gallon drums, plywood boxes, and SWBs; tele-robots and MSMs, plasma arc cutting torches; and real-time radiography. Also, the TWF was to have a borated fire protection system, a criticality safe design, and emergency power.

The estimated capital cost for the TWF was $180M in FY1990 or approximately $228 million in FY1998 dollars.

B-2. Status of Facility

The TWF at the SRS was a FY1990 line item. However, funding for this project has been canceled, apparently because the estimated cost for the facility was higher than expected.

B-3. Facility Operation

The design and construction of the TWF at SRS would have been performed through the site's existing O&M organization as would operation of the facility.

B-4. Schedule

Project authorization to the point of issuing Title I Design was completed May 1990. Title II design was to be completed September 1992. Construction was to be initiated October 1993, with construction scheduled for completion November 1997. The Operational Readiness Review (ORR) was scheduled for completion July 1998.

B-5. Waste Sources and Types

This facility was specifically designed to repackage TRU wastes for disposal. The TRU waste would be transferred to the TWF in 55-gallon drums, 55-gallon drums inside concrete culverts, and plywood containers inside carbon steel boxes. The culverts could contain up to 14 drums in two layers of seven drums each. The culverts were 7' 0" outside diameter by 7' 6" high, and weigh approximately 22,000 pounds.

The carbon steel boxes measured 12' 0" by 18' 0" by 7' 0" high and contained plywood boxes, large HEPA filters, and other loose material. The plywood boxes varied in size, with the largest measuring 8' 0" by 12' 0" by 6' 0" high, weighing approximately 400 pounds empty, and a maximum of 5,000 pounds full.

The LLW was to have been sorted from the TRU waste during repackaging. LLW may have also been generated as secondary waste during the operation of the TWF.

It was planned that this facility would annually process approximately 21,000 cubic feet of retrieved TRU waste and 4,500 cubic feet per year of TRU waste generated while the facility was in operation. This would have resulted in an annual throughput of 25,500 cubic feet or a total projected life-of-facility throughput of 480,000 cubic feet. It was expected that it would take between 18 and 20 years to process the stored TRU waste, as well as the waste generated during the process period. The duration of processing would have depended on when the facility actually started processing waste. Dividing the design bases waste volume by the throughput rate results in a processing period of about 18 years. If startup took a little longer, then additional waste would have accumulated and the processing period would have been longer. Thus a range of 18 to 20 years was being provided. The design life of the facility was 30 years.

The guidance regarding whether the waste was contact-handled or remote-handled (provided in Reference 3) is as follows:

“The nature of this being handled requires protection of the operating personnel, therefore, most processing operations will be handled remotely. However, no isotopic analysis, giving the source terms, was presented in the basic data. Therefore, only alpha radiation was considered. No special radiation-resistant equipment or materials were utilized, except for the camera lenses, and lead glass windows.... If there are high energy gamma sources in the waste, special operating procedures would be required to meet ALARA, or the facility would have to be designed to accommodate them.”

Thus, the facility was, in effect, designed to remotely process CH-TRU and LLW.

B-6. Size of Facility

The TWF Process Building (see Figures B-6.1 through B-6.5) extended from one story below grade (-12' 10") to two stories above grade (33' 10"). The TWF Process Building was to be a rectangular enclosed concrete structure with approximate dimensions of 174' by 274' (including a truck unloading drive). In addition, the Process Off-Gas System (POGS) Building would have been located adjacent to the west wall of the Process Building.

The first floor area would have approached 39,000 square feet, with the storage/opening areas and waste preparation areas open to above. The second floor area was to be approximately 30,000 square feet and the area of the basement was to be 23,000 square feet. The total volume of the facility was approximately 1,420,000 cubic feet.

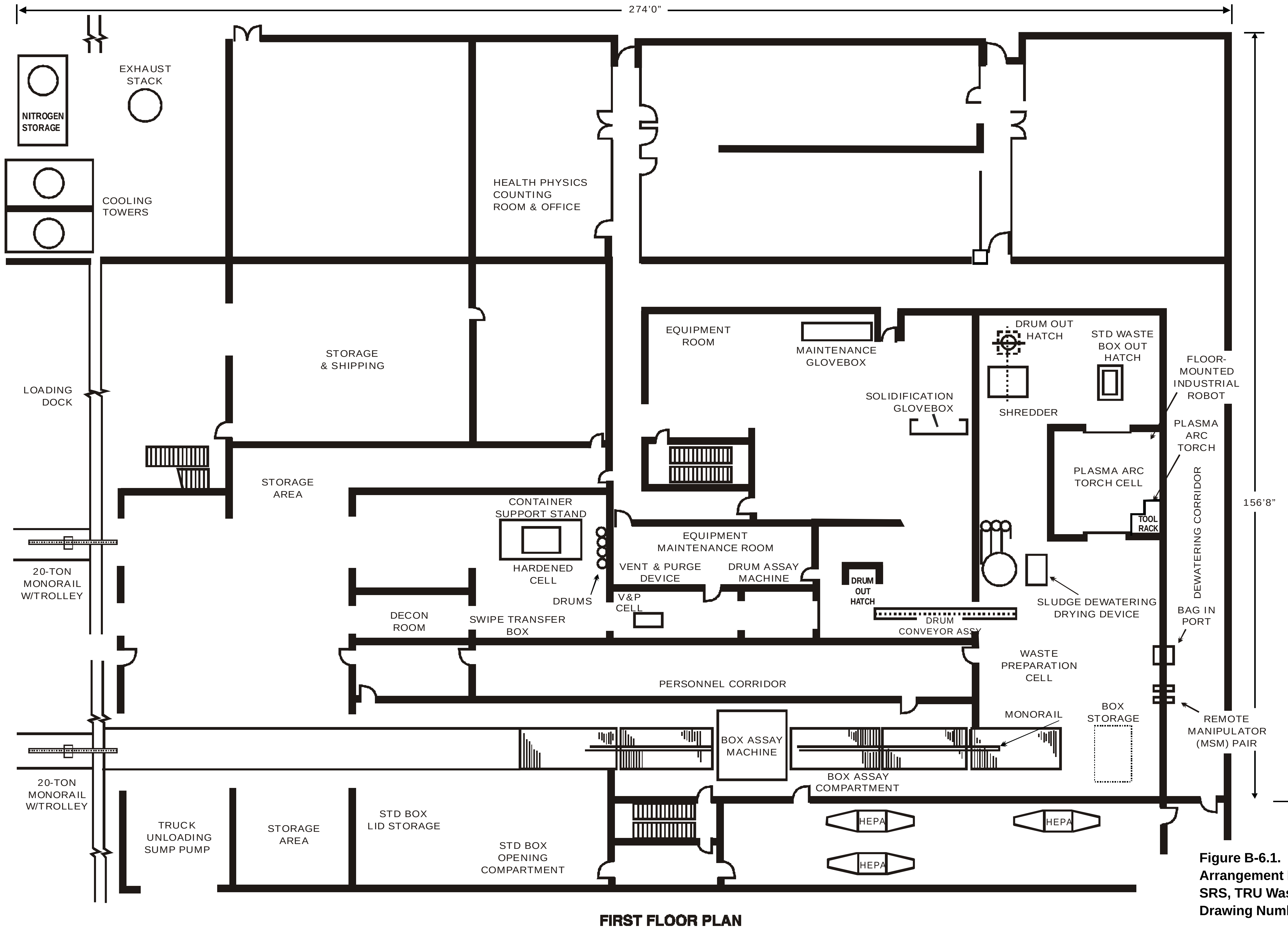


Figure B-6.1. A Schematic of the Equipment Arrangement Process, First Floor Plan at the SRS, TRU Waste Facility (Adapted from Drawing Number SE5-2008820, Rev. E)

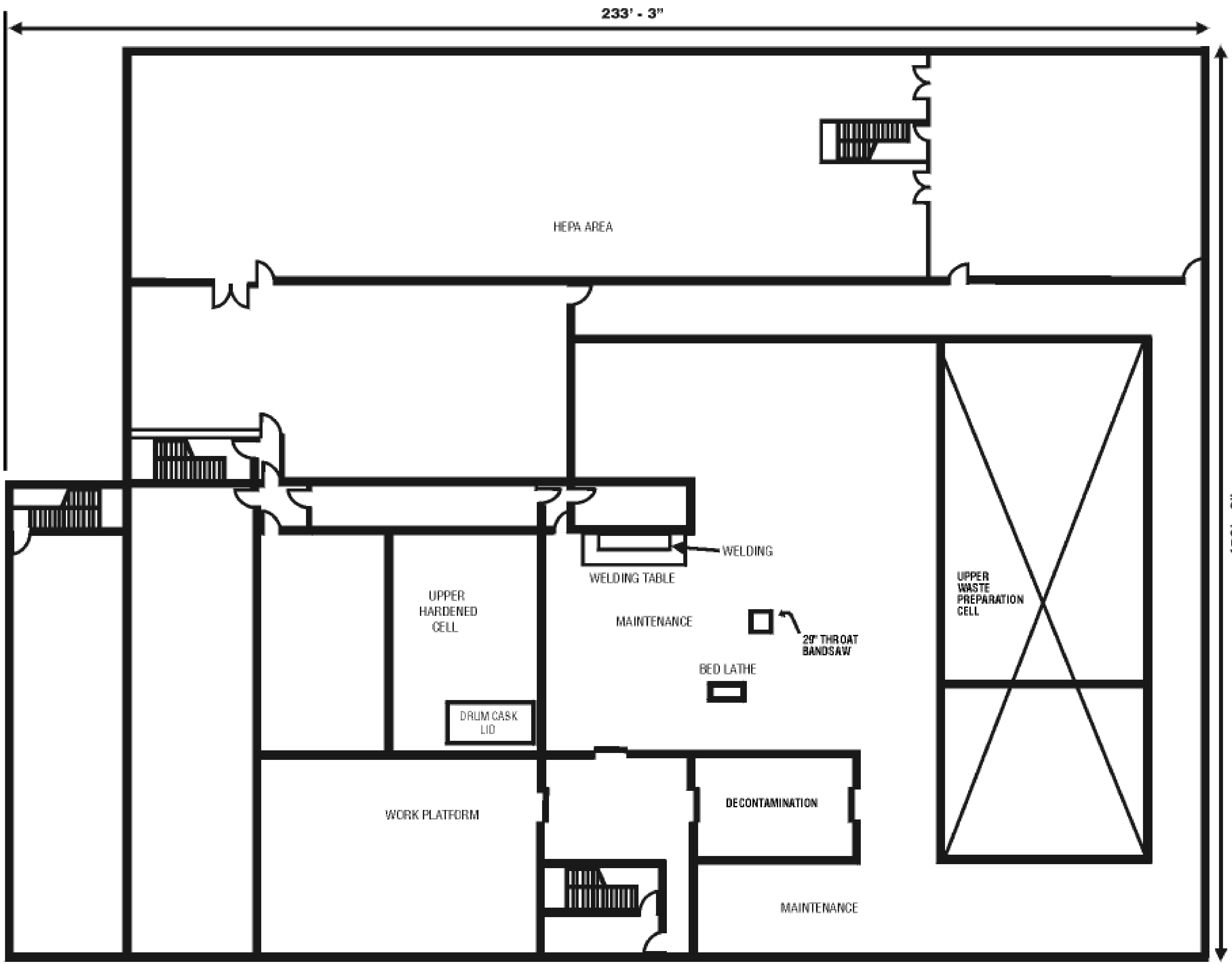


Figure B-6.2. A Schematic of the Equipment Arrangement Process, Second Floor Plan at the SRS, TRU Waste Facility (Adapted from Drawing Number SE5-2008821, Rev. D)

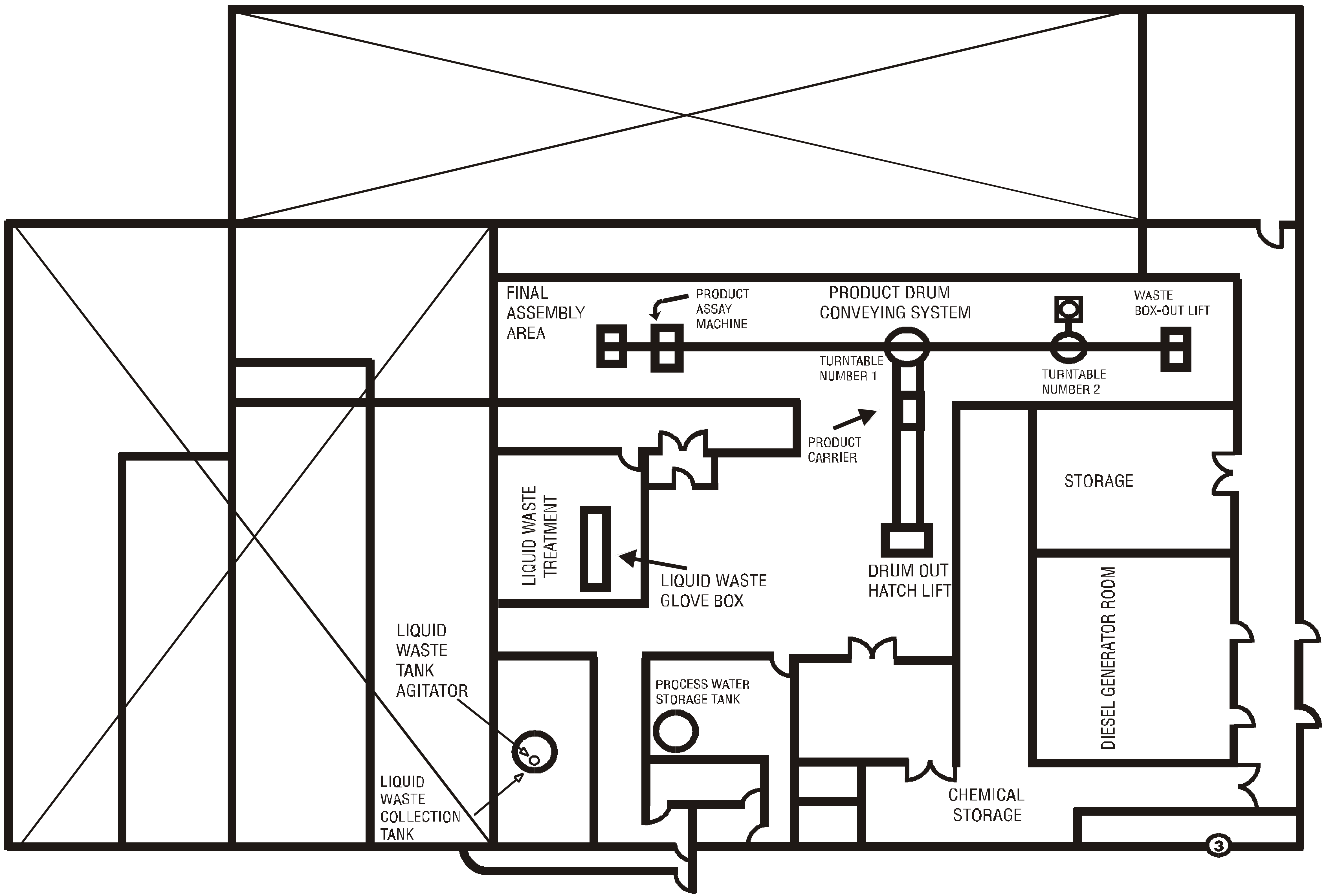


Figure B-6.3. A Schematic of the Equipment Arrangement Process, Basement Floor Plan at the SRS, TRU Waste Facility (Adapted from Drawing Number SE5-2008822, Rev. D)

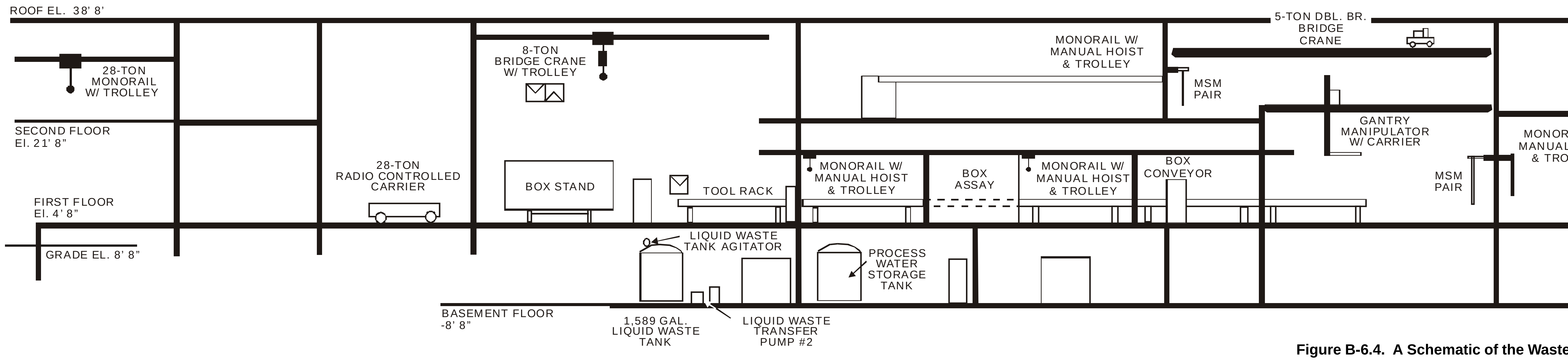


Figure B-6.4. A Schematic of the Waste Storage Tanks and the Waste Transfer System at the SRS, TRU Waste Facility (Adapted from Drawing Number SE5-2-2008823, Rev. D)

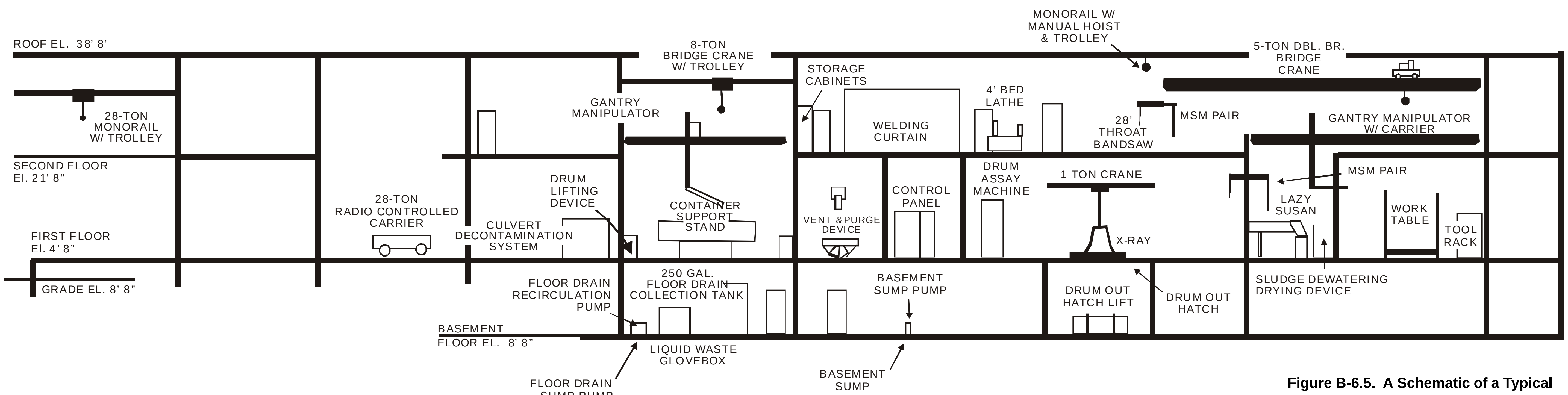


Figure B-6.5. A Schematic of a Typical Sectional View of the Work Cell, Maintenance Area, and the Waste Transfer System at the SRS, TRU Waste Facility (Adapted from Drawing Number SE5-2-2008823, Rev. D)

B-7. Ventilation System

The ventilation system design segmented the process facility into two ventilation areas. One of the ventilation areas was designated the “Process Areas” and included the radiologically controlled areas of Zone 1 and part of Zone 2 classifications (Waste Preparation Cell, Hardened or Explosion Proof Cell, the Box Opening Compartment, and the Vent and Purge Cell). The primary design criteria for this area was to maintain the necessary air ventilation control to ensure the desired level of negative pressure in the individual zones. To achieve this goal, supply air would have been ducted directly to these cells, and HEPA filters were to be used to prevent contamination during a possible air reversal.

The other ventilation area was designated the “Radiologically Controlled Areas” and served the remainder of the radiologically controlled areas; consisting of part of Zone 2, 3a, and 3b classifications. These areas would have potentially less significant concentrations of radioactive contamination since there was no waste material processing in these areas. In addition, these areas may have had personnel present that would have required comfort requirements be satisfied.

Airlock doors with interlocks that only permit one door to be open at a time were to be an integral part of the facilities ventilation system design.

Both ventilation subsystems exhausts would have been HEPA filtered and both subsystems would have exhausted through their own stack. The exhaust from the two process area subsystems would be combined with exhaust from the POGS and discharged via a 80" diameter, 110' tall stack.

B-8. Methods of Waste Processing

Drums would have been vented and purged with nitrogen to remove any hydrogen gas. After assay and X-ray, the drums would have been passed into a Waste Preparation Cell (WPC) where any liquids (free or containerized) would have been removed. The waste would then have been repackaged in new 55-gallon drums or placed into a standard waste box (SWB) and sent to the Waste Certification Facility.

Plywood boxes would have been assayed; conveyed to the WPC; opened; have its contents sorted and size-reduced, if necessary (using a plasma arc torch, hydraulic shears, or shredder); transferred into new drums or a SWB; and sent to the Waste Certification Facility.

HEPA filters would have been be dipped into a tank containing a fixative to coat the filters and prevent the release of respirable fines during filter processing for repackaging.

Sludges, resins, and removed liquids would have been solidified by mixing them with a solidification agent in a glovebox and then they would have been drummed out or placed in a SWB. Capabilities were also to be provided to dry “wet items.”

B-9. Decontamination Technologies

Provisions were to be provided to decontaminate the various processes and equipment needed to support contact maintenance and equipment replacement. The proposed system was the “Kelly System” that provided for a heated stream of heated, high-pressure water to impact the surface being cleaned. The heated water was to flash to steam and be collected along with the removed contaminants by a vacuum head that surrounds the spray nozzle. No provisions were going to be provided to decontaminate any of the waste feed.

B-10. Analytical Laboratory/Capabilities

A laboratory was to be included in the Health Physics (HP) facilities located inside the TWF. A primary effort of this laboratory was to have been processing swipes taken in the facility as part of the RadCon surveys. Equipment that was identified included a: laboratory alpha counting system, laboratory beta counting system, low-level automatic sample counting system, low-background alpha/beta/gamma counting system for counting swipes from the personnel corridor, low-background alpha/beta/gamma counting system for counting swipes from the final assay area, and low-background alpha/beta/gamma counting system for counting planchets from the liquid waste glovebox. In addition, assay equipment was incorporated in the design to permit TRU determination prior to repackaging.

B-11. Secondary Waste

The objective of this facility was simply the repackaging of TRU waste. As such, little secondary waste would be generated. The used 55-gallon drums and plywood boxes would be shredded and packaged for disposal along with the waste being processed. The clean outer culverts and metal boxes would be returned to the storage pad.

Similarly, quantities of secondary liquid wastes would be generated. Provisions were made to collect and process these wastes.

There would also be maintenance waste and worn-out parts that would also constitute secondary wastes. These wastes would have been processed along with the feed material.

B-12. Facility Duty Cycle

The design basis duty cycle was 24-hour operation with a 65% utility or availability factor.

B-13. Support Facility Description

The SRS TWF would have also interfaced with the Solid Waste Support Facility (SWSF) that would have provided clean services facilities such as a lunchroom, offices, clean maintenance, and electrical and instrument shops. The SWSF was intended to support two nearby waste processing facilities. These were the Consolidated Incineration Facility and the TWF.

