5. TECHNICAL DESCRIPTION

The conceptual design for the AR Project presents a safe, simple approach to waste zone material removal needs, and achieves this at a lower cost than previously proposed methods of retrieval. The project approach allows personnel in PPE to operate commercially available excavation and material handling equipment for waste excavation, packaging, and transportation activities. Facilities consist of relocatable enclosures for weather protection and contamination control. Sampling, characterization, and required treatment activities will occur in skid-mounted units or relocatable trailer units. The design concept is simple and meets the project T&FRs (TFR-265). The key components of the design (excavator, retrieval/airlock enclosure, storage enclosure, and treatment skids) use standard commercial products, fabrication techniques, and construction methods.

This section describes the conceptual retrieval process, structures, equipment, and support systems, including key features and benefits, for AR Project operations. The conceptual design drawings are included in Appendix C.

5.1 Process Description

The AR Project is comprised of the following six major processes, which are summarized in Figure 5-1 and discussed in this section:

1. Retrieval
2. Sampling
3. Interim storage
4. Characterization and WIPP certification by CCP
5. Treatment of TRU material that fails gas generation testing (GGT)
6. Return-to-pit and site closure.