APPENDIX C. TRANSURANIC WASTE REMEDIATION FACILITY (TWRF) AT THE OAK RIDGE NATIONAL LABORATORY (ORNL)

C-1. The Facility

The Transuranic Waste Treatment Project will involve the use of the "privatization contracting process" for the design, construction, operation, and decontamination & decommissioning (D&D) of a TRU Waste Remediation Facility (TWRF). The TWRF will be built near the Melton Valley Storage Tanks on land leased to the facility operator. The TWRF and surrounding land will be separated from ORNL by a fence that will provide a physical barrier between the TWRF and ORNL, as well as a visible indication of the separation between the privatized TWRF and the surrounding DOE facility. Services such as water and power will be provided from ORNL. Information presented in this appendix was derived from References 4, 16, and 17.

This facility will process liquids, sludges, and solid wastes. The final product will be packaged to meet the waste acceptance criteria for the disposal site to which it must be sent. Volume reduction of the waste feed is a contractual requirement.

The TWRF must be designed/sized to process the base (required) waste quantities for each waste type over a two-year period. Following the base processing campaign it may be decided to process additional waste either from Oak Ridge or other sites within the DOE complex.

The facility constructor/operator will recover some of the costs under fixed priced payments (e.g., D&D) and other costs under fixed unit price payments (e.g., waste processing). The life-cycle costs for this facility are:

Activity	Payment Type	Cost
Licensing & Permitting	Fixed Price	$24 million
Construction & Pre-Op Testing	No Payment*	$77 million
Treatment & Packaging	Fixed Unit Price	$90 million
D&D	Fixed Price	$4 million
Total		$195 million

*This cost is recovered through the fixed unit prices charged to process and package the waste feed to the facility.

C-2. Status of Facility

Phase I activities, which consist of licensing and permitting efforts, were to be initiated June 1998 and were to be completed November 2000. Construction of the TWRF would start December 2000.

C-3. Facility Operation

Design, permitting & licensing, construction, and operation of the TWRF will be done by the Foster Wheeler Environmental Corporation under a privatization program. Segments of this privatization program will involve fixed price reimbursements, while waste processing will be performed using fixed unit price reimbursement. Additional information related to the privatization effort is presented in the corresponding subsection of
Appendix 1.

C-4. Schedule

The schedule for the Transuranic Waste Treatment Project is:

Phase	Actions	Start	Complete
I	Licensing and Permitting	06/98	11/00
II	Construction & Pre-Op Testing	12/00	11/02
III	Waste Processing	12/02	01/05
IV	D & D of the TWRF Facility	01/05	09/06

The above dates will be adjusted to reflect changes in the startup of the Waste Isolation Pilot Project (WIPP). Also, if the optional waste quantities are processed through the TWRF, completion of Phase III would be deferred until November 2007. Phase IV activities would then be correspondingly deferred.

C-5. Waste Sources and Types

The TWRF must process the RH-TRU sludge and low-level waste supernatant from the Melton Valley Storage Tanks. In addition, it must process the liquid/sludge wastes generated as the Gunite and associated tanks, and the old Hydrofracture Facility tanks are cleaned out. Also to be sent to the TWRF are solid wastes (e.g., paper, glass, rubber, cloth, plastic, and metal).

Sludge waste feed to the TWRF will consist of the following waste types:

- Alpha, low-level waste—this is low-level waste contaminated with alpha-emitting radionuclides with an atomic number greater than 92 and half-lives greater than 20 years, in concentrations between 10 and 100 nCi/g.
- TRU waste—this is material contaminated with alpha-emitting radionuclides with an atomic number greater than 92 and half-lives greater than 20 years, in a concentration of 100 nCi/g or greater.
- Waste not meeting either of the above two definitions are classified as low-level waste.

Much of the waste displays RCRA characteristics and may, therefore, be classified as mixed waste.

Also, waste is classified as contact-handled (CH) when it has an associated dose rate of 200 mrem/hr or less, and remote-handled (RH) when the associated dose rate is greater than 200 mrem/hr.

The estimated composition of the wastes requiring processing in the TWRF is:

Type	Total Volume m^3/ft^3	Average Annual Volume m^3/ft^3
RH-TRU Sludge	750/26,500	375/13,250
LLW Supernatant	600/21,200	300/10,600
CR-TRU/ LLW Solids	1,000/35,300	500/17,650
RH-TRU/ LLW Solids	150/5,300	75/2,650

There is also an option for additional waste to be sent to the TWRF for processing following completion of the above waste processing campaign. This waste may come from other locations at the Oak Ridge Site or from other facilities within the DOE complex. The volumes of waste beyond those listed above that may be processed through the TWRF are limited to the following values:

Type	Total Volume m^3/ft^3	Average Annual Volume m^3/ft^3
RH-TRU Sludge	150/5,300	53/1,870
LLW Supernatant	1,000/35,300	353/12,500
RH-TRU/ LLW Solids	400/14,100	141/5,000

C-6. Size of Facility

The TWRF will be a four-story building with the fourth story a HVAC penthouse. The floor area within the facility will total approximately 37,000 square feet. The area dedicated to the penthouse was not specified so it is being estimated that each floor has a cross-sectional area of about 11,000 square feet with the remaining area being allocated to the penthouse.

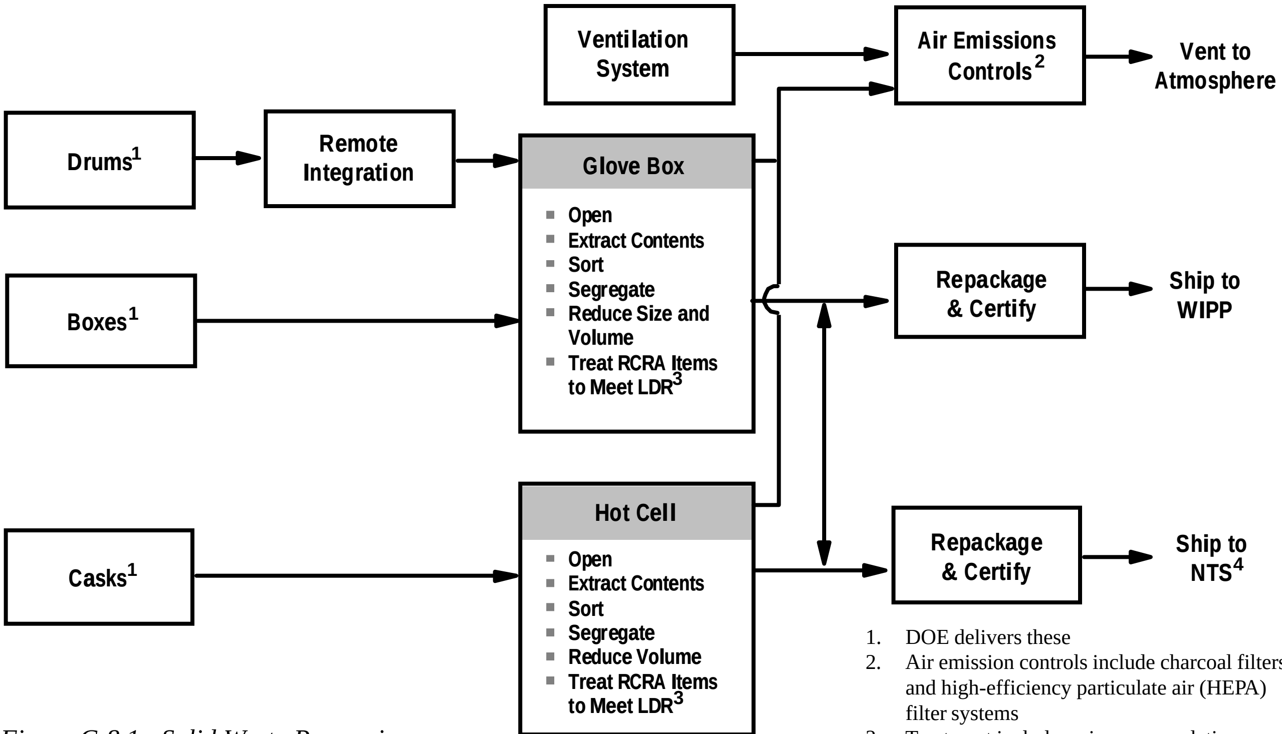
The first floor contains an interim storage area for RH solid wastes. It also houses the load-out area for the final waste forms of both RH and CH solid wastes. The supernatant processing area is located on an intermediate level between the first and second floors. The second floor contains an interim storage area for CH solid wastes as well as characterization areas and solid waste processing areas for both the CH and RH wastes. The third floor houses the sludge processing systems.

C-7. Bases for Shielding Design

Specifics of the shielding designed were not provided; however, information was given on radiation levels around the storage tanks in the Melton Valley Facility. These radiation levels have been as high as 5R/hr. Bringing the sludge contents of these tanks to dryness will concentrate (possibly significantly) the radioactive source term. This concentrating effect on the source of the radiation will require significant shielding for all areas of the TWRF housing the sludge processing equipment or containers of the dried Melton Valley sludge.

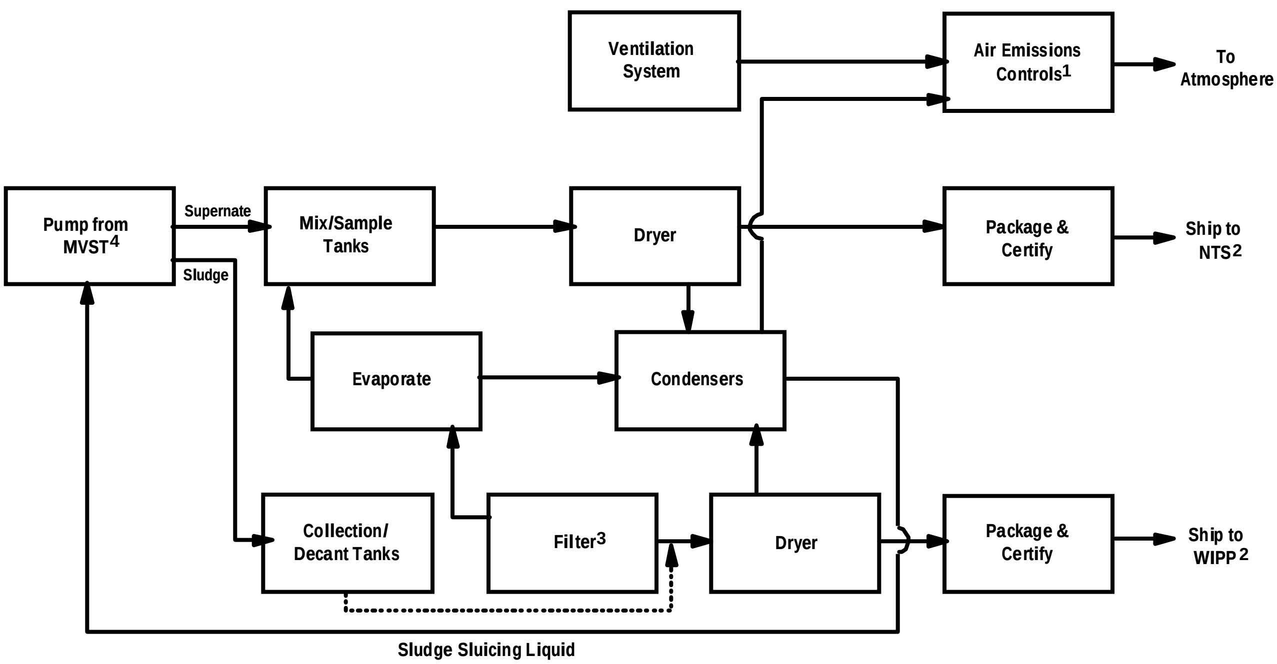
C-8. Methods of Waste Processing

The waste feed streams to the TWRF fall into four categories as they relate to developing the process facility design: 1) tank supernatant 2) tank sludge 3) CH-TRU solid wastes, and 4) RH-TRU solid wastes. The TWRF will house a separate process line for each of these waste streams, thus allowing simultaneous processing of all four waste streams. Figure C-8.1 provides a solid waste process flow diagram and Figure C-8.2 provides a wet waste process flow diagram.



1. DOE delivers these
2. Air emission controls include charcoal filters and high-efficiency particulate air (HEPA) filter systems
3. Treatment includes microencapsulation or amalgamation, as appropriate
4. NTS—Nevada Test Site

Figure C-8.1. Solid Waste Processing Block Flow Diagram



1. Air emission controls include High Efficiency Particulate Air (HEPA) filter systems.
2. WIPP—Waste Isolation Pilot Plant (New Mexico)
3. Cross-flow filter is optional
4. MVSTs—Melton Valley Storage Tanks

Figure C-8.2. Wet Waste Processing Block Flow Diagram

C-8.1. CH Solid Waste

Contact-handled waste will be transferred in drums with up to a 110-gallon capacity and in boxes with dimensions of up to 10' x 8' x 6'. Drums up to 85 gallons in capacity will be screened using both nondestructive examination and nondestructive assay. This process will define those drums that can be certified as LLW or TRU waste without additional processing. The LLW drums will be compacted and prepared for off-site shipment.

Drums larger than 85 gallons or boxes and drums that, following pre-screening, are found to require processing will be fed into their respective gloveboxes through airlocks. In the gloveboxes waste will be tipped from the drums (using a drum tipper) or removed manually through ports in the glovebox. Boxes will be emptied using tools. The waste will be sorted to segregate discrete RCRA materials, LLW, TRU, and materials that have high levels of radiation. Most waste will be compacted. The compactor will be sized to accept drums and smaller containers.

Waste items made of, or contaminated with RCRA metals, will be placed on trays and transferred to an adjacent treatment station.

Waste processed through the CH glovebox will be characterized or certified. Where this occurs in the process sequence was not addressed in the information provided.

C-8.2. RH Solid Waste

Remote-handled waste will be transferred to the TWRF in a cask. This cask will be overpacked. The overpacked liner will then be transferred to the hot cell. The top of the cask will extend into the hot cell while the overpack seats against the hot cell providing the second containment. The contents of the cask will be removed using tools mounted on an overhead crane. Waste articles will be placed in trays that are then conveyed through a nondestructive examination station. Once through the examination station the sorting will be done remotely. The final waste form will be loaded into appropriate shipping containers for transportation off site.

Waste processed through the RH hot cell will be characterized and certified. Where this occurs in the process sequence was not addressed in the information provided.

C-8.3. Waste Segmenting

Waste items removed from boxes or casks that are too large to fit into disposal containers will be segmented. Technologies used for sizing/segmenting waste used will not “burn” or “create particulate matter.” Cutting devices such as shears will meet the performance requirements for segmenting technologies

C-8.4. Treatment of RCRA Wastes

The waste treatment performed will ensure the final waste form meets RCRA land disposal restrictions (LDRs). Liquids removed from the waste containers (with RCRA metals), if found, will be treated in the wet waste system or be microencapsulated. Waste lead, or wastes contaminated with lead, cadmium, silver, and/or dispersed mercury will be macroencapsulated with a polymeric agent (or equivalent) in a stainless steel container. Elemental mercury will be amalgamated with a zinc-powdered additive (or equivalent).

C-8.5. Wet Waste Processing

The supernatant and sludge will be processed using low-temperature thermal treatment. More specifically, the system will contain one forced circulation evaporator that can be shared by both the supernatant and sludge waste streams, and two vacuum dryers of proprietary design (one for each waste stream). The process sequence for wet waste processing is outlined below:

- Obtain and characterize samples for defining treatment steps
- Provide chemical addition (if required)
- Decant or filter excess liquid (filtrate) from the sludge solids and concentrate (evaporate) the filtrate and supernatant, as required
- Dry the sludge solids using a vacuum dryer
- Dry the supernatant and filtrate concentrates in a vacuum dryer
- Provide final characterization per the waste disposal site's Waste Acceptance Criteria (WAC)
- Certify and document LDR compliance
- Load the containers into appropriate shipping casks for transport off site.

C-9. Decontamination Technologies

Decontamination technologies will not be required to support processing the supernatant or sludge waste streams as well as the non-RCRA contaminated solid wastes. Decontamination/flush subsystems may be provided to decontaminate process equipment in support of maintenance efforts.

C-10. Analytical Laboratory/Capabilities

The TWRF site will be isolated from the ORNL. It will be an independent facility operated by the Foster Wheeler Environmental Corporation. Thus, laboratory capabilities for waste characterization (both radiological and hazardous) will either have to be provided at the TWRF or provided by an outside laboratory for a fee.

C-11. Secondary Waste

The cost to handle, process, and dispose of secondary waste generated at the TWRF will be the responsibility of the facility operator. Secondary wastes will include condensed evaporator and dryer distillate, waste generated as a result of maintenance activities, the old containers in which the solid waste was packaged when transferred to the TWRF, and the typical "clean office trash" generated in the nonprocess areas of the facility.

The TWRF is designed to preclude any discharge of secondary liquid waste. Processed waste water is reused to slurry sludge from the tanks to the wet waste processing system in the TWRF. This significantly reduces the volume of secondary waste water generation. As the inventory of processed secondary waste increases, quantities of this waste water will be evaporated, but not condensed. This vapor is further heated, routed through the ventilation system HEPA filters, and discharged via the facility's ventilation stack.

The facility operator will be able to use installed systems/equipment to process solid secondary waste for off-site disposal.

C-12. Support Facility Description

The TWRF is a single, totally self-contained facility. It will essentially be on a "private island" within the boundary of a DOE site. Therefore, all support systems, functions, and areas must be contained within the TWRF. Hotel loads (e.g., water, power) will be provided by the facility operator. Current power demands for the TWRF are estimated to be 2,600 kVA.

C-13. Regulatory Requirements and Contractual Obligations

Regulatory permits and requirements for the design and operation of this facility are not seen as being any different than those imposed on any other similar facility in the U.S. However, there are performance requirements on the waste products and on the process systems themselves that could significantly influence the total cost of this facility. The waste forms must meet appropriate disposal requirements on waste form. These are the WIPP-Waste Acceptance Criteria (WAC), Nevada Test Site (NTS)-WAC, and RCRA Land Disposal Requirements. Since wastes other than LLW will be processed through this facility, the need to ensure TRU waste and mixed-LLW are properly treated/prepared could influence facility cost. An example of this is the installation of a macroencapsulation subsystem to ensure waste acceptability for RCRA Land Disposal Requirements.

There is a contractual requirement that volume reduction be achieved. This will result in increased shield wall thicknesses, as well as compaction equipment to achieve volume reduction of dry active waste.

APPENDIX D. MISCELLANEOUS BETA GAMMA WASTE STORE (MBGWS) AT SELLAFIELD, ENGLAND

D-1. The Facility

The Miscellaneous Beta Gamma Waste Store (MBGWS) is located at BNFL's Sellafield Site near Seascale, Cumbria on the West Coast of England. Sellafield is a large site on which are located a power station, two fuel reprocessing plants, and various waste treatment plants and storage facilities of which the MBGWS is one. The MBGWS is built to handle select intermediate-level wastes. This facility provides for repackaging the received waste into large unshielded steel waste boxes (suitable for disposal). It also provides for interim storage of the waste boxes inside a fully shielded storage building for up to 50 years. The waste is repackaged as received (i.e., packages, drums, etc.) and are placed in the waste boxes without being opened. Information presented in this appendix was derived from Reference 5.

The MBGWS includes two structurally independent buildings—the Receipt Buildings and the Vault, which are both designed to resist earthquakes. Waste is received into the Receipt Building while it is in its shipping cask. The waste remains in the cask while being moved through the facility to the cask unloading area. Once the waste has been removed from the cask and repackaged, the waste is transferred to the storage vault.

Material handling is performed using cranes. A 20-tonne crane is used when moving the cask into or within the Receipt Building. A 5-tonne crane is used to unload the cask and to move material around within the cell. A 16-tonne crane is used to handle the filled waste boxes.

Around 1990, the cost to construct the MBGWS was projected to be in the range of £50 million (approximately $90 million). The projected cost to construct this facility in 1998 dollars is $114 million.

D-2. Status of Facility

The MBGWS has been designed, licensed, and is currently in operation.

D-3. Facility Operation

The MBGWS at Sellafield, England is operated by BNFL.

D-4. Schedule

This facility, which is currently in operation, is designed to process intermediate-level waste (ILW) generated over a 20-year period and provide interim storage for the processed, intermediate-level waste for the next 30 years, resulting in a design life of 50 years for the storage vault.

D-5. Waste Sources and Types

The MBGWS is designed to receive, process, package, and provide interim storage of intermediate-level wastes generated at the Sellafield complex as well as at other nuclear facilities within Great Britain.

The distinction between the three categories of radioactive waste (i.e., low-, intermediate-, and high-level waste) is made based on the waste's concentration of radioactivity and are as follows:

- High-Level waste (HLW) is generally heat generating. HLW containers hold practically all (97 to 99%) of the fission product (neptunium and transplutonium elements) from reprocessing irradiated fuel.
- Low-Level Waste (LLW) contains radioactive materials other than those acceptable for authorized conventional refuse disposal (very low level), but not greater than 0.1 curies per tonne alpha radiation or 0.3 curies per tonne beta/gamma radiation.
- Intermediate-Level Waste (ILW) exceeds the LLW criteria, but is not significantly heat generating.

The MBGWS is not intended to receive all types of intermediate-level waste, but is limited to waste such as ventilation filters, scrap metallic objects, or possibly what, in the U.S., might be termed dry active waste.

The facility is designed to provide storage for 3,000 m^3 (106,000 ft^3) generated over 20 years. Thus, the annual throughput would be 150 m^3 (5,300 ft^3).

D-6. Size of Facility

The MBGWS consists of two structurally independent buildings. The first is the "Receipt Building," which measures approximately 236' long by 105' wide by 56' high. The cross-sectional area of this facility is approximately 24,800 ft^2. This building is divided into two separate areas: (1) the support side, which houses the mechanical and electrical services equipment as well as Change-Room facilities, and (2) the production side where flask handling and waste processing is performed. Figure D-6.1 provides a cross-sectional view of the MBGWS.

The second building is the "Vault" or shielded storage bay that measures approximately 272' long by 137' wide by 56' high. The horizontal cross-sectional area of this storage vault is approximately 37,500 ft^2 and is slightly larger than the floor area.

D-7. Bases for Shielding Design

All in-cell activities are carried out remotely behind one-meter (3.3')-thick walls. Lead glass windows and closed-circuit TV are used to view operations. The vault has 900 mm (35.4")-thick reinforced concrete shielding walls and a 800 mm (31.5")-thick reinforced concrete shielding roof.

Applicable radiation standards are defined in References 14 and 15. However, it must be realized that just as at most U.S. facilities, site administrative limits on radiation exposures may be lower than regulatory limits. Legal limits for radiation exposures to radiation workers are:

- Maximum single-year exposure is 5 rem
- Average yearly exposure over any 5-year period is 2 rem/year.

The administrative controls for radiation exposure to workers at the BNFL site is 1.5 rem per year. The average major dose rate across the site is only 200 mrem. The MBGWS Facility is designed to limit operator dose rate to 50 mrem per year.

D-8. Methods of Waste Processing

The treating, segmenting, etc. of waste is not performed in this facility. Only the verification that the fissile content of the waste is within allowable limits is performed, followed by packaging the waste for disposal in a standardized waste box. “Flasks” (transport casks) are received into the building one at a time. The bolts holding the lid to the flask in place are manually removed. From here all activities, except for the replacement of the lid bolts, are performed remotely. The flask is first moved to the lid removal area and then to the area were the flask interior can be remotely inspected. Once inspected, the flask is moved to mate-up against the underside of the Flask Port. Inside the flask is either a reusable liner or disposable liner. Reusable liners are placed into an in-cell tipping machine so that the contents can be tipped onto a sorting tray. The reusable liner is then returned to the flask. Disposal liners are placed directly on the sorting tray. From here the waste is either placed directly into a waste box or first checked for fissile material content. Waste with an unacceptably high fissile material content is returned to the sender for additional sorting.

Photographs of the various facility features are included in this appendix. The features shown in these photos are:

- D-8.1. The fissile material detector
- D-8.2. A 20-tonne crane moving a flask loaded with a waste liner into the process area
- D-8.3. A waste box as it is being filled
- D-8.4. A full waste box being transferred to where it will be stacked on a stool.

For each package, an inventory database is generated that allows the package to be traceable back to the plant of origin through its unique package number. This allows a full inventory of the contents of the package to be available at any time.

Figure D-8.1. Fissile Material Detector

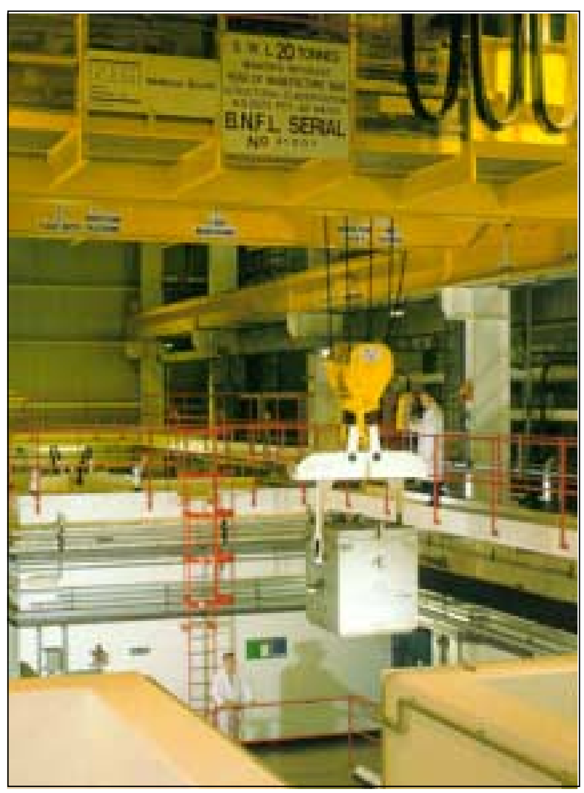


Figure D-8.2. 20-Tonne Crane Moving a Loaded Flask

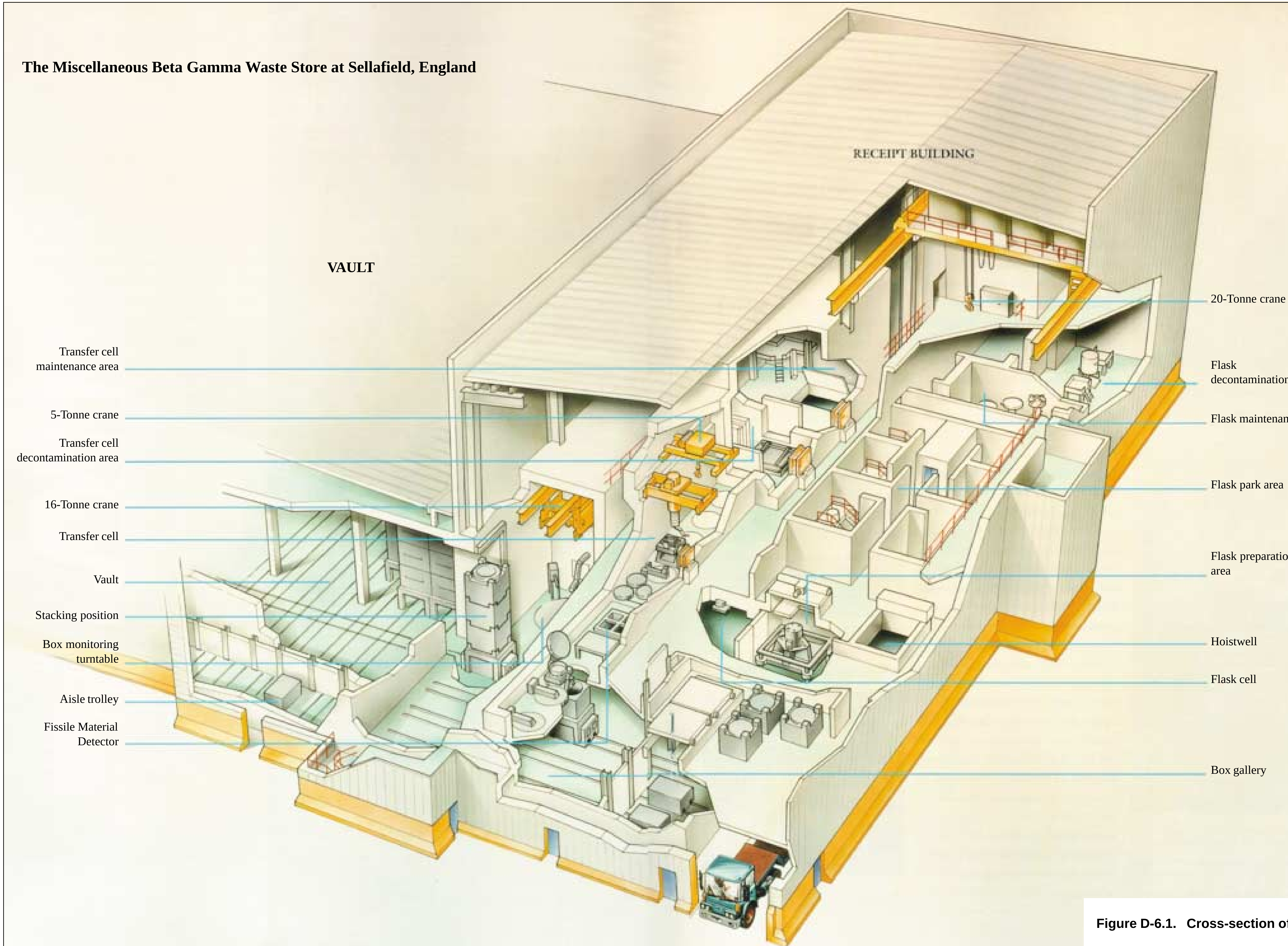


Figure D-6.1. Cross-section of the MBGWS

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Figure D-8.3. Waste Disposal Container as it is being Filled

Figure D-8.4. Full Waste Disposal Container being Transferred to where it will be Stacked on a Stool

Once the waste disposal container is full, sealed, and the inventory completed it is ready for transfer to the vault. The transfer is accomplished by first stacking three waste disposal containers on a "stool." The "stool" is, in effect, a specially designed skid to facilitate remote transport and long-term storage of the waste disposal containers. The stool, loaded with three waste disposal containers, is picked up by the transfer trolley. The door between the Storage Vault and Receipt Building is opened and the transfer trolley is remotely moved into the Storage Vault where the stool containing the three waste disposal containers is placed into longer-term storage.

D-9. Decontamination Technologies

This facility utilizes decontamination to support equipment maintenance. There are both a decontamination spray tank and a spray booth that decontaminates surfaces using a "hot cleansing solution." This facility also has the capability to decontaminate the flask used to transfer the waste to the facility.

D-10. Analytical Laboratory/Capabilities

The MBGWS incorporates into its design a fissile material detector capable of providing the fissile level of high-activity waste packages. The underlying technology for this detector was developed at the Los Alamos National Laboratory.

Waste known through process knowledge to have little if any fissile material content is placed directly into the waste disposal containers from the sorting table. Packages (small containers up to 55-gallon drums) and pieces of suspect waste are transferred from the sorting table to the fissile material detector for monitoring.

D-11. Secondary Waste

Secondary liquid wastes are generated during washdown (decontamination) of the transport flask and equipment/areas within the Receipt Building in support of maintenance activities. Routine maintenance of the facility and equipment will also generate dry solid secondary wastes. These wastes are routed to other facilities for processing.

APPENDIX E. PROPOSED REMOTE-HANDLED WASTE FACILITY (RHWF) AT THE WEST VALLEY DEMONSTRATION PROJECT (WVDP)

E-1. The Facility

The conceptual design of a new, standalone RHWF at the WVDP was completed in June 1998. As proposed, the RHWF would receive, sort, water-wash, characterize, size-reduce, and package for off-site disposal, approximately 53,000 ft^3 (1,500 m^3) of radioactive waste currently stored, and an additional 49, 400 ft^3 (1,400 m^3) of waste that was to be generated during site closure. The RHWF was to have material handling, cutting, decontamination, assaying, and packaging systems. To process the secondary liquid waste, a system with two filters and two ion-exchange columns was to be provided.

The waste that was to be processed in the RHWF is unique in its configuration, container size and shape, source of waste origination, and radioactivity levels. Waste for the RHWF would typically result from "remote-handled operations" and "remote-handled cleanup activities" such as cleanup of the hot cells. The waste would have been typically high dose, high contamination, and nonhomogeneous.

The RHWF was to be a new, standalone facility that would have been one level (open to the roof) for the shielded process portion of the facility and three levels for the surrounding operating and support areas. Its design included a main waste receiving area and a separate shipping area, both inside the RHWF. The RHWF was to house processing areas, administration and personnel support areas, and secondary waste treatment areas, but did not include an analytical laboratory, which was available elsewhere on site.

The process areas were to be large cells with painted concrete shield walls. The floor and the lower part of the walls of the principal process cell were to be lined with stainless steel. One glovebox was included for transfers of small samples through the cell's shield wall. The ventilation system HEPA filters were inside the RHWF process areas and the ventilation equipment was located on the third level of the support areas.

WVNS estimated the cost for the RHWF to be $55 million in FY1998.

E-2. Status of Facility

The size and processing capabilities of this facility were reevaluated because of the higher-than-expected facility cost. The evaluation was completed in January 1999 and resulted in a smaller less costly facility described later in this report as the Rescoped Remote-Handled Waste Facility.

E-3. Facility Operation

Design, construction, and operation of the RHWF was to have been done by WVNS as part of the DOE contract for O&M of the WVDP Site.

E-4. Schedule

Construction of the RHWF was postponed pending the results of the rescoping effort. However, the preliminary schedule developed for the this facility was:

Design	2-$^1/_2$ years
Construction	4 years
Operation	11 years.

E-5. Waste Sources and Types

The RHWF was to have the capability to treat all existing WVDP waste streams now in storage and also have the flexibility to treat future wastes generated during closure of the WVDP Site. The expected wastes did not include any off-site waste streams. The existing WVDP waste streams planned to be processed in the RHWF were mostly dry solids in storage at various locations around the WVDP. The primary objective of the RHWF was to process the backlog of waste in storage and prepare it for off-site shipment and disposal. Once this task was accomplished, the RHWF would be available to process future wastes from the closure of the WVDP Site.

Tables E-5.1 through E-5.4 present a listing of the wastes that were planned to be processed in the RHWF:

- Table E-5.1 provides a complete list of the waste types and anticipated processing steps to prepare the waste in a disposal-ready form.
- Table E-5.2 provides a listing of the physical dimensions, volume, and weight of the waste containers to be processed in the RHWF. Compared to facilities at other sites that typically process one or two types of waste packages of standard configuration, the RHWF had to accommodate a variety of nonstandard and physically large packages.
- Table E-5.3 presents the major waste streams by volume. It should be noted that there were not only many different waste streams, but that none of them individually represented a major portion of total waste volume. Thus, the variety of the waste streams that were to be processed, significantly contributed to the complexity of the design and construction of the facility.
- Table E-5.4 lists the major key parameters that drove the RHWF design for structure, shielding, and material handling equipment.

Specifically, the facility was designed to receive and process radioactive wastes packaged in drums, boxes, and other similar containers. The incoming waste containers would have had a wide range of sizes. The two boxes with the largest dimensions that the facility was sized to accept were a dissolver vessel box at 12' x 12' x 20' and a Waste Tank Farm pump box at 4' x 4' x 50'. The weight limit on a container that was used to size the facility's handling equipment was 27 tons for a vent filter box. The dose rate limit used in the design of the shield walls in the facility was approximately 6 R/hr for the general radiation level from a container.

This facility was also expected to be capable of processing many of the wastes to be generated during closure of the WVDP site. The limiting factors would again be container size, weight, and radiation level.

The RHWF was designed to process approximately 260 cubic meters per year (9,300 cubic feet per year). Based on a total expected volume of waste of approximately 2,900 cubic meters (102,000 cubic feet), the facility would have been in operation over an 11-year period. The following is an estimated volumetric breakdown by waste types of the feed to the RHWF:

Waste Types	Cubic Meters	Cubic Feet
Remote-handled TRU (RH-TRU)	1,753	61,900
Contact-handled TRU (CH-TRU)	588	20,800
Remote-handled LLW (RH-LLW)	510	18,000
Contact-handled LLW (CH-LLW)	37	1,300
Total	2,888	102,000

Proposed Waste Streams and Processing Activities

04/21/98

	Box #	Waste Type (note 1)	Weight of Contents (note 2)	Waste Volume (cu. ft.)	Average Dose Rate (mR/hr)	Hot Spot Dose Rate (mR/hr)	Location of Waste/ Container	Pre-processing Waste Class Estimate(note 9)	On-Site Shielded Transfer	Open Box	Sort & Segregate	Survey, Assay, Sample	Size Red. for Shipping	Size Red. for Decon	Mild Decon Req'd	Aggres. Decon Req'd	Min. DF Needed (note 3)	Dewater	Stabilize (by others)	Repackage as req'd (note 4)	Total Packages Produced	Ship as CH-LLW	Ship as RH-LLW	Store/Ship as CH-TRU (note 5)	Store/Ship as RH-TRU	Interim Storage	Package/ Container Cost	Off-site Transport Mode	Transport Cost	Disposal Site	Disposal Cost
1	3E-2/3E-3	Dissolver Condensor 3E-2 Dissolver Condensor 3E-3	7,500 7,500	41 41	42	75	CPC-WSA	LLW		X	X	X								X	3	3					?	Truck	?	NTS	?
2	7D-10	LLW Accountability Tank	9,900	254	47	360	CPC-WSA	LLW		X	X	X								X	5	5					?	Truck	?	NTS	?
3	7C-4	Rework Evaporator	9,900	402	98	360	CPC-WSA	LLW		X	X	X								X	9	9					?	Truck	?	NTS	?
4	J1	Jumpers & Debris	4,800	?	157	572	CPC-WSA	LLW/Mixed	X	X	X	X								X	8	8					?	Truck	?	NTS	?
5	J4	Jumpers & Debris	5,800	?	196	515	CPC-WSA	LLW/Mixed	X	X	X	X								X	8	8					?	Truck	?	NTS	?
6	J5	Misc. waste including: Account. Tank Condensor HLW Evaporator Condensor LLW Evaporator Condensor	5,300 (880) (660) (660)	? 8 4 4	326	1,400	CPC-WSA	LLW	X	X	X	X								X	8		8				?	Truck	?	NTS	?
7	J6	Jumpers & Debris	3,600	?	226	420	CPC-WSA	LLW/Mixed	X	X	X	X								X	8		8				?	Truck	?	NTS	?
8	J7	Jumpers & Debris	2,500	?	266	920	CPC-WSA	LLW/Mixed	X	X	X	X								X	8		8				?	Truck	?	NTS	?
9	J8	General Debris	5,000	?	329	810	CPC-WSA	LLW/Mixed	X	X	X	X								X	8		8				?	Truck	?	NTS	?
10	J9	General Debris	5,000	?	1,057	2,600	CPC-WSA	LLW/Mixed	X	X	X	X								X	8		8				?	Truck	?	NTS	?
11	J10	General Debris	5,000	?	1,550	4,600	CPC-WSA	LLW/Mixed	X	X	X	X								X	8		8				?	Truck	?	NTS	?
12		Ventilation Filters (42 containers, some shielded)	?	?		?	LAG-shielded	Suspect TRU	X	X	X	X	X						X	X	?	?	?	?	?	X	?	Truck	?	WIPP/NTS	?
13		FRS Resins - HICs A,D&E - HIC B - HIC C	23,250 7,750 7,750	300 100 100		? <8,000 <8,000	FRS yard	LLW TRU Mixed TRU	X X X	X X X		X X X						X X X	X X X	X X X	? ? ?	X ? ?	 ? ?	 ? ?	 ? ?	 X X	? ? ?	Truck Truck Truck	? ? ?	NTS WIPP/NTS WIPP/NTS	? ? ?
14		360 CH-TRU Containers	?	?		?	LAG	Suspect TRU		X	X	X			X		?				?	X					?	Truck	?	NTS	?
15		13 LLW Shield Boxes (same size as jumper boxes)	75,000	?	30		CPC-WSA	LLW		X	X	X									?	X					?	Truck	?	NTS	?
16	7C-1	HLW Evaporator	5,500	157	1,239	6,900	CPC-WSA	LLW	X	X	X	X	X							X	5		5				?	Truck	?	NTS	?
17	7C-2	LLW Evaporator	14,000	427	120	3,000	CPC-WSA	LLW	X	X	X	X	X							X	10	10					?	Truck	?	NTS	?
18	7D-4	HLW Accountability Tank	6,000	157	743	1,900	CPC-WSA	Suspect TRU	X	X	X	X		X	X		2			X	5	5					?	Truck	?	NTS	?
19	3D-1	Account. & Adjust. Tank	10,600	308	250	2,500	CPC-WSA	LLW	X	X	X	X	X							X	4		4				?	Truck	?	NTS	?
20	7E-5/7E-8 /3E-1	General Waste	2,800	?	2,360		CPC-WSA	STRU/Mixed	X	X	X	X		X	X	X	15			X	7	7					?	Truck	?	NTS	?
21	J2	Jumpers & Debris	5,200	?	1,378	5,800	CPC-WSA	STRU/Mixed	X	X	X	X		X	X		5			X	8	8					?	Truck	?	NTS	?
22	J3	Jumpers & Debris	7,100	?	1,680	7,800	CPC-WSA	STRU/Mixed	X	X	X	X		X	X		5			X	8	8					?	Truck	?	NTS	?
23	J11	General Debris	5,000	?	2,034		CPC-WSA	STRU/Mixed	X	X	X	X		X	X		2			X	8	8					?	Truck	?	NTS	?
24	J12	General Debris	5,000	?	2,360		CPC-WSA	STRU/Mixed	X	X	X	X		X	X		3			X	8	8					?	Truck	?	NTS	?
25		15 Hi-Vac Canisters	?	140		~15,000 @5'	CPC/GPC	Suspect TRU	X	X		X							X	X	?	?	?	?	?	X	?	Truck	?	WIPP/NTS	?
26		4 FRS Pool Debris Canisters	?	29		~200,000	FRS pool	Suspect GTCC		X	X	X								X	?					X	?	Truck	?	?	?
27		Other LLW being considered (2@22.5 ton, 1 @ 27 ton)	144,000	?		?	LAG	LLW		X		X	X							X	?	X					?	Truck	?	NTS	?
28		*HEC Minor Debris*	?	?		?	GPC/PMC	Suspect TRU	X	X		X							X	X	?	?	?	?	?	X	?	Truck	?	WIPP/NTS	?
29	3C-1	Dissolver 3C-1	26,000	822	2,634	107,000	CPC-WSA	Suspect TRU	X	X	X	X	X	X	X	X	4			X	15	12		3		X	?	Truck	?	WIPP/NTS	?
30	3C-2	Dissolver 3C-2	26,000	822	2,854	24,000	CPC-WSA	Suspect TRU	X	X	X	X	X	X	X	X	5			X	15	12		3		X	?	Truck	?	WIPP/NTS	?
31		*HEC Large Equipment (note 6)* *(cranes, vessels, etc.)*	?	?		2,000,000	GPC/PMC	RH-TRU/HLW	X	X	X	X	X	X	X	X	?			X	?	?	?	?	?	X	?	Truck	?	WIPP/NTS	?
32		*Vit Expended Mat'l* *(SBS pumps, inserts, jumpers, etc.)*	?	*2,000*		~30,000 @ 5'	CPC/VF	GTCC/HLW	X	X	X	X				X	?			X	?	?	?	?	?	X	?	Truck	?	WIPP/NTS	?
33		*WTF Pumps & Equipment (50' L)* *(10 mob, 1 decant, 2 transfer pumps)* *(note 7)*	*100,000*	*1,500*		~425,000 in the tank	WTF	GTCC/HLW	X	X	X	X	X	X		X	?			X	?	?	?	?	?	X	?	Truck	?	WIPP/NTS	?
		Totals	542,750	7,616																											

This shaded area represents existing waste information.

This shaded area represents shipping and disposal information.

NOTES:
1. D&D wastes and other wastes awaiting the EIS ROD are not included at this time.
2. Weight of contents (in lbs) for J-1 thru J-7 calculated from jumper info in the Meigs/Vlad notebook. This is considered a minmum. Weight of contents for J-8 thru J-12 is an estimated minimum. (10,000 lb estimated maximum)
3. Theoretical minimum decontamination factor (DF) required to reduce waste class to Class C or less.
4. Repackaging includes shielding and/or overpacking
5. The CH-TRU packages shown for waste stream #1 represent 5% of the total TRU volume in the 8 boxes in the CPC-WSA. This is the volume assumed to remain after processing. The packages are summarized and shown in one location for convenience.
6. Waste type names that are italicized represent future waste streams that may feed the remote handled waste processing facility.
7. Assumes that 8 mob pumps, 2 decant pumps and 6 mechanical arms remain in 8D-1 and 8D-2.
8. Secondary waste stream information to be added later.
9. Some or all of the CPC-WSA jumper & general debris boxes may contain hazardous materials.

NTS - Nevada Test Site
WIPP - Waste Isolation Pilot Program

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Table E-5.1. Proposed Waste Streams, and Processing Activities in the RHWF (1998 Conceptual Design) at the WVDP

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Table E-5.2. Characteristics of the Waste Streams to be Processed in the Remote-Handled Waste Facility (1998 Conceptual Design) at the West Valley Demonstration Project

			Restrictive Dimensions*						
No.	**Waste Container Designator**	**Number of Waste Container or Items**	**Max. Length or Diameter (ft)**	**Max. Width (ft)**	**Max. Height (ft)**	**Total Weight on Hook (lbs)**	**Total Waste Weight in all Containers (lbs)**	**Total Waste Volume (ft^3)**	**Dose Rate (mR/hr)**
1	WTF Mobilization Pumps	12	~50	4	4	~8,000	~100,000	9,600	50,000
2	WTF Transfer & Decant Pumps	5	50	4	4	~8,000	41,667	4,000	50,000
3	Concrete Pedestals	3	10.5	10.1	9	45,000	112,500	2,374	< 2
4	Vit Jumpers	20	10”	cyl	~12	TBD	TBD	433	30,000@5’
5	Vit Melter Inserts	50	8”	cyl	~18	TBD	TBD	5.5	18,000
6	Vit Discarded Equipment	91	10	6	10	TBD	TBD	1,955	100 to 30,000
7	FRS Resins in HICs in SUREPAC®	7	10	cyl	9.5	77,550	0	882	3,000 to 15,000
8	Shielded Boxes	38	12	6	6	10,500	139,525	5,357	1 to 170
9	Shielded Drums	25	2	cyl	2.5	1,390	15,861	184	0.1 to 100
10	FRS Pool Debris Cans	4	1.95	cyl	12	TBD	TBD	143	200,000
11	Hi-Vac® Cans	15	1.83	cyl	3.5	248	671	130.8	15,000@5’
12	HEC Waste	50	2	cyl	2.5	TBD	TBD	370	TBD
13	Suspect CH-TRU Drums	227	2	cyl	2.5	471	53,345	1,668	0.1 to 160
14	Suspect CH-TRU Boxes	99	12.92	6.92	6.96	13,274	410,800	7,460	0.1 to 230
15	Vent Filter Boxes (in cement)	5	7.54	5.38	5.56	9,220	44,000	1,015	1 to 230
16	Vent Filter Boxes	37	6.45	3.95	4.59	13,274	147,000	3,500	1 to 230
17	Main Plant Closure Wastes	46	6.5 dia. 10.75” dia.	tank column	12 43	9,800	72,280	4,400	40 to 50,000
18	Dissolver Vessel Boxes	2	19.875	11.79	11.2	35,854	71,708	5,260	107,000
19	Vessel Boxes (TRU)	2	13.72	8.42	8.95	9,942	15,842	1,368	1,900
20	Vessel Boxes (LLW)	6	16.58	11.44	11	21,119	15,842	8,555	360 to 6,900
21	Jumper Boxes (TRU)	4	12.96	6.92	6.96	3,870	15,480	1,728	2,600 to 7,800
22	Jumper Boxes (LLW)	8	12.96	6.92	6.96	3,870	30,960	3,456	420 to 1,400
23	Shield Boxes	13	12	6	6	TBD	TBD	5,322	1 to 30
24	Vit Cell Deactivation Wastes	TBD	TBD	TBD	TBD	TBD	TBD	TBD	100 to 30,000
25	Other Miscellaneous Wastes	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

* The dimension shown is the largest if containers with different sizes exist.

Table E-5.3. Remote-Handled Waste Facility—Waste Streams Grouped According to Volume

Major Waste Streams	% (Volume)
Dissolver (2-CPC-WSA)	5%
Waste Tank Farm Pump (16)	11%
Concrete Pedestal (2+)	2%
Vessels (8-CPC-WSA)	15%
Jumpers (12+2) i) vit jumpers (2)	13%
Vit Melter Inserts (50)	
Vit Discarded Equipment (later) (10)	2%
FRS resins in liners / HICs in SUPREPAC® (5)	4%
Shielded boxes with HEPA filters (42-LSAs)	6%
Other LLW boxes (13+50) a) WSA shield boxes (13) b) Shielded boxes in LSAs (50)	18%
Debris (4+16+50) a) FRS Pool Debris (4) b) Hi-Vac® Cans (16) c) HEC Minor Debris (later) (50)	3%
Suspect CH-TRU (424-Lag Storage B) a) Drums (283) b) Boxes (141)	20%

Table E-5.4. Key Parameters of the Waste Streams for Processing in the Remote-Handled Waste Facility

	Weight		Size		Quantity	
Design Requirements	22.5 tons	Dissolver Pedestals (2)	50’ long	Mob Pumps (16)	424 Packages	CH-TRU in LSB
	27 tons	HEPA Filters in Concrete	20’x12’x13’	Dissolver Boxes (2)	13 Large Boxes	WSA Shielding
	18 tons	Dissolver Boxes (20	13’x7’x7’	Jumper Boxes (11)	5 SUPREPAC®	FRS HICs

	Dose		Contamination	
Design Requirements	~ 50 R	Mobilization Pumps (2)	>10^6 dpm alpha	CPC-WSA Box Contents
	~ 30 R	Vit Discarded Jumpers	>10^6 dpm alpha	Mobilization Pumps
	107 R	Dissolver Box	>10^6 dpm alpha	HEPA Filters
Design Considerations	300 R	Railcar Buried in NDA (1)	>10^6 dpm alpha	
	8,000 R	NPR Fuel Buried in NDA (1)	>10^6 dpm alpha	

The waste feed to the RHWF would have included:

- Metal wastes, including vessels, tanks, pumps, and piping
- Organic wastes, including ion-exchange resins, plastics, and clothing
- Concrete wastes.

E-6. Size of Facility

The conceptual design of the RHWF was for a 57' x 101' process building and an attached 45' x 32' receiving area. The facility had a height of 35'. The process building had two shielded cells. One cell was to be used as an air-lock and staging area for incoming waste containers. The second cell was to be used for processing the waste. Surrounding these two cells on three sides in a U-shaped configuration were three levels of rooms that housed the operating aisles, a shipping area, administrative and personnel support areas, the ventilation system, assay systems, the secondary waste treatment system, and a crane maintenance area.

The first floor had an area of approximately 7,200 ft^2, and of that area, approximately one-half of the area was the receiving area and shielded cells. The areas of the second and third floors were approximately 3,200 ft^2 each. The volume of the facility was approximately 250,000 cubic feet. The three general arrangement drawings for the RHWF detailing the configuration and equipment arrangement are included in this appendix. Also included is the RHWF's air flow diagram. The list of figures included are:

Of the total 13,600 ft^2 of area provided under the roof of the RHWF, primary space allocations would have been as follows:

Activity	Area in ft^2
Waste processing cell	1,430
Staging/interim storage area	570
Receiving area	1,440
Operating aisles and administrative support areas	3,200
Shipping area	1,360
Ventilation system	1,360

The remaining area was for crane maintenance, the secondary waste system, assaying equipment, airlocks, and miscellaneous equipment areas.

E-7. Ventilation System

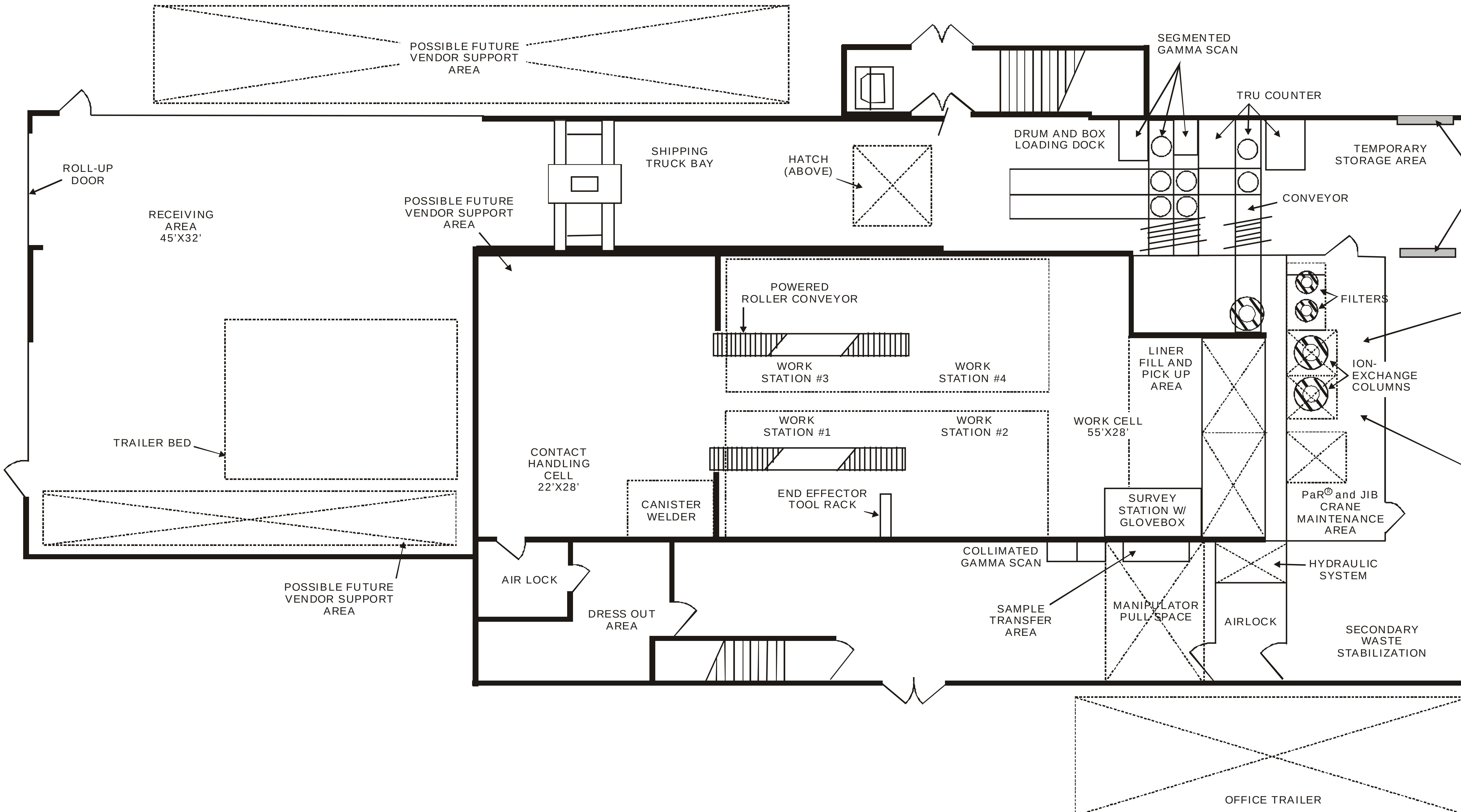
There were to be three ventilation zones in the RHWF for confinement of airborne radioactivity, referred to as Zones III, II, & I, with Zone III the least contaminated and Zone I the most highly contaminated. Waste containers with the potential for containing large amounts of alpha contamination would be opened only in Zone I. Transfers of waste containers from one confinement zone to the next would have been through the use of two sets of interlocked doors where only one set of doors can be open at a time (i.e., an airlock system).

Air flow within the RHWF would have generally been from the outside clean area through Zone III, then into Zone II, and finally into Zone I. The airlocks would allow waste containers and supplies to pass from one ventilation zone to another without disrupting the air flow toward Zone III.

The HVAC system would have been located on the third level of the support area, while there would be local intake HEPA filters located within the process cell itself. The main facility stack would have been a round duct 4' in diameter. The top of the stack would have been approximately 15' above the facility roof.

E-8. Bases for Shielding Design

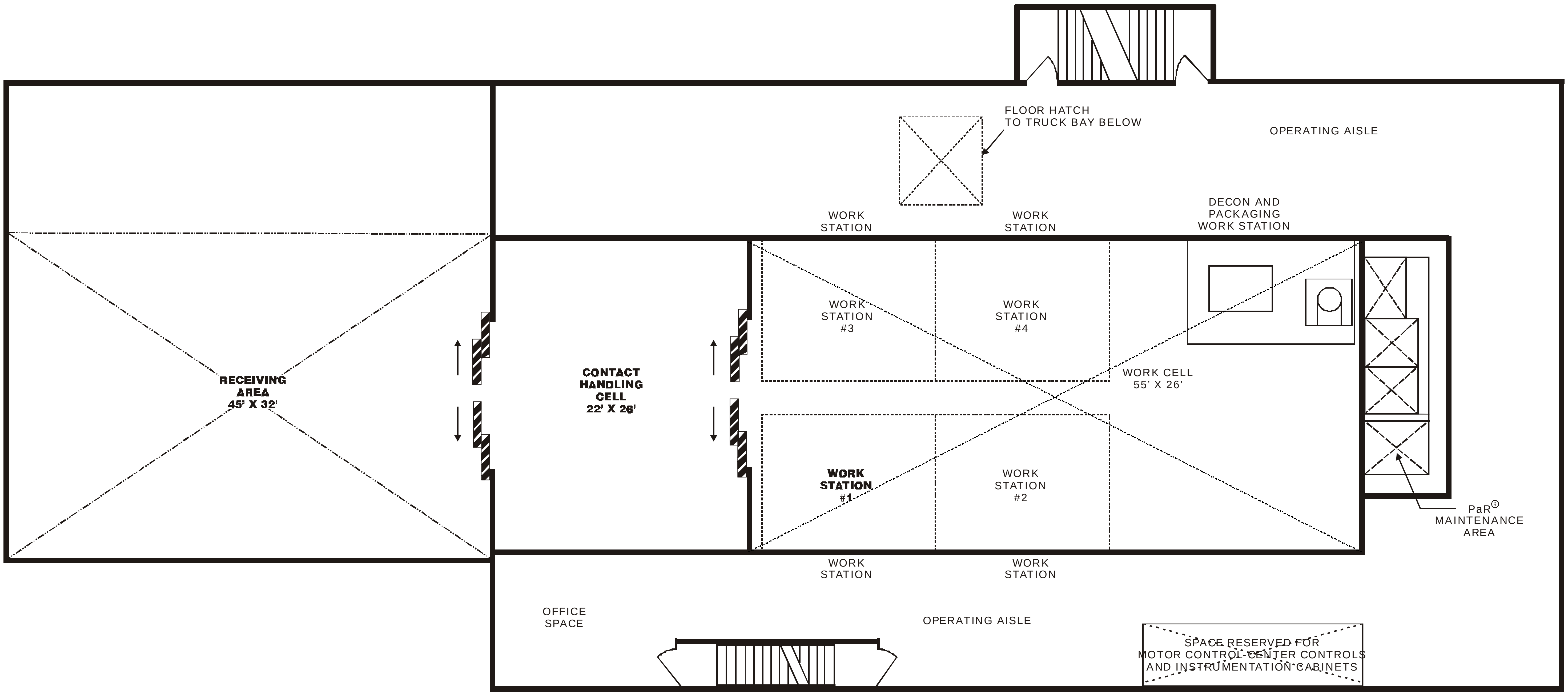
The RHWF was designed to ensure radiation levels of less than 0.1 mrem/hr in normally occupied work areas. Preliminary calculations showed that the dose rate objectives could be met using two-foot-thick concrete walls and limiting the placement of selected waste boxes within the process cell. Until the RHWF effort was put on hold, the shielding design was to be revisited with the intent to eliminate any restrictions on waste movement within the cell. Preliminary calculations showed that a shield wall thickness between 3' and 3' 6" would have been required to allow unrestricted movement of a 107 R/hr source composed of Cs-137 and Co-60.



PLAN AT GROUND LEVEL

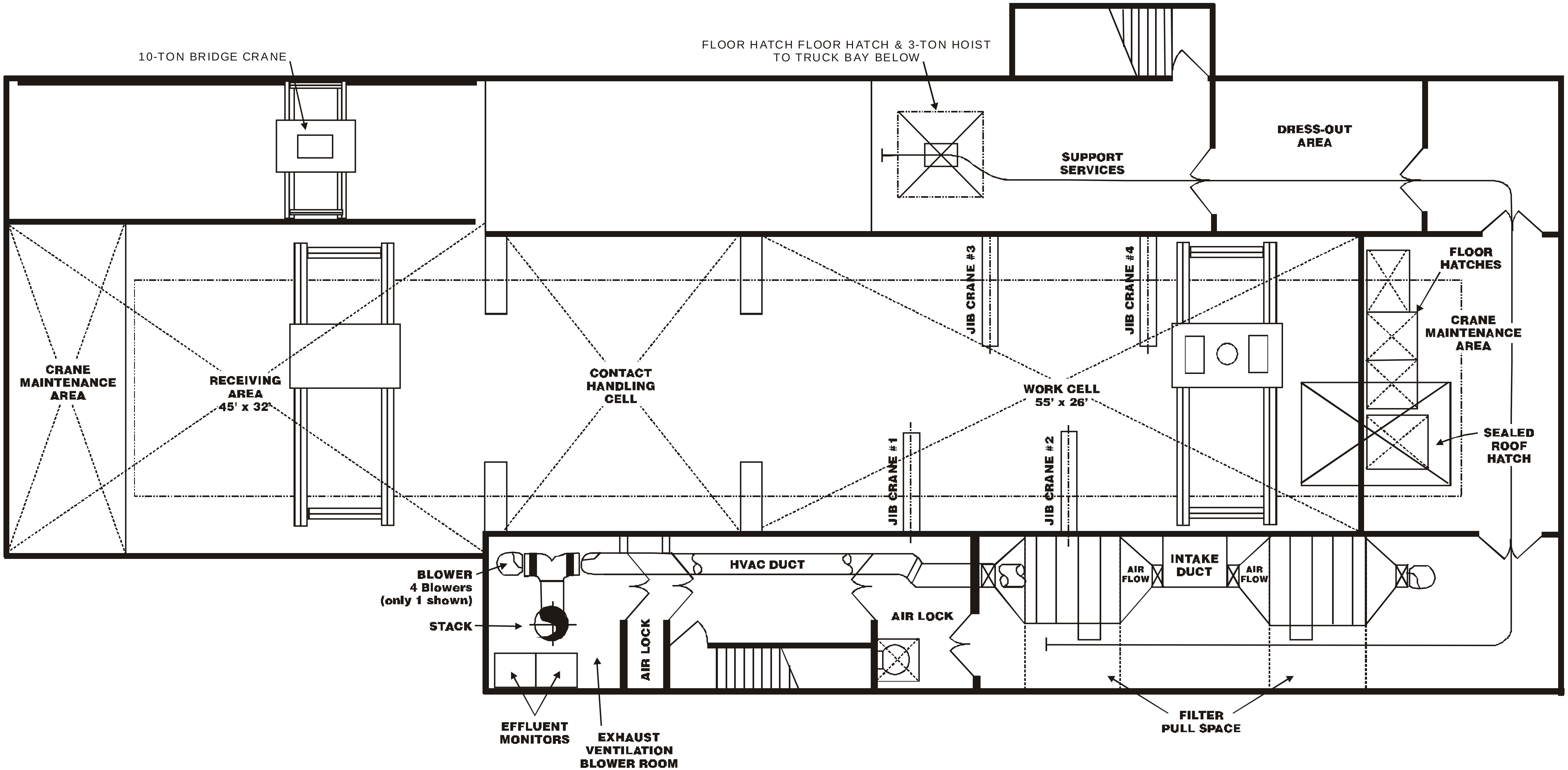
(Floor Elevation @ 4' 0")

Figure E-6.1. A Schematic of the Ground Level of the RHWF at the WVDP—June 1998 Conceptual Design (Adapted from Drawing Number SK-4307-07-007, Sheet 1, Rev. B)



PLAN AT SECOND LEVEL
(Floor Elevation @ 13' 0")

Figure E-6.2. A Schematic of the Second Level of the RHWF at the WVDP—June 1998 Conceptual Design (Adapted from Drawing Number SK-4307-07-007, Sheet 1, Rev. B)



PLAN AT THIRD LEVEL
(Floor Elevation @ 22' 0")

Figure E-6.3. A Schematic of the Sectional Views of the Third Level of the RHWF at the WVDP—June 1998 Conceptual Design (Adapted from Drawing Number SK-4307-07-007, Sheet 2, Rev. B)

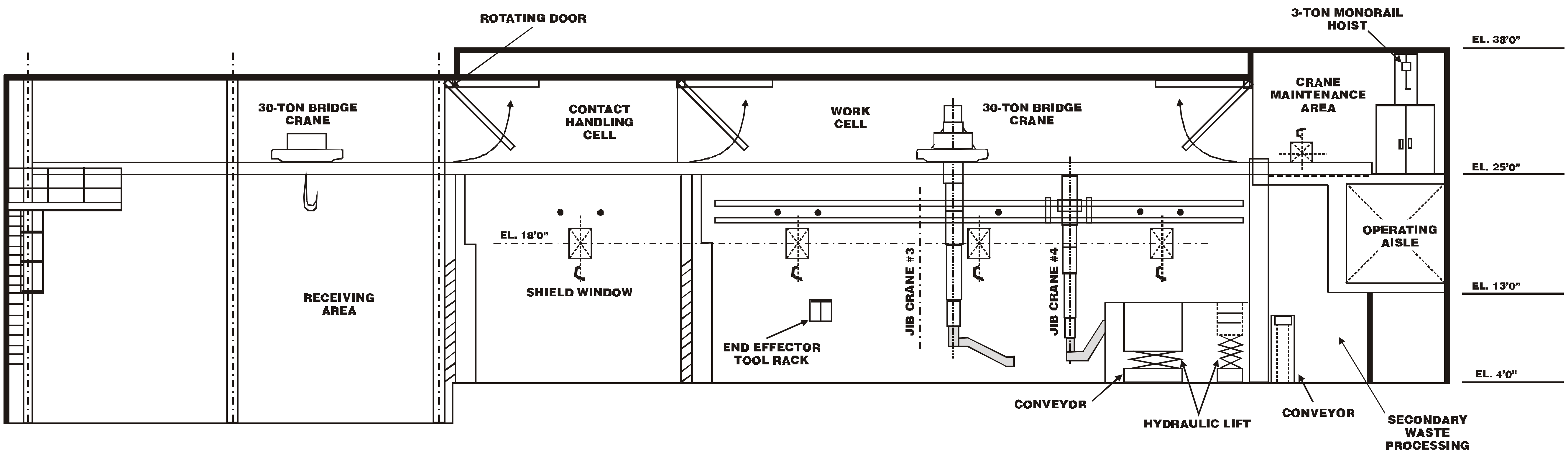


Figure E-6.4. A Schematic of the Sectional Views of the RHWF at the WVDP—June 1998 Conceptual Design (Adapted from Drawing Number SK-4307-07-007, Sheet 3, Rev. B)

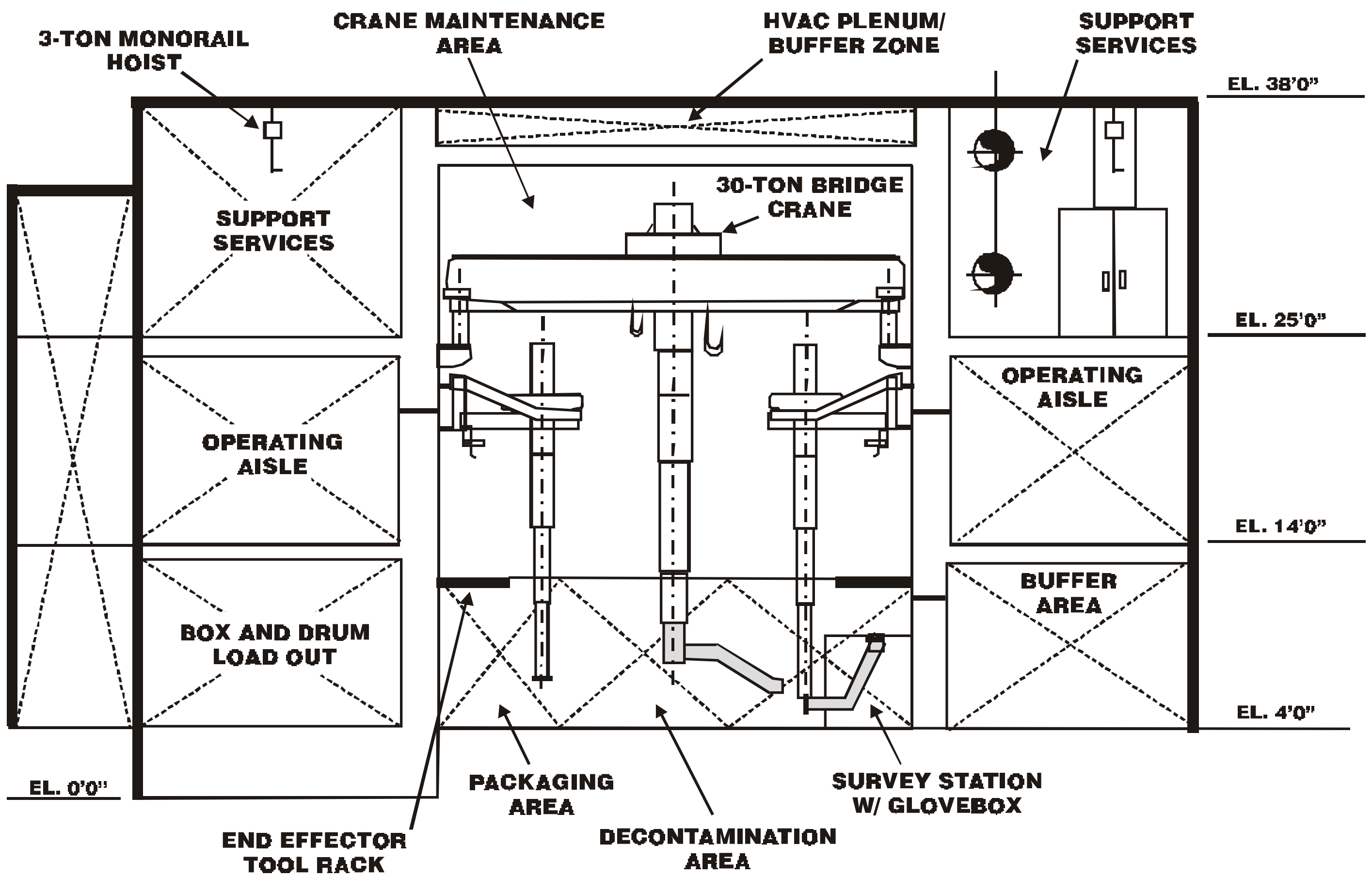


Figure E-6.5. A Schematic of the Sectional Views of the RHWF at the WVDP—June 1998 Conceptual Design (Adapted from Drawing Number SK-4307-07-007, Sheet 2, Rev. B)

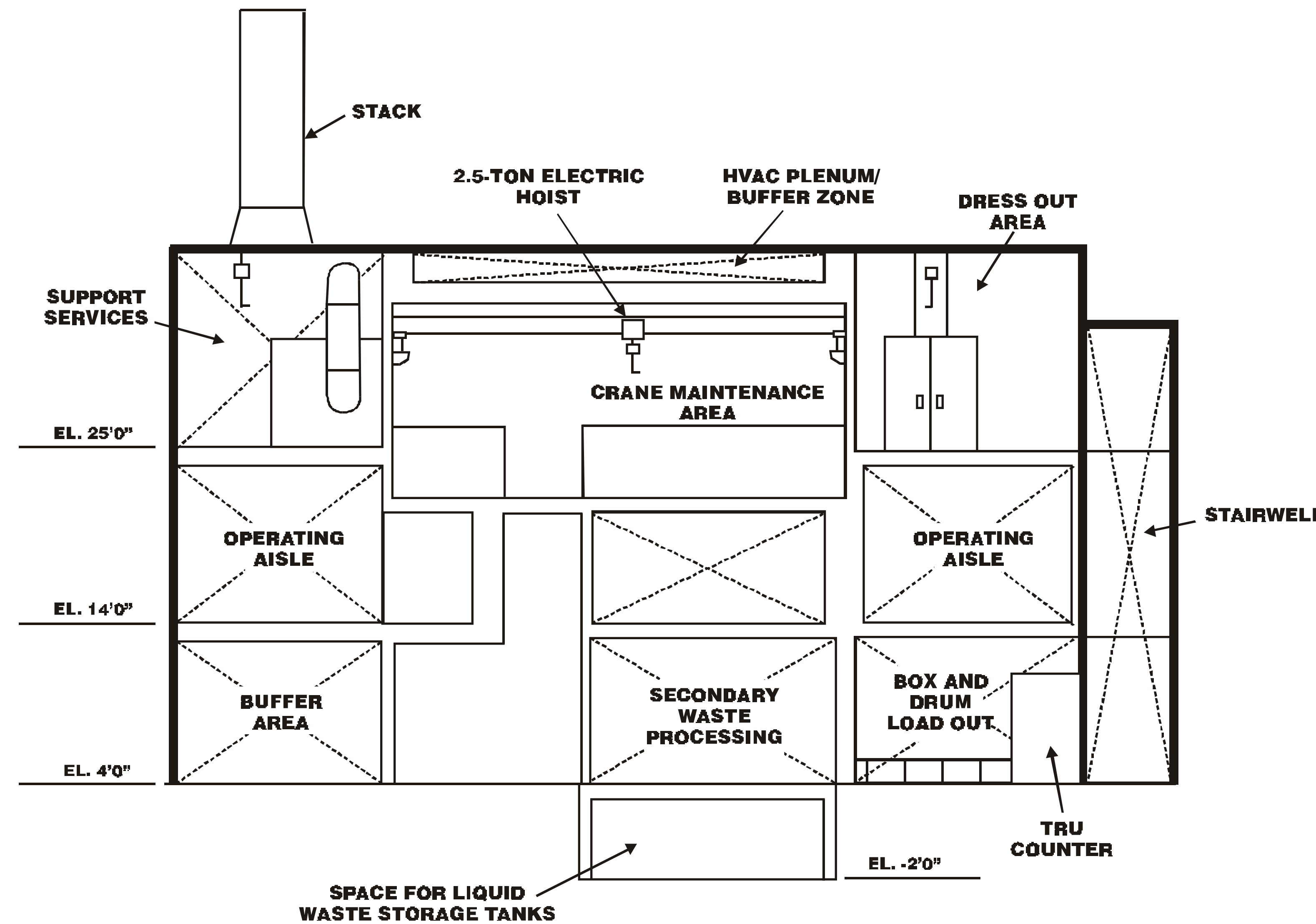


Figure E-6.6. A Schematic of the Sectional Views of the RHWF at the WVDP—June 1998 Conceptual Design (Adapted from Drawing Number SK-4307-07-007, Sheet 2, Rev. B)

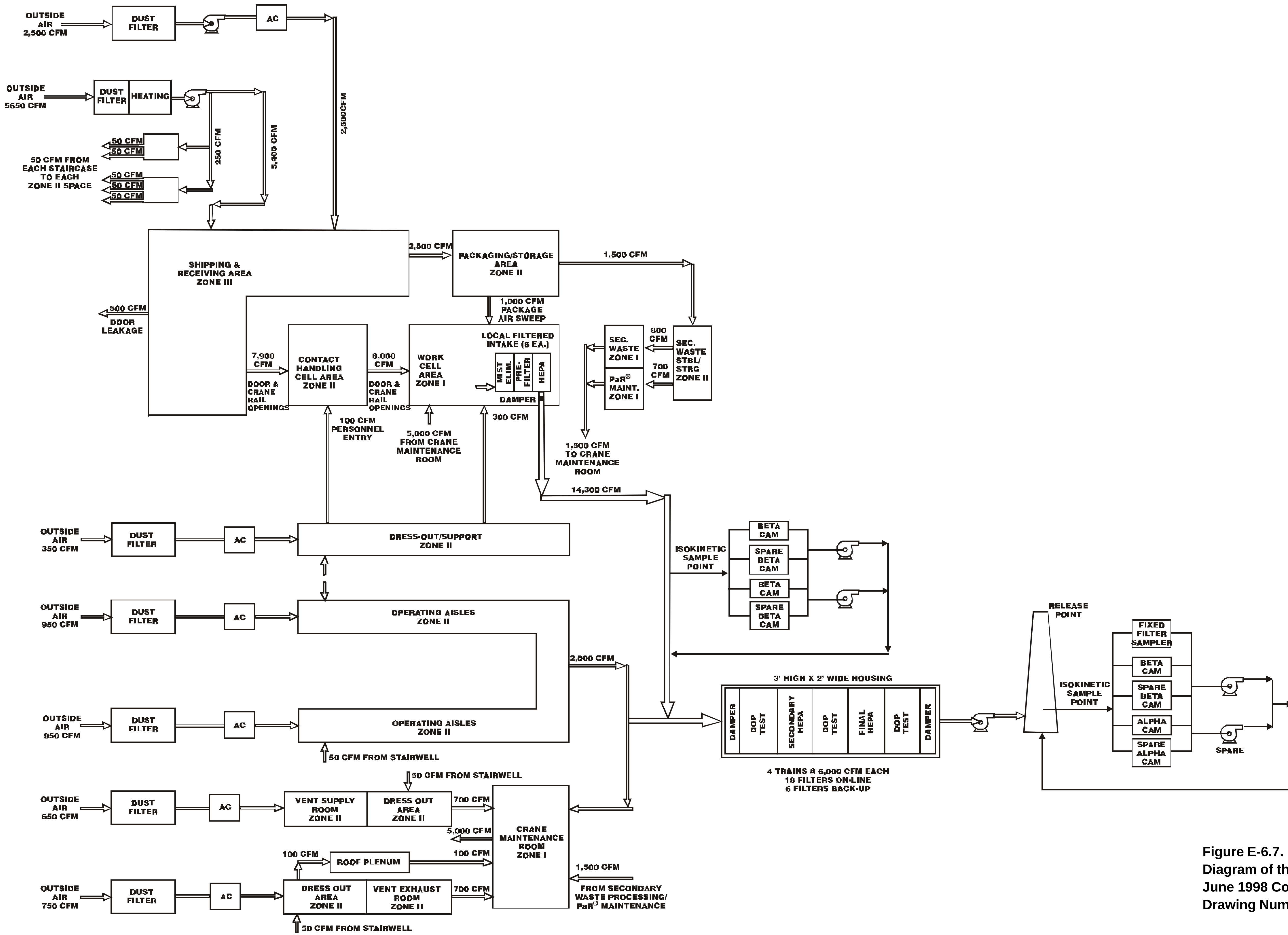


Figure E-6.7. A Schematic of the Air Flow Diagram of the RHWF at the WVDP— June 1998 Conceptual Design (Adapted from Drawing Number SK-4307-07-008, Rev. B)

E-9. Methods of Waste Processing

The RHWF was designed to receive waste containers, move them through an airlock into the work cell, process the contents, and package the processed waste. The flow through the facility was designed to allow safe handling of drums, boxes, or other waste containers.

The principal processing area of the RHWF was called the Work Cell and it contained four work stations for remote-handled waste processing operations. Each work station had access to a moveable jib crane with a power manipulator. The manipulator is designed to accept various end effectors suitable for gripping or cutting waste items. This type of remote-handling equipment would have been used to open waste containers, remove the contents, sample and survey the radioactivity, sort and segregate waste items, size-reduce large items, place highly contaminated items into a decontamination system, and move finished waste items into liners for packaging in preparation for shipment and disposal. A set of remote manipulators (MSMs) was provided for detailed radiation surveys and the handling of transfers of small samples for analysis.

In the Work Cell, waste containers would have been opened and the contents visually inspected for nonconforming items or conditions. A high-flow, low-velocity water wash would be used initially to decontaminate all waste surfaces. Radiological information would be obtained to assist in determining the follow-on processing required and where to cut waste items for processing. Highly contaminated pieces cut off from a waste item would be moved back to the decontamination system for further decontamination. Other less contaminated waste and pieces from the decontamination system would be placed into liners that would have been used to collect the various final waste streams. Drum or box liners were to be used for RH- and CH-TRU wastes, LLW, and mixed LLW.

Volume reduction of the waste was not provided in the traditional manner by compressing the waste using (super) compactors. Volume reduction was to be achieved, however, by reducing the volume of waste that was in a classification having a very high associated disposal cost by correspondingly increasing the volume of waste having a much lower disposal cost. This approach had the potential to provide cost savings comparable to volume reduction. Two methods were available for reducing the quantities of waste in selected waste classifications:

- Remove/segment highly contaminated sections of waste from the remaining portion of the waste/component.

- Lower the waste classification of a given waste by decontamination to the extent that the waste classification can be changed. The RHWF design provided for the use of contractor-provided decontamination services. In addition, the RHWF design included a high-pressure water decontamination system (with the ability to add abrasives).

When full, the liners would be lifted and removed from the Work Cell through sliding contamination control doors into a packaging area. After the doors would close, a double-lid system would open to allow the liners to be lowered into a disposal container. The loaded container would then be surveyed before being moved to the shipping area. Empty drums, boxes, and other containers would be sized-reduced for disposal as LLW.

E-10. Decontamination Technologies

Both dry and wet decontamination technologies were planned for use at the RHWF. The dry system would have been a vacuum hose at each work station for the removal of loose surface contamination. One wet system would have performed a high-flow, low-velocity water wash of the incoming waste that would have been performed at a work station. The second wet system was to have been used for pieces or small items brought to a decontamination station. This system was a low-flow, high-velocity water decontamination system used to blast the surfaces with high-pressure water. This system had the option to add abrasives to the flow stream for more aggressive decontamination.

The decontamination fluids would have been treated in the secondary waste processing system. Following secondary waste treatment, the cleaned-up portion of the flow stream would be recycled for use as the high-flow, low-velocity water wash fluid. For the low-flow, high-velocity decontamination process, clean (non-recycled) water would be used.

The RHWF also had an area designated as a location where a contracted vendor could set up a portable decontamination system. This would have allowed other-than-water-based decontamination technologies to be used. The designated location would have provided an enclosure for decontamination system set-up; electrical, water, and air services; material handling capabilities; and the collection and return of decontamination fluids (liquids or gases).

E-11. Analytical Laboratory

The RHWF did not have an analytical laboratory since one is already available elsewhere at the WVDP.

E-12. Secondary Waste

The secondary waste generated at the RHWF would have consisted of used decontamination fluids, expended filters, discarded tooling, routine maintenance waste, and nonreusable, anti-C clothing. For the decontamination fluids, both the high-flow, low-velocity waste water and the low-flow, high-velocity waste water would have been collected together and processed as a single waste stream. The secondary waste system had a waste water collection tank, process pump, two filters installed in parallel (only one filter is online at a time), two ion-exchange columns operated in series, and a recycled fluid hold-up tank. The RHWF also had additional options for routing liquid waste to other WVDP waste processing systems.

The expended filters from the secondary waste and ventilation systems would be moved to a liner in the Work Cell for further packaging prior to being transferred from the RHWF.

E-13. Facility Duty Cycle

The RHWF duty cycle had been identified as:

- 8 hrs/day for 250 days/yr, with the option to add more shifts if necessary
- A 75% availability factor was assumed based on three of four work stations equipped with jib-mounted PaR® arms being available for use at any time.

The estimated process time for emptying a waste disposal container and processing the contents varied based on the waste. The total number of processing hours needed ranged from a couple of hundred hours for a WTF pump, up to almost one thousand hours for a large dissolver vessel. The number of elapsed hours needed to complete the processing of a waste disposal container's contents would be less since some processing activities would have been performed in parallel at the four work stations.

E-14. Support Facility Description

The RHWF did not require a separate building for support services. Utilities were provided from existing facilities.

E-15. Regulatory Requirements and Contractual Obligations

The design of the RHWF was influenced by current regulatory requirements that were reflected in both the proposed facility design and the equipment installed in the facility.

E-16. Quality Assurance

The QA Program imposed on the design of the waste processing facility was based on ASME NQA-1.

E-17. Alternative Concepts for Processing Remote-Handled Waste at the WVDP

The approach for processing remote-handled waste at the WVDP was not limited to the development of the RHWF concept. Many concepts were evaluated before approval was given to develop the conceptual design for the RHWF. Other remote processing concepts included:

Use of the Vitrification Cell, Equipment Decontamination Room, and the Chemical Process Cell - This option was evaluated in great detail because this approach permits the WVDP to benefit from the existing shield cell, material-handling equipment, remote-handling equipment, and ventilation system. This option proved workable and was evaluated to essentially the same level of detail as the RHWF.

The need for such processing capabilities was recognized prior to the efforts described above. The first attempt to develop a remote-shielded, remote-processing facility was initiated in the early 1990s. The effort lead to the development of the Shielded Container Management Area (SCMA). This concept integrated the Chemical Process Cell—Waste Storage Area (CPC-WSA) into the process facility design. The CPC-WSA would have been enclosed and a bridge installed to perform material handling within the CPC-WSA. The waste disposal containers would be delivered to a transfer cart that would transfer the waste disposal containers to the process facility. The facility incorporated processing, packaging, and various support cells and areas. This was a standalone facility.

APPENDIX F. OTHER FACILITIES CONSIDERED FOR BENCHMARKING THE RHWF

Information received on the facilities that follow was insufficient to warrant inclusion in the comparative evaluation (matrix) and are being included here in order to capture the information that was collected.

F-1. The Hauptabteilung Dekontaminationsbetriebe (HDB) at the Karlsruhe Nuclear Research Center (KfK)

The KfK is situated on an area of just under 1.2 square miles, some 7.5 miles north of the city of Karlsruhe, Germany. The KfK was founded in 1956 to generate and evaluate scientific and technical know-how and experience in the peaceful utilization of nuclear energy. More recently, the KfK has also been engaged in activities outside the nuclear field. The KfK has a staff of almost 5,000 persons. One third of the staff are scientists and engineers.

The operation of test reactors and technical facilities for examining or reprocessing spent fuel, as well as the use of radionuclides in research, gives rise to radioactive residues (waste streams) that must be collected and treated in appropriate facilities. It is the function of the HDB to collect and process these waste streams. The HDB is one of the largest utility operations of the KfK, with a staff of approximately 130 persons. The HDB is subdivided into three units responsible for liquid effluent treatment, solid waste treatment, and central services. The HDB processes the radioactive wastes from the following facilities:

- All laboratories and nuclear reactors at the KfK
- Karlsruhe reprocessing plant
- European Institute for Transuranic Elements
- Institute of Food Preservation operated by the Federal Institute of Nutrition
- Baden-Württemberg Central Waste Collection Facility
- Central waste collection facilities of other German Federal states
- A number of institutions and industries (universities, nuclear power plants, and fuel element factories).

The process installations of the HDB are based essentially on research and development work conducted at KfK in the 1960s. They are still run as experimental facilities supported by a number of central operating systems used for planning, quality control, and performance analysis.

The liquid effluent treatment subsystem consists of:

- Sewage collection systems
- Sewage treatment systems
- Evaporation plants
- A concentrate cementation plant.

The HDB is responsible for processing both domestic and production wastes from the KfK. This discussion will be limited to production wastes, which include low-level and medium-level wastes (MLW), as well as a kerosene purification process stream. The MLW are generated at laboratories and experimental facilities for reprocessing nuclear fuels. These MLW contain fractions of the organic solvent used in reprocessing. All liquid wastes are processed using evaporation. The MLW is processed through a natural circulating evaporator. The distillate is cascaded forwarded to the LLW collection tank. The off-gas (organic volatiles) are passed through a kerosene purification subsystem for the recovery of the kerosene, and the concentrates from this evaporator are routed to the solidification system.

The LLW is processed through a forced recirculation evaporator. The distillate is routed to the treatment plant where it will be discharged. Noncondensable gases are routed to a combustion chamber to destroy any organics that might still be present. The concentrates are routed to the solidification system.

Solidification was originally performed using a bitumen volume-reduction, solidification system. Currently, solidification of filter sludges, spent ion-exchange media, and evaporator concentrates is performed using a cementation process. The cementation process is performed as follows:

- The correct amount of cement is placed in a drum
- The waste is then added to the drum
- A mixer is lowered into the drum and the drum contents are mixed.

Solid waste treatment activities at the HDB include the operation of the incineration plants, scrapping plants, equipment decontamination, sludge and resin cementation (previously discussed), and interim storage.

Technologies being used to process solid wastes include:

- Compaction
- Super-compaction
- Grouting of solids
- Incineration
- Metal waste chopping.

At the HDB, higher-activity metals are chopped and solidified in cement, while lower-activity, noncombustible solids are compacted. Figure F-1.1 shows a scrapping press, while Figure F-1.2 shows the high-pressure (supercompaction) system.

Figure F-1.1. Scrapping Press in the Caisson; the Pressing Force is 337,000 lbs/ft

Figure F-1.2. High-Pressure Press with Transport System. The Pressing Force is 3,370,000 lbs/ft

Figure F-1.3. Large Caisson in which Dismantled Plant Components are Decontaminated

However, there are three waste management alternatives preferred to the disposal of contaminated residual materials as radioactive wastes. These alternatives are:

- *Repair and Reuse*—Components to be reused are repaired in workshops which, as a rule, are located in noncontrolled areas of the plant, but still within the surrounding monitored plant area. Consequently, it must be possible to work on those components without taking special radiation precautions.
- *Safe Utilization*—Components that cannot be reused may be regarded as metal scrap if the activity of the material is low enough to require no handling permit under the Radiation Protection Ordinance.
- *Release as Ordinary Waste*—Parts or materials from controlled areas, which can neither be reused nor disposed of as metal scrap, may be disposed of as ordinary waste if it can be proved that specific, very low-activity limits are not exceeded.

To achieve any of the above three waste management options, decontamination of the waste is needed. A decontamination caisson is shown in Figure F-1.3. At the HDB both mechanical and chemical decontamination are used. Specific decontamination technologies used are:

- *Mechanical Methods*—Parts whose surface are easily accessible can be cleaned with high-pressure water jets or by high-pressure sand blasting. Sand blasting is only used on surfaces to be re-coated or to be disposed of as metal scrap.
- *Chemical Methods*—If contamination is present in a specific chemical form, preferably on components to be reused and requiring appropriate nondestructive or specific aggressive treatment, surfactants or corrosive chemicals are applied as solutions or pastes and later removed by immersion in water or by spraying.

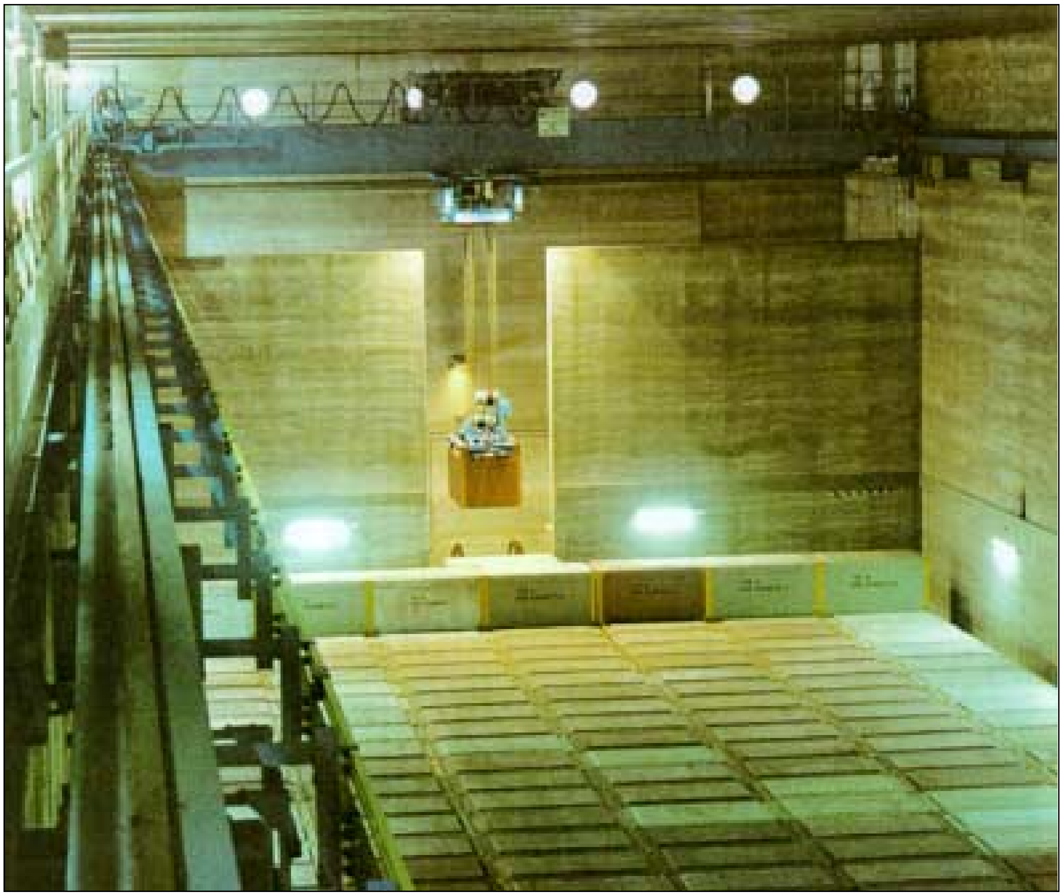


Figure F-1.4. Container Storage Hall

- *Physico-Chemical Methods*—In individual cases, small parts of simple geometry are decontaminated electrolytically.

The third subdivision of the HDB is central services. This subdivision is responsible for planning, quality assurance, and performance analysis and documentation.

The HDB has four buildings dedicated to waste processing, and even larger areas dedicated to waste storage. A container storage hall is shown in Figure F-1.4.

Throughput at the HDB varies from year to year for each waste type. The values given below are the most recent data, presented in review documents, for each waste type.

Type	Year	Quantity
Evaporation plants	1976	500 m^3
Kerosene purification	1976	20 m^3
Cementation plants	1977	2,000 200-liter drums
Equipment decontamination	1968	700 m^3
Incineration plant	1986	40,000 Kg
Scrapping plant	1984	3,000 m^3

F-2. BNFL's Low-Level Waste High-Force Compaction Facility at Sellafield

This facility is dedicated to the compaction of dry active LLW waste and supports the day-to-day operation of the Sellafield Site. The waste arrives at the process facility either in 55-gallon drums or as loose waste containers. The packages of LLW are typically removed using an unshielded forklift. Once in the facility however, all processing of the LLW is performed remotely. (See Figure F-2.1.) Loose waste is sorted and size-reduced before being loaded into 35.3 cubic foot boxes. Size-reduction techniques include shredding, metal chopping, and concrete crushing, followed by low-force compaction of the material into the box. (See Figure F-2.2.) The 55-gallon drums and boxes are fed to a super-compactor that can be remotely configured to take either the drums or the boxes. Following super-compaction, the compressed containers are remotely loaded into a multipurpose International Standards Organization (ISO) freight disposal container. This is an overpack that acts as both the on-site transport container and final disposal container. At the disposal facility, the ISO freight disposal container is filled with grout to encapsulate and stabilize the waste.

Figure F-2.1. Size-Reduction Cell

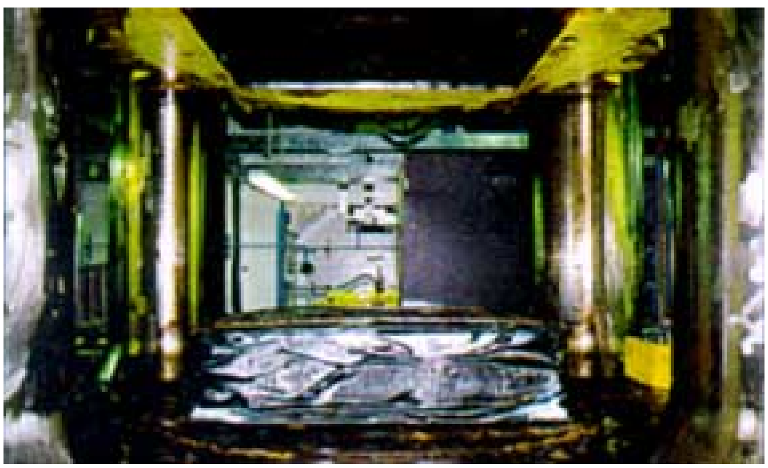


Figure F-2.2. BNFL's Low-Level Waste Monitoring and Compacting Plant

F-3. BNFL's Waste Treatment Complex (WTC)

The WTC, shown in Figure F-3.1, processes plutonium-contaminated material (PCM). The WTC has two objectives. One is to reduce the volume of this material that must ultimately be transferred for disposal to the deep waste repository. The other objective is to put this waste into a form suitable for interim storage and then ultimate disposal with no need for future repackaging or similar operation.

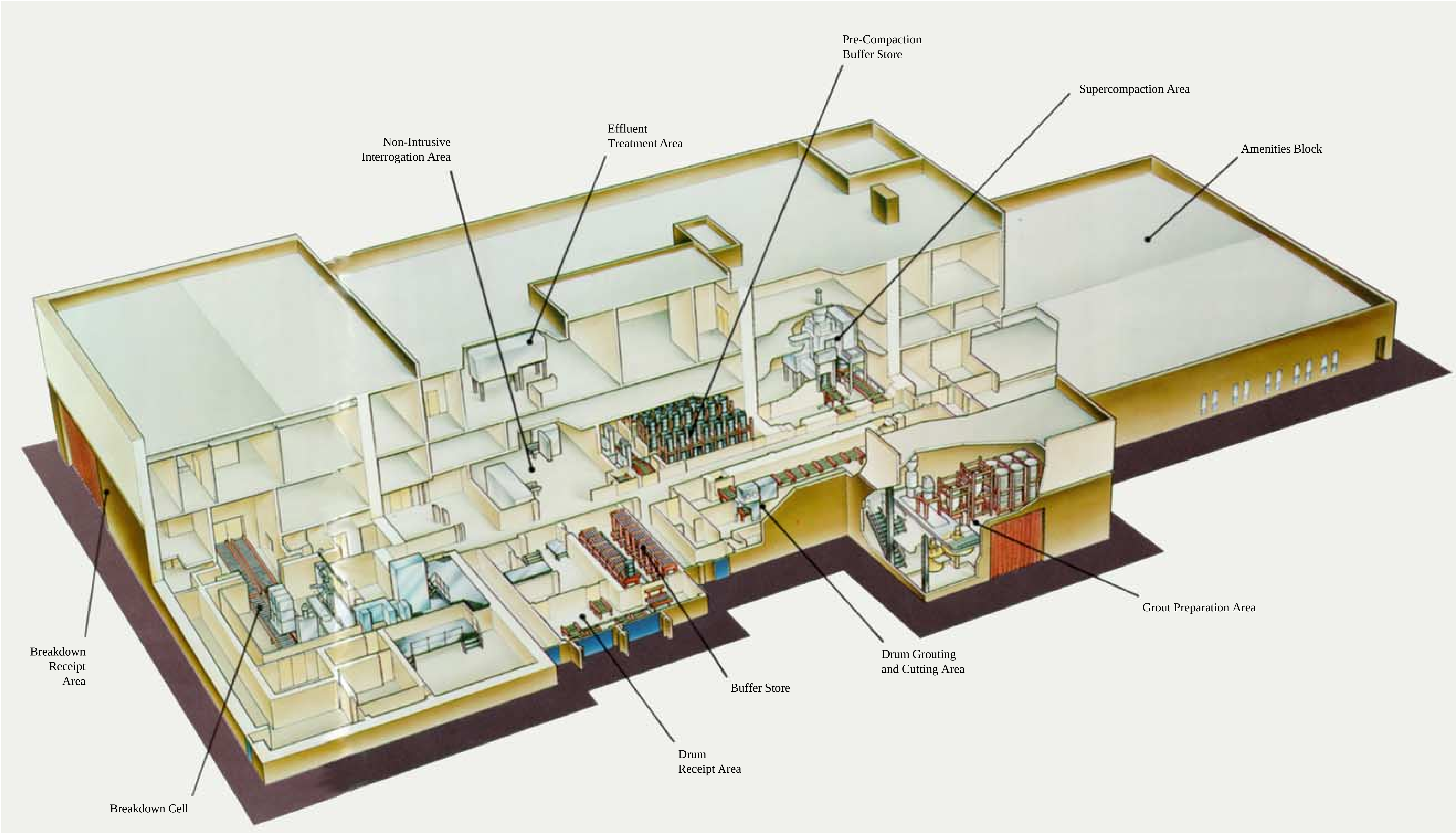


Figure F-3.1.
BNFL's Waste Treatment Complex

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The waste feed to the WTC arrives in one of three forms. These are: 1) 55-gallon drums, 2) wrapped HEPA filters, and 3) crates that contain assorted waste items such as gloveboxes. This waste arrives at a loading dock at the WTC. At the loading dock an inflatable weather shield provides a seal between the transport vehicle and the building. This feature is shown in Figures F-3.2 and F-3.3.

Figure F-3.2.
Docking of Drum Transport Vehicle

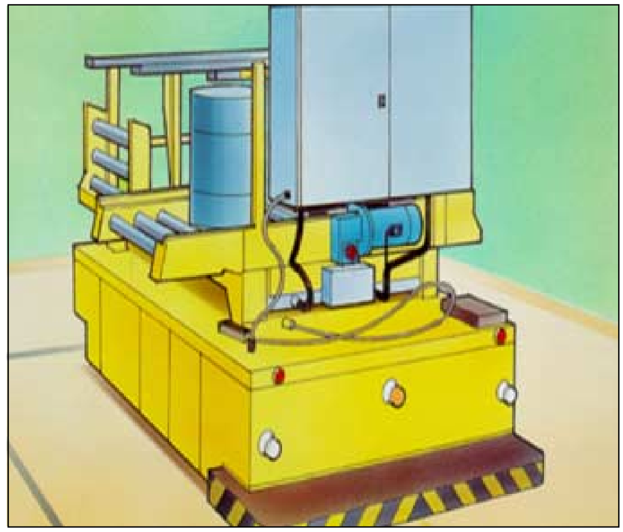


Figure F-3.3.
Automatically Guided Vehicle (AGV)

The WTC is designed to process 55-gallon drums through a super-compactor. The compacted drums are overpacked into a 132-gallon drum. The 132-gallon drum, once full or loaded with the maximum allowable plutonium content, is then grouted with a cement-pulverized fuel ash mixture. A summary of the processing is:

- Filters and crates are transferred to the Breakdown Receipt Area
- All drums are bar coded. Some drums are randomly selected for a check of the surface contamination level
- The drums are weighed and inspected. Drums that are damaged, oversize, or weigh more than 550 pounds are transferred to the Breakdown Receipt Area
- Next, drums undergo non-intrusive interrogation using X-ray imaging, a high-resolution gamma spectrometer, and a passive neutron coincidence counter. At this station, the nature of the waste is determined and the plutonium quantified. Unacceptable drums (e.g., too much plutonium) are transferred to the Breakdown Receipt Area
- The acceptable drums are placed in the Pre-Compaction Buffer Store. The Store has the capacity to hold 84 drums
- Drums from the Pre-Compaction Buffer Store are selected for compaction based on weight and the plutonium content of each drum. Compacted drums are placed into the Product Drum. The emphasis is to maximally utilize the Product Drum to its rated capacity for weight and plutonium content
- Once the 500-liter drum has reached its volume, weight, and/or plutonium limit, it is transferred to the outing area
- Waste in the Breakdown Receipt Area is remotely segmented, assayed, and loaded into 55-gallon drums that are then fed back into the drum processing line. Packages containing high plutonium inventories are subdivided as needed to ensure the allowable limits for 55-gallon drums are met.

A majority of the material handling within the WTC is performed by an automatically guided vehicle (shown in Figure F-3.3), which is a computer-controlled drum transport vehicle that can be programed to automatically pick up and deposit drums at various stations within the WTC. Crates and filters are handled by fork-lifts.

The approach taken by BNFL for both LLW and PCM waste is very similar. The only real difference is the size of the final container and, with PCM, the need to ensure the package limits for plutonium are met. In fact, the drum line process subsystem planned for the INEEL AMWTF (designed by BNFL) is also very similar to that described above for the WTC.

F-4. Los Alamos' Transuranic Waste Size-Reduction Facility (SRF)

The SRF is shown in Figure F-4.1 and is an experimental, production-oriented facility designed to reduce the volume of and permit the repackaging of metallic waste items contaminated with TRU. The objective is to achieve a volume-reduction factor of four for gloveboxes and other similar metallic wastes.

The SRF is a 30' x 15' x 15' high enclosure divided into four modules (see Figure F-4.2) according to function: an airlock module, a disassembly module, a cutting module, and a packaging module. The modules are assembled on a base pan that provides a foundation for the enclosure and a catch basin for cutting wastes. The enclosure has a stainless steel skin with a mild steel external skeleton. Each module has multiple gloveports and windows.

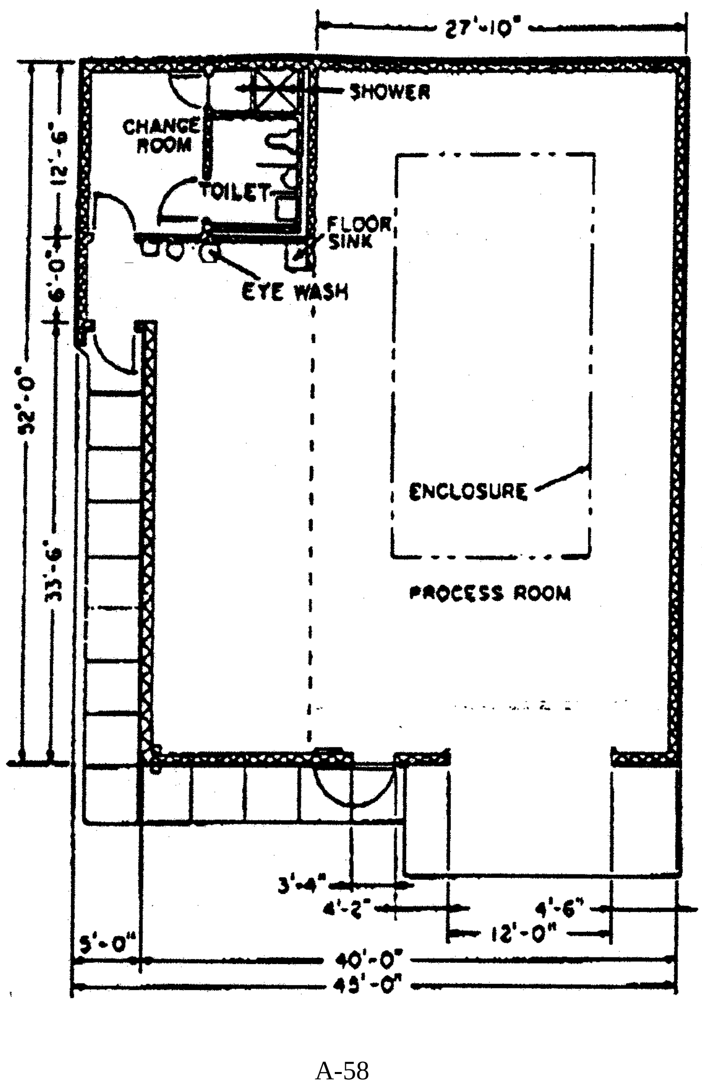


Figure F-4.1. TRU Waste Size-Reduction Facility at Los Alamos

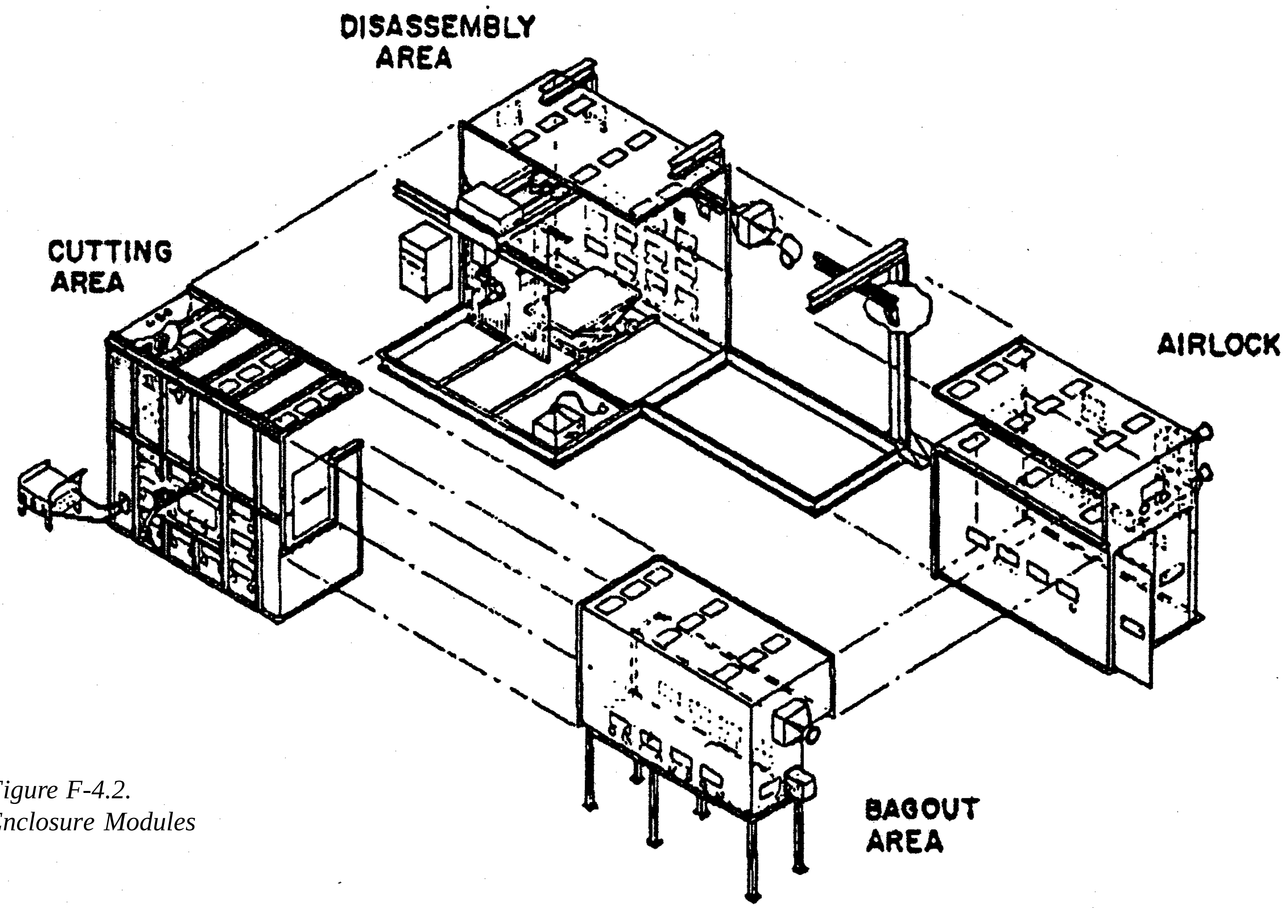


Figure F-4.2.
Enclosure Modules

The SRF contains two types of equipment: The first type is manually operated, lightweight equipment used primarily for disassembly of waste. This equipment is operated through the gloveports and consists of hand tools (e.g., impact wrenches, chisels, and saws). The second type is the remotely operated heavy equipment that consists of a 2-ton bridge crane, 3-ton capacity positioning table, electromechanical manipulator, and a plasma-arc cutting torch.

Ventilation for the facility includes both primary and secondary air-filtration systems. The enclosure is maintained under negative pressure. Normal air flow provides about six changes an hour. Air can enter the enclosure at any of three locations through HEPA filters that protect the building from contamination in the event the enclosure experiences a positive pressure. The exhaust system includes an electrostatic precipitator to help reduce the load on the exhaust filters from the plasma torch.

This enclosure was originally intended to be retrofitted into an existing facility. This decision was changed, but that approach was changed to a new, standalone facility. The enclosure was fabricated elsewhere and delivered to the site for installation into the new enclosure structure. The cost to fabricate the Los Alamos TRU SRF was $875,000 and consists of the following cost factors:

Cost Factor	Approximate Cost
Glovebox Enclosure	$230,000
Manipulation/Hoist System	126,000
Plasma Torch	6,000
Support Steel	5,000
Lift Table	7,000
Miscellaneous Components	20,000
Installation, Facility Preparation	45,000
Engineering Design Support	11,000
Fork Lifts	25,000
Building Design/Construction	400,000
Total	$875,000

Following completion of the SRF, gloveboxes were disassembled to permit evaluation of the facility and the segmenting process. The segmented gloveboxes were a “sandwich” of lead and stainless steel. The facility functioned well, but problems were encountered with the use of the plasma arc torch. These problems included maintaining the proper standoff distance for the torch, smoke, rapidly loading up the precipitator, and plugging of the filters. Changing the plasma gas from nitrogen to argon greatly reduced the smoke, but then cleaning the cut became a problem. Fusing the molten metal in the cut prevented separation of the cut pieces. When the plasma gas was changed to a mixture of 6% hydrogen in argon, the molten metal problem improved, but was still troublesome. A further increase in the hydrogen concentration to 20% made the cut quality adequate, but not optimal.

The SRF is an experimental, production-oriented facility. Modifications will be made as operating experience is gained. For example:

- Design changes to accommodate the WIPP waste containers
- Redesigning the roughing filter change-out
- Designing and fabricating a variety of manual, remote-handling tools
- Protecting several enclosure windows against possible breakage during packaging.

At full operation, the objective is to process two standard gloveboxes (10' x 5' x 5') per week.

F-5. The Waste Receiving and Processing (WRAP) Facility at Hanford

The WRAP Facility at Hanford is for processing drums and small boxes of LLW, mixed-LLW, and CH-TRU waste for permanent disposal. The WRAP inspects, treats, and repackages wastes to ensure they meet the waste acceptance criteria of the disposal facility. Most waste handling operations are performed robotically to minimize worker exposure to radioactive and hazardous materials.

The facility has automated processes to x-ray and analyze waste using both gamma and neutron assay equipment to properly characterize the waste for disposal. After characterization, remote packaging is performed, if required, and the waste is readied for transport to WIPP or for disposal at Hanford.

F-6. The Dekontaminationsbetriebe at the Juelich Nuclear Research Center

The radioactive waste processing facilities at the Juelich Research Center have the following capabilities:

- LLW evaporation
- Wet/dry high-pressure and chemical decontamination
- LLW segmenting, compacting, conditioning, and packaging
- Incineration of solids and liquids.

One facility is identified as REBEKA and is used for recycling and treatment of radioactive materials. This building is a three-story structure, with a one-story main processing area that is 55.8' x 213.3' by about 23' In this building, there:

- Are areas to measure the radioactivity of incoming wastes (open space 14.7' x 39.4')
- Are areas to dismantle, cut-up, and decontaminate wastes (confined space 33' x 29.5' x 16.4')
- Are areas to sand blast wastes (confined space 33' x 9.8' x 9.8')
- Are areas to wash and coat wastes (confined space 33' x 33' x 9.8')
- Is a container loading area (open space 37.7' x 39.4')
- Is a shielded storage area (confined space 13.1' x 37.7' x 9.8')
- Is a compaction and drying area (open space 3.4' x 39.4')
- Is a cement system area (32.8' x 39.4').

F-7. The Siemens Service Center at Karlstein

The radioactive waste processing facilities at the Siemens Service Center have the following capabilities:

- LLW segmenting, compacting, conditioning, and packaging
- Wet/dry high-pressure, chemical/electrochemical decontamination
- Drying.

The processing of waste is performed in a support area with a 2,580 square foot disassembly cell. There are saws, flame cutters, and shredders in the cell for the disassembly of wastes. Drums of waste are processed in a 1,500-tonne super-compactor. Mixed wastes and evaporator concentrates are dried. There are three cells for high-pressure chemical decontamination that are, 35.3 ft^3, 883 ft^3, and 2825 ft^3, respectively. There is also an electrochemical decontamination system. The wastes are characterized for waste disposal classification.

APPENDIX G. THE RESCOPED REMOTE-HANDLED WASTE FACILITY (RRHWF) AT THE WEST VALLEY DEMONSTRATION PROJECT (WVDP)

G-1. Introduction

Facility decontamination activities at the West Valley Demonstration Project (WVDP) have resulted in the removal of quantities of highly contaminated vessels, piping, and equipment that are currently stored at the WVDP in the Chemical Process Cell—Waste Storage Area (CPC-WSA). Future facility D&D activities will result in the generation of additional high-dose rate or highly contaminated wastes. High-dose rates and high- contamination levels will require that these materials be processed in a facility that has been designed for remote handling and processing.

The purpose of the Remote-Handled Waste Project (RHWP) is to process high-dose / high-contamination WVDP wastes for off-site disposal. The conceptual design, of a remote-handled waste facility was initiated in October 1997. That particular conceptual design, issued in June 1998 (titled RHWF in this report), provided for all remote-handled waste streams of a facility called the Remote-Handled Waste Facility (RHWF) to be processed in a single, standalone facility. The design and construction cost for the facility was estimated to be $55 million. Under direction from the DOE, the conceptual design was revisited to cut costs, using innovative ideas and approaches.

The RRHWF is estimated to cost only $31 million. This cost reduction (and significant improvement in schedule) was achieved by using existing facilities for processing 11 of the 24 waste streams, with minimal cost for modifications to the existing facilities utilized to process these waste streams.

The original concept of the Remote-Handled Waste Facility at the WVDP (i.e., the June 1998 conceptual design) was optimized using the following methods:

- Benchmarking with other facilities within the USA and abroad. The adoption of innovative technologies and building layouts resulted from the benchmarking effort.

- Performing an independent Value Engineering study of the RHWF by industry experts. Incorporating the Value Engineering recommendations into the conceptual design of the RRHWF.

- Conducting multiple, independent cost estimates for the facility. Incorporating cost and schedule data into facility plans and proposals.

- Performing engineering studies and safety evaluations of the areas identified for improvement in the original RHWF conceptual design and incorporating the results

The outcome of incorporating the recommendations from the above-noted activities was an improved conceptual design and better utilization of resources (i.e., use of existing facilities and a reduction in project funding requirements).

The RRHWF is expected to cost $31 million. It will be designed and constructed in four years and will have to operate for seven years vs. 11 years for the original concept.

The following is a brief overview of the RRHWF. It covers key facility features, waste streams, waste processing and examination activities, a preliminary hazard analysis, and the safety analysis approach.

G-2. Waste Inventory

Table E-5.2 listed waste streams in scope for the Remote-Handled Waste Facility. Of these waste streams, only 13 are identified as candidate waste streams for processing in the RRHWF. The remaining waste streams will be processed in other existing facilities at the WVDP.

G-3. Waste Characteristics

Physical parameters of the waste streams to be processed in the RRHWF are provided in Table G-3.1. It should be noted that although the incoming waste may have radionuclide distributions similar to spent nuclear fuel (SNF) or HLW, this does not imply that the incoming waste will be classified as such. In fact, the bulk of the processed waste that is ready for shipment will be LLW, with small quantities of CH-TRU and RH-TRU.

Table G-3.1. Typical Physical Parameters of the Waste Streams to be Processed in the Rescoped Remote-Handled Waste Facility at the West Valley Demonstration Project

Waste Container Designator Number		Number of of Waste Containers or Items	Max. Length or Diagonal (ft)	Max. Width (ft)	Max. Height (ft)	Max. Wt. on Hook (lbs)	Total Waste Wt. in all Containers (lbs)	Total Waste Volume (ft^3)
1	WTF Transfer & Decant Pumps	5	50	4	4	8,000	41,667	4,000
2	Jumper Boxes (TRU)	4	12.96	6.92	6.96	3,870	15,480	1,728
3	Jumper Boxes (LLW)	8	12.96	6.92	6.96	3,870	30,960	3,456
4	Dissolver Vessel Boxes	2	19.88	11.79	11.22	35,854	71,708	5,260
5	Vessel Boxes (TRU)	2	13.72	8.42	8.96	9,942	15,842	1,368
6	Vessel Boxes (LLW)	6	16.58	11.44	11.02	21,119	15,842	8,555
7	Vent Filter Boxes (in cement)	4	6.33	7.33	9.50	53,800	191,300	1,700
8	Vent Filter Boxes	53	6.33	7.50	6	13,274	200,000	4,500
9	Shield Boxes	13	12.50	6.50	6.50	9,648	32,237	5,322
10	Shielded Boxes (DAW)	28	12	6	6	10,500	139,525	5,357
11	Shielded Boxes (Resins)	10	6	6	4	2,000	20,000	254
12	Shielded Drums	25	2	—	3	1,390	15,861	184
13	Main Plant Closure Wastes	46	0.5"dia	—	12	9,800	72,280	4,400

Note: The dimension shown is the largest if more than one container with a different size exists.

G-4. Facility Description

The RRHWF will consist primarily of three cells: a Receiving Cell, a Buffer Cell, and a Work Cell. The RRHWF will provide for sorting and segregation, size reduction, and packaging of remote-handled waste behind thick concrete shield walls. Whereas the permanent shield walls should provide adequate shielding for processing the majority of the designated waste in the RRHWF, temporary shielding will be added for some special cases to address the remaining waste streams. Figures G-4.1 through G-4.6 provide details of the conceptual design of the RRHWF.

The five main areas of the RRHWF that will directly support waste processing operations are: the Receiving Area, Buffer Cell, Work Cell, Waste Packaging Area, and Operating Aisle. The other areas of the facility that will perform support functions are the HVAC Areas, Contact Maintenance Area, Sample Packaging and Screening Area, Secondary Waste Collection System, Load Out/Truck Bay, and Offices. Each area is briefly described below.

Receiving Area

This area will receive incoming containers of waste from a transport vehicle and provide weather protection during unloading operations. The Receiving Area will provide confinement during the movement of a waste container into the Buffer Cell. This area will act as a secondary buffer to ensure confinement of radioactive contamination in the more highly contaminated parts of the RRHWF. This area normally will be radiologically clean, but may become slightly contaminated, temporarily. The cell will be equipped with a 20-ton commercial bridge crane.

Buffer Cell

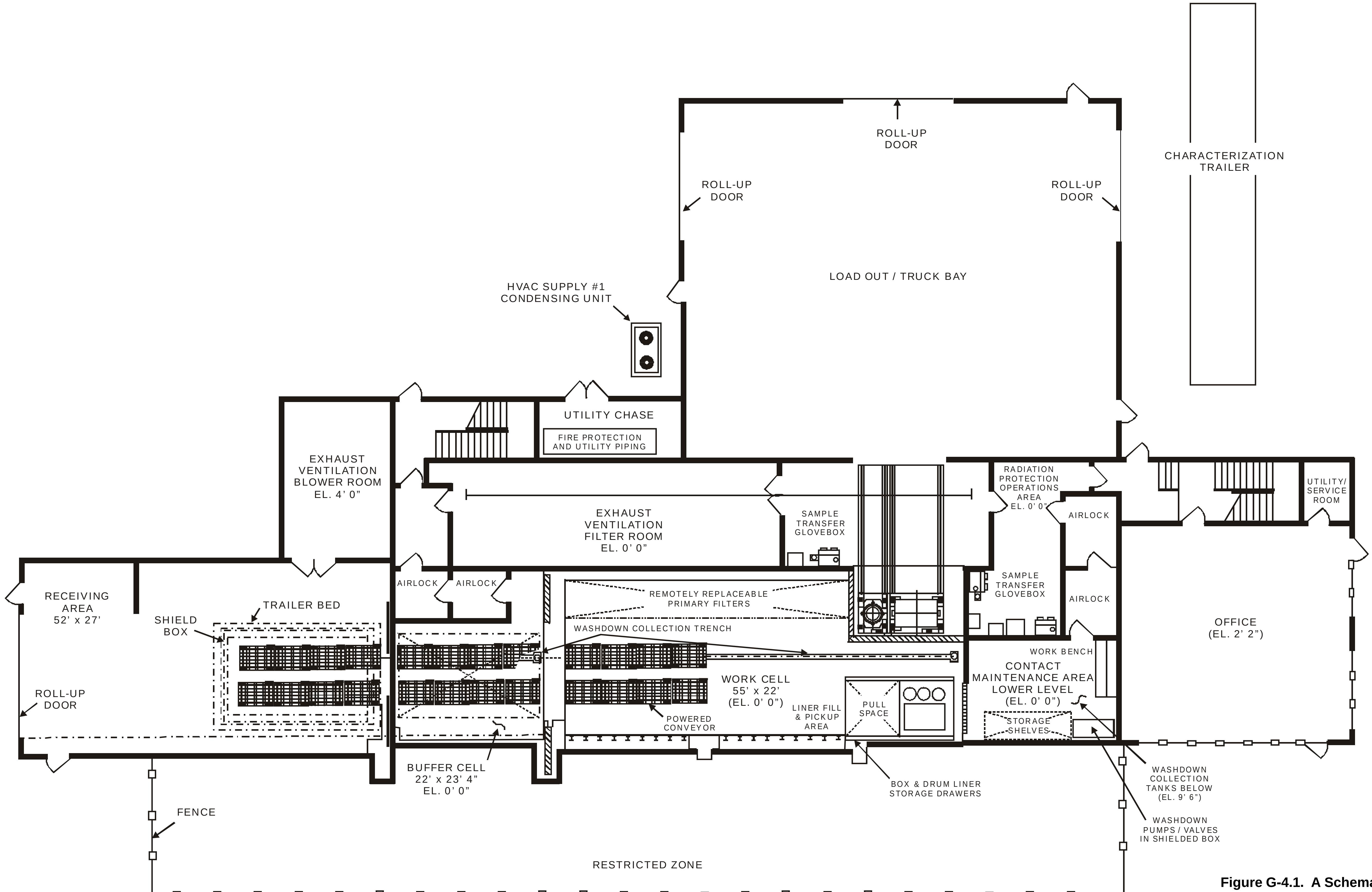
The Buffer Cell will act as an airlock between the Receiving Area and the highly contaminated Work Cell. The Buffer Cell will provide confinement during the movement of a waste container into the Work Cell and also provide some shielding. This cell may be used as a radiologically controlled area for contact-handled operations such as repackaging, over-packing, or removing large-sized waste boxes when radiological conditions do not mandate remote-handling operations. Radiological contamination levels as high as 10^4 to 10^6 dpm/100cm^2 may be present. Powered conveyors can be moved to match the width of the various waste boxes. The 20-ton commercial bridge crane will also be capable of servicing this area.

Work Cell

The Work Cell will be the primary work zone within the RRHWF for remote handling, surveying, sampling, sorting, segmenting, decontaminating, segregating, and packaging of waste. It is a 55-foot-long by 22-foot-wide by 37-foot-high shielded space. Space will be provided to operate up to three work stations, although two are planned initially. There will also additionally be space for staging incoming waste containers and the temporary storage of waste disposal drum and box liners. Radiological contamination levels $>10^{12}$ dpm/100 cm^2 are expected in this cell. There will be a radiologically contaminated 30-ton bridge crane with rails extending the full length of the Work Cell. The bridge crane trolley will support a telescoping tube that is the attachment point for the various end effectors used to perform remote-handling operations. There will also be two jib cranes that support telescoping tubes. The interchangeable end effectors will include heavy-duty cutting equipment, powered dexterous manipulators (PDMs), and PDMs with light-duty cutting equipment. The PDMs and cranes will be used to operate a full range of fixtures and tools for all remote operations.

Figure G-4.6 provides a schematic of the Washdown Collection System. The collection sumps are equipped with disposable basket strainers. The collection system, including sumps, drains, and the tanks, is designed to be criticality safe.

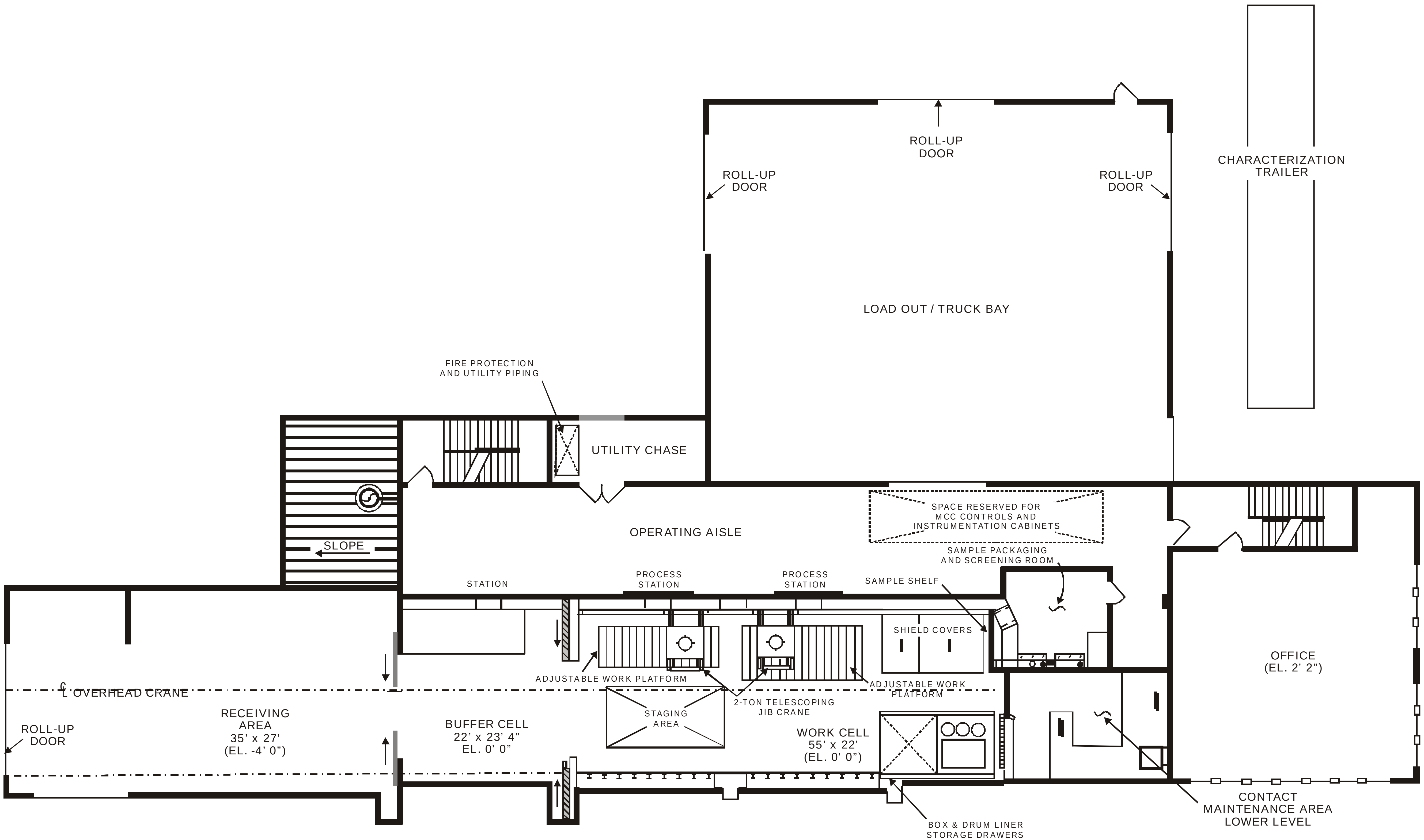
Waste that is ready for packaging will be temporarily stored in liners in the Box & Drum Liner Storage Drawers prior to being transferred out of the Work Cell through the Bagless Transfer System in the Waste Packaging Area.



PLAN AT FIRST LEVEL

(Floor Elevation @ 0'-0")

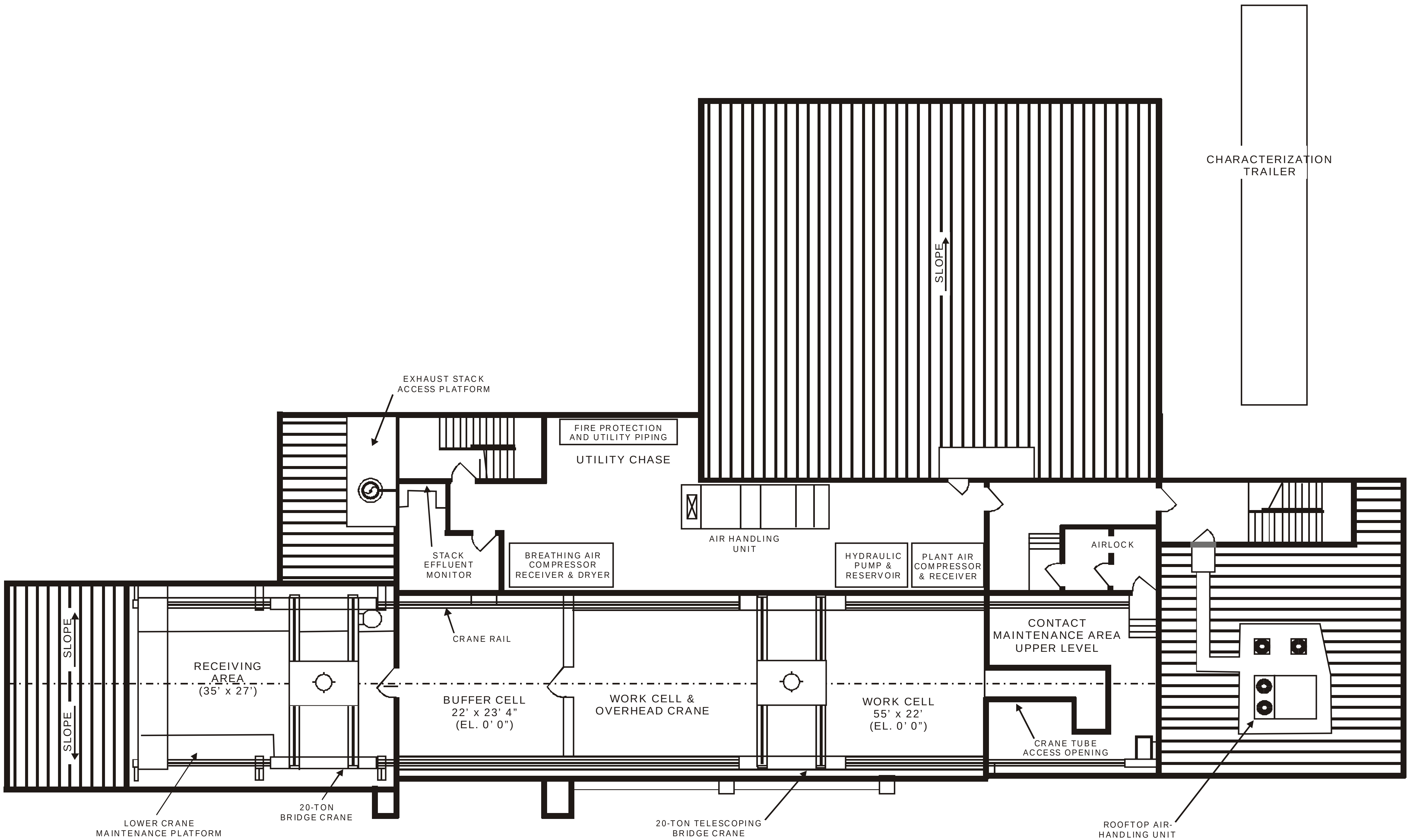
Figure G-4.1. A Schematic of the RRHWF at the WVDP—June 1999 Conceptual Design (Adapted from RRHWF Drawing Number SK-4307-042-001, Sheet 1, Rev. B)



PLAN AT SECOND LEVEL

(Floor Elevation @ 13' 0")

Figure G-4.2. A Schematic of the RRHWF Plan at the WVDP—June 1999 Conceptual Design (Adapted from RRHWF Drawing Number SK-4307-042-001, Sheet 2, Rev. B)



PLAN AT THIRD LEVEL

(Floor Elevation @ 26' 0")

Figure G-4.3. A Schematic of the RRHWF Plan at the WVDP—June 1999 Conceptual Design (Adapted from RRHWF Drawing Number SK-4307-042-001, Sheet 3, Rev. B)

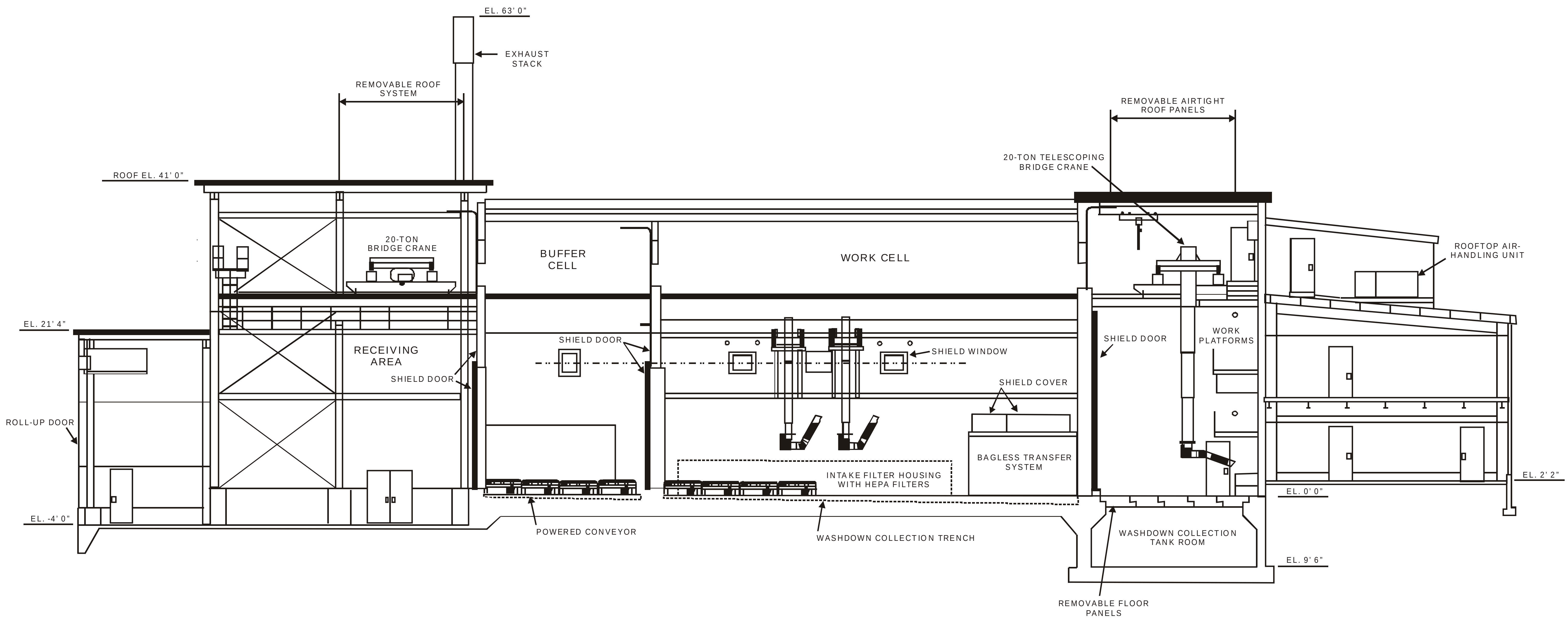


Figure G-4.4. A Schematic of a Sectional View of the RRHWF at the WVDP—June 1999 Conceptual Design (Adapted from RRHWF Drawing Number SK-407-042-001, Sheet 4, Rev. B)

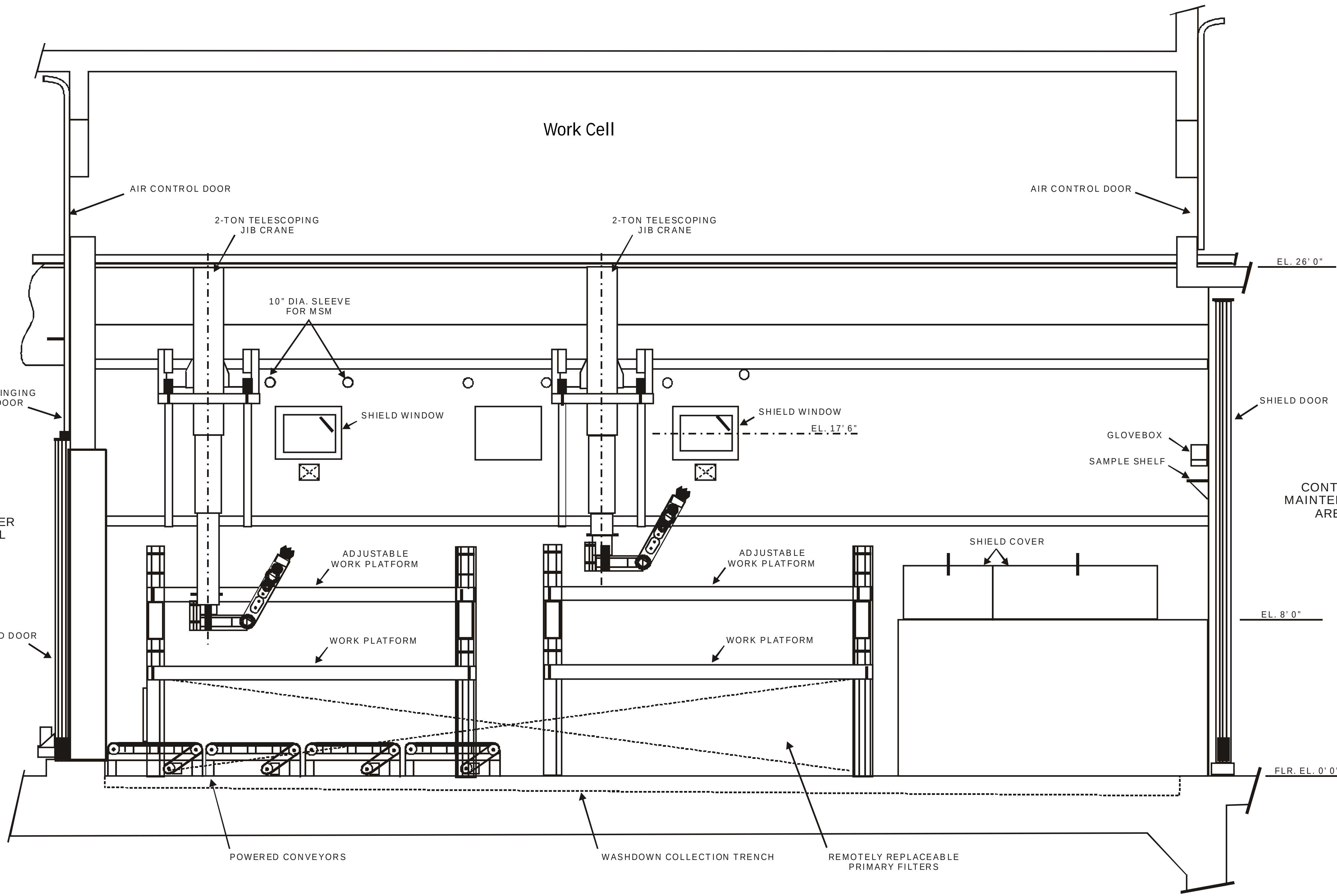


Figure G-4.5. A Schematic of a Sectional View (close-up) of the Work Cell of the RRHWF at the WVDP—June 1999 Conceptual Design (Adapted from RRHWF Drawing Number SK-407-042-012, Sheet 3, Rev. B)

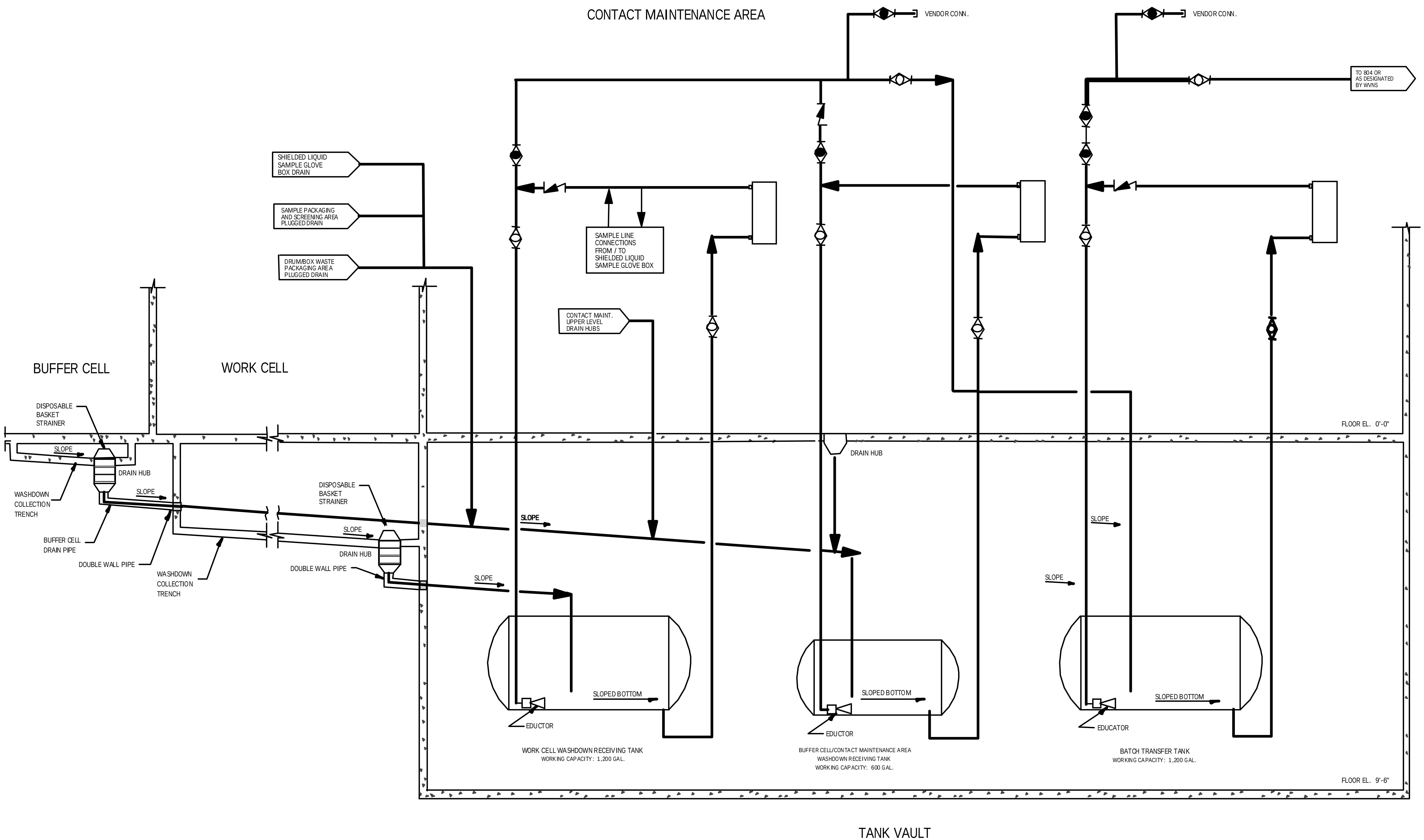


Figure G-4.6. A Schematic of the Washdown Collection System for the RRHWF at the WVDP (Adapted from RRHWF Drawing Number SK-407-042-040, Rev. B)

Waste Packaging Area

The Waste Packaging Area will provide a shielded contamination control space for efficiently loading out liners that are filled with waste into a drum or a box. Two Bagless Transfer Systems (one for drums and one for boxes) will be mounted on top of the Waste Packaging Area. These systems will provide the physical boundaries necessary to bring waste out of the work cell with radiological contamination levels greater than 10^{12} dpm/100 cm^2, while maintaining the exterior of the waste disposal container free of radiological contamination. The Waste Packaging Area will be equipped with two carts on tracks for moving drums and boxes, a shielded fork lift, and a monorail transfer hoist.

Operating Aisle

The Operating Aisle will provide a safe place for workers to remotely operate facility equipment. Three shield windows will be installed in the Work Cell walls. Up to three operator work stations will be provided at the shield windows.

HVAC Areas

The Mechanical Equipment Area will house the air-handling system for the make-up air distributed to the stairwells and operating spaces within the RRHWF. The Exhaust Blower Room will provide an isolatable space for the large blowers that will draw air from the Work Cell through the HEPA filters. The Exhaust Filter Area and Exhaust Blower Room will be on the ground level for ease of operations and maintenance. Equipment to be located in these areas typically require hands-on maintenance.

Contact Maintenance Area

The Contact Maintenance Area will provide a shielded zone, isolated from the Work Cell, where personnel can perform contact maintenance on the crane, PDMs, and other equipment removed from the Work Cell. It will be located adjacent to the Work Cell. The first floor of the maintenance area will contain a lay down area and storage shelves for the end effectors. A workbench and tool storage area will also be provided for hands-on maintenance of the heavy- and light-duty end effectors, jib cranes, or crane telescoping tubes.

Sample Packaging and Screening Area

This area will provide for removal of samples from the Work Cell and placement of these samples in containers for transfer to a laboratory for analyses. The samples will be removed from the transfer drawer inside a sample transfer glovebox. The contained samples can be transferred out of the glovebox though a bagless transfer system to a shielded container for transporting samples, or to the sample hood. A dumbwaiter will be installed to lower the shielded sample to the first floor for transfer out of the RRHWF to a laboratory. Samples can also be pre-screened and counted for gross Beta and Alpha activity using counting equipment that will be available in the area.

Secondary Waste Collection System

It is anticipated that some liquid waste may be generated during decontamination of the cranes and the maintenance of PDMs and other equipment. Also, there may be a need to perform aggressive liquid decontamination of some hard-to-clean waste components. A secondary waste collection and disposition system has been designed to address these needs. The liquid waste collected in the tanks will be either treated and discharged to a waste discharge facility, or a subcontractor will be engaged to treat the waste and make it disposal ready.

Load Out/Truck Bay

Load out of filled waste disposal containers and receipt and storage of empty waste disposal containers will be performed inside an all-weather enclosure called the Load Out/Truck Bay. It will be a clear-span, pre-engineered metal building (approx. 60 feet by 50 feet). A shielded fork lift will be used to load packaged waste containers onto trucks parked inside the area.

Offices

This area will provide a clean, low-dose rate area adjacent to the RRHWF for performing administrative functions. It will be built adjacent to the low-dose end of the RRHWF (outside the Contact Maintenance Area) as a two-story office facility with about 2,000 sq ft of floor space for crew offices, meeting rooms, a lunch room, and sanitary facilities. Personnel Contamination Monitors (PCM) will be located at all access routes from the RHWF to the Offices.

G-5. Waste Processing Activities

The following major waste processing functions will be performed on the RHWF waste streams to take the materials from their existing configuration and prepare them for transport off site for storage or disposal. The activities to be performed within the RRHWF are shown in Figure G-5.1.

Transfer On Site to the RRHWF

The waste streams to be processed in the RRHWF are being temporarily stored at several locations on the WVDP site. Some of the higher dose rate waste streams may require supplemental shielding during an on-site transfer to the RRHWF.

Survey and Sample

Each incoming waste container will be surveyed upon arrival in the Work Cell to help estimate the amount of radioactivity present in the waste. After the container is opened, samples will be obtained as the contents are removed to help determine the type of radionuclides present. This information will be used to support sorting, segmenting, and segregating operation decisions.

Segment (size reduction)

For some of the waste streams, large waste items may be cut into smaller pieces before they are loaded into a waste disposal container liner. Segmenting may also allow segregation of TRU waste pieces removed from LLW.

Sort and Segregate

Waste containers will contain varying items that differ in size, waste type, and mateials. Waste components will be sorted, based on radionuclide concentration, as LLW or TRU waste. Some waste components may contain regulated hazardous contituents that will be sorted out and segregated as mixed waste for processing in another facility.

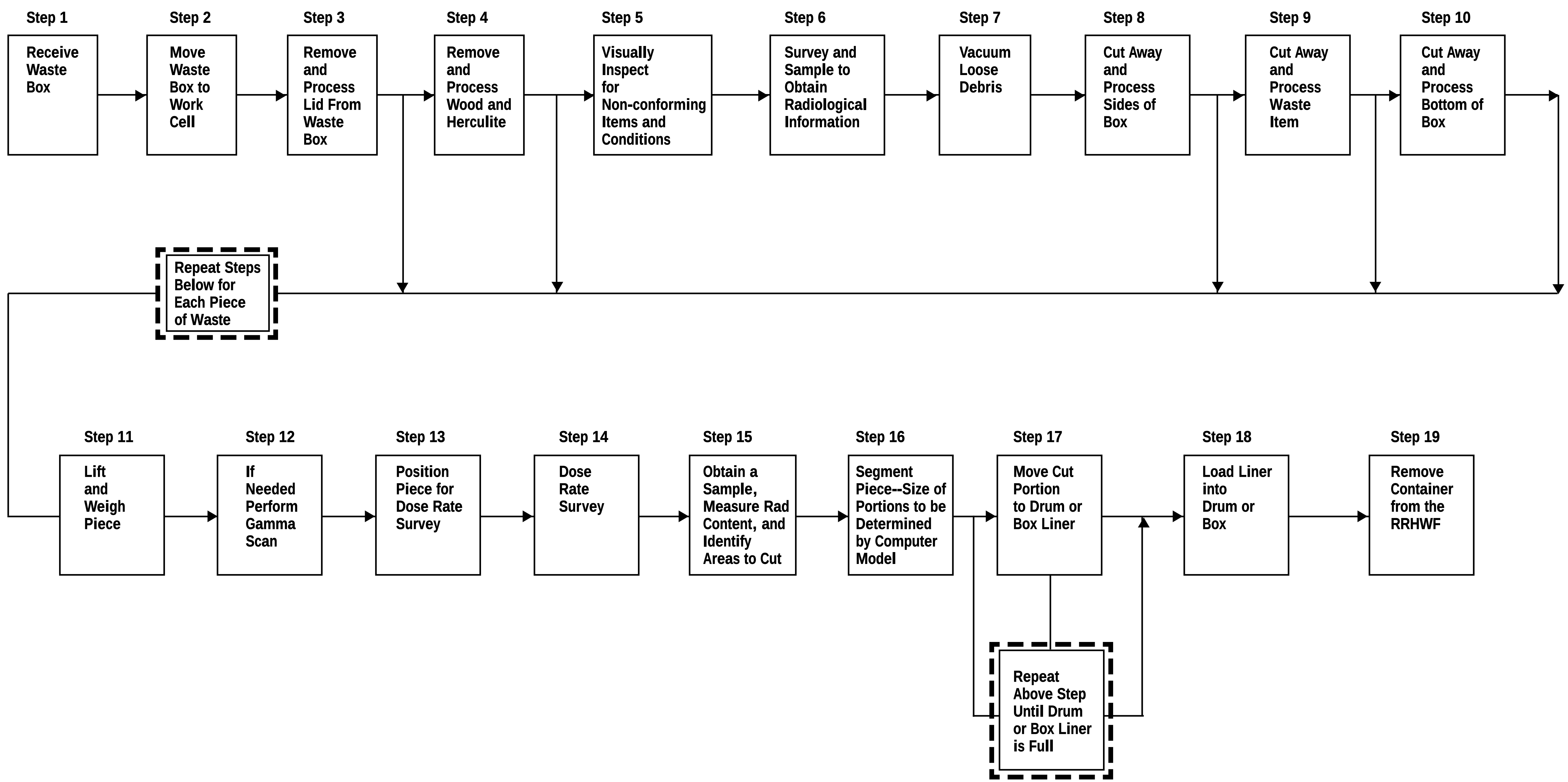


Figure G-5.1. A Schematic of the Process Flow Diagram for the RRHWF at the WVDP (Adapted from RRHWF Drawing Number SK-407-042-110, Rev. A)

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Stabilization/Void Filling

Selected LLW disposal containers will require stabilization to meet shallow-land disposal requirements. For most of the LLW containers to be generated at the RRHWF, this will require filling the voids present in the container.

Characterization for Shipment

Surveys and assays will be performed on final waste disposal containers to support characterization of the radioactive contents for shipment and waste-disposal classification.

Schedule

A conceptual design for the facility was developed in June 1999. A design-build contract has been approved by DOE and is in place. The contract requires the design activities to start in October 1999. The final design will be complete in October 2000, thus allowing the start of construction immediately thereafter. Construction is scheduled to be completed by October 2002.

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Appendix H
Table H.1-1
Summary Comparison of the Rescoped Remote-Handled Waste Facility with the Benchmarked Facilities

No.	Category	Comparisons					
		RRHWF (WVDP)	**AMWTF (INEEL)**	**TWF (SRS)**	**TWRF (ORNL)**	**MBGWS (BNFL)**	**RHWF (WVDP)**
1	Facility Type:						
	• Type of Facility	New Standalone	New Standalone	New Standalone	New Standalone	New Standalone	New Standalone
	• Facility Structure	Work Cell isolated by three zones of confinement with shielding. For earthquake safety, it is designed to withstand 0.1 g acceleration at ground level.	Two separate buildings under one roof, separating high-thermal output processes from other processes. Each building has work areas isolated by three zones of confinement.	Two processing areas isolated by three zones of confinement. Facility contains two explosion-resistant areas.	Two process areas isolated by three zones of confinement. Not earthquake resistant.	Two sets of shield walls. Designed to be earthquake resistant, has a halon gas flooding system.	Work Cell isolated by three zones of confinement, with shielding.
	• In-Facility Transport Systems	Powered rollers, 20- and 30-ton bridge cranes, two 2 ½-ton jib cranes	Conveyor belts, vibro-chute, shuttle trolley	Two 20-ton monorails, two 5-ton bridge cranes, one 1-ton crane, conveyors, automatically guided vehicle, motorized product carrier	Transfer carriage, overhead hoist, pumps with double-contained, aboveground piping	5-, 16-,and 20-tonne cranes, trolleys, tipping machine	Powered rollers, bridge and monorail cranes
2	Facility Integration:						
	• Utilities	Integrated	All utilities are in a separate facility.	Integrated	Hotel loads (e.g., water, power) provided by ORNL.	Section of the facility dedicated to utilities.	Integrated
	• Decontamination	Low-velocity, high-volume water spray, vacuum system	It does not appear that any decontamination capabilities would be required to support the waste processing objectives of the facility.	Kelly spray-vacuum decontamination system (hot water under high pressure flashes to steam on impact and is vacuumed up)	No decontamination of waste.	Decontamination facilities for flask (cask) and equipment is accomplished with a spray tank or a booth using a hot cleansing solution.	Limited water-jet decontamination, vacuum system
	• HVAC System	Integrated, nuclear-grade HVAC system, 2 blowers, 3 sets of HEPA filters in series	Two separate HVAC systems. In each system, air moves in towards zone 3, then exits through HEPA filters.	Separate HVAC systems for process area and for radiologically controlled areas.	HVAC system located in 3rd floor penthouse, HEPA filters are in the process areas.	Two separate exhaust systems for contaminated and clean areas.	Integrated nuclear-grade HVAC system, 4 blowers, 3 sets of HEPA filters in series
3	Processing Methodology and Technologies:						
	• Processing Equipment or Technologies	2 work stations for multiple waste streams	Two separate waste treatment lines. One for boxes, one for drums.	One process flow for all waste.	Four subsystems for: sludge, supernate, CH-TRU, and RH-TRU	One distinct production line for opening, sorting, and repackaging waste.	4 work stations for multiple waste streams
	• Material Handling Tool or Technologies	Power manipulators, decontamination system., cutting saws, shears	Power manipulators and MSMs for opening containers, sorting, size-reducing, and transferring waste; incinerator, evaporator; system for solidifying ashes; shredder; super-compactor; shuttle trolley; gloveboxes; grouting system for macro encapsulation; cutting saws; shears	Power manipulators, MSMs, tele-robots, shredder, plasma arc cutting torches, ability to purge waste containers with nitrogen	Power manipulators and gloveboxes, evaporator, compactor, macro-encapsulation system	Power manipulators, grouting, supercompactor, grinders, cutters	Power manipulators, decontamination system, cutting saws, shears
4	Throughput:						
	• Total Throughput	62,000 cu. ft.	3,000,000 cu. ft.	480,000 cu. ft.	143,000 cu. ft.	106,000 cu. ft.	102,000 cu. ft.
	• Annual Throughput	8,900 cu. ft.	231,000 cu. ft.	25,500 cu. ft.	44,000 cu. ft.	5,300 cu. ft.	9,300 cu. ft.
	• Duration of Operations	7 yrs	13 yrs	18 yrs	2 yrs (3 more years optional)	20 yrs	11 yrs
5	Cost	$31 million for capital cost	$570 million for capital costs	$228 million for capital costs	$101 million for design and construction	$114 million for capital cost	$55 million for capital cost

Appendix H
Table H.1-1
Summary Comparison of the Rescoped Remote-Handled Waste Facility with the Benchmarked Facilities

No.	Category	Comparisons					
		RRHWF (WVDP)	AMWTF (INEEL)	TWF (SRS)	TWRF (ORNL)	MBGWS (BNFL)	RHWF (WVDP)
6	Waste Characterization:						
	• Characterization Process	Smears, samples, TRU monitor, dose rate monitors, collimated gamma scanner	Pretreatment lines have x-ray systems. Samples taken at sorting areas.	After venting and purging, containers are assayed and x-rayed with real-time x-ray equipment.	Waste initially assayed by mobile assay system to determine if RH-TRU, CH-TRU, or LLW. RH materials put through NDE station.	Waste known to not have fissile material put directly in final boxes, waste with uncertain fissile material put in a fissile material detector before being put into boxes.	TRU counter, segmented gamma scanner, collimated gamma scanner
	• Analytical Laboratory	Use either the lab on site in another facility, or a commercial lab.	Graphite furnace atomic analyzer, inductivly coupled plasma atomic emissions spectrometer, muffle furnace, scales, balances, XRF spectrometer, pH meter, gas chromatograph, flame atomic analyzer, packet x-ray system, TRU determination equipment	Laboratory alpha and beta counting systems, low-level automatic sample counting system, three alpha-beta-gamma counting systems for swipes and liquid samples, TRU determination equipment	Lab analysis done by outside lab.		Use the lab in another facility on site.
7	Final Waste Classification:						
	• Final Container Type	Drums and Boxes	Drums and Boxes	55- and 83-gallon drums, boxes	Drums, boxes	Unshielded boxes	Drums and Boxes
	• Final Classification	TRU, LLW	TRU, LLMW, alpha LLMW	CH-TRU, LLW	TRU, LLW	Intermediate-Level Waste	TRU, LLW
8	Waste Disposal Locations	All waste will be shipped off site.	All waste shipped off site. TRU waste will go to WIPP.	LLW buried on site. TRU waste will go to WIPP.	TRU waste will go to WIPP, LLW to NTS.	All waste put in interim storage on site.	All waste will be shipped off site.

APPENDIX I. ACRONYMS

AGV	Automatically Guided Vehicle
ALARA	As Low As Reasonably Achievable
AMWTF	Advanced Mixed Waste Treatment Facility
BNFL	British Nuclear Fuels Limited
CAM	Continuous Air Monitor
CFM	Cubic Feet per Minute
CH	Contact-Handled
CPC	Chemical Process Cell
CPC/VF	Chemical Process Cell / Vitrification Facility
CPC-WSA	Chemical Process Cell / Waste Storage Area
D&D	Decontamination and Decommissioning
DAW	Dry Active Waste
DEIS	Draft Environmental Impact Statement
DOE	Department of Energy
DOP	Dioctyl Phthalate
EDR	Equipment Decontamination Room
EIS	Environmental Impact Statement
EM	Environmental Management
FRS	Fuel Receiving and Storage Area
GTCC	Greater than Class “C”
HDB	Hauptabteilung Dekontaminationsbetriebe
HEC	Head End Cell
HEPA	High-Efficiency Particulate Air Filter
HEV	Head End Ventilation
HIC	High-Integrity Container
HLW	High-Level Waste
HP	Health Physics
HVAC	Heating, Ventilation, and Air Conditioning
ILW	Intermediate-Level Waste
INEEL	Idaho National Engineering and Environmental Laboratory
ISO	International Standards Organization
KfK	Kernforschungszentrum Karlsruhe
LDR	Land Disposal Restriction
LLW	Low-Level Waste
LSA	Lag Storage Area
LSB	Lag Storage B
MBGWS	Miscellaneous Beta Gamma Waste Storage at Sellafield, England
MLW	Medium-Level Wastes
MSM	Remote Manipulators
MVST	Melton Valley Storage Tanks
NDA	NRC Licensed Disposal Area
NTS	Nevada Test Site
O&M	Operations and Management
ORNL	Oak Ridge National Laboratory
ORR	Operational Readiness Review
PAG	Passive Aerosol Generator

Benchmarking the Remote-Handled Waste Facility at the West Valley Demonstration Project

PCM	Plutonium-Contaminated Material
PHA	Process Hazards Analysis
PMC	Process Mechanical Cell
PMP	Project Management Plan
POGS	Process Off-Gas System
PUREX	Plutonium/Uranium Extraction
RC	Radio Controlled
RCRA	Resource Conservation and Recovery Act
RH	Remote-Handled
RHWF	Remote-Handled Waste Facility
RHWP	Remote-Handled Waste Project
RHWS	Remote-Handled Waste System
ROD	Record of Decision
RRHWF	Rescoped Remote-Handled Waste Facility
RTR	Real-Time Radiography
RWMC	Radioactive Waste Management Complex
SBS	Submerged Bed Scrubber
SCMA	Shielded Container Management Area
SCW	Special Case Waste
SRF	Los Alamos TRU Waste Size Reduction Facility
SRS	Savannah River Site
STRU	Suspect TRU
SWB	Standard Waste Box
SWSF	Solid Waste Support Facility
TRU	Transuranic
TWF	Transuranic Waste Facility
TWRF	Transuranic Waste Remedial Facility
WIPP	Waste Isolation Pilot Plant
WNYNSC	Western New York Nuclear Service Center
WPC	Waste Preparation Cell
WRAP	Waste Receiving and Processing
WTC	Waste Treatment Complex
WTF	Waste Tank Farm
WVDP	West Valley Demonstration Project
WVNS	West Valley Nuclear Services Co.
XRF	X-Ray Fluorescence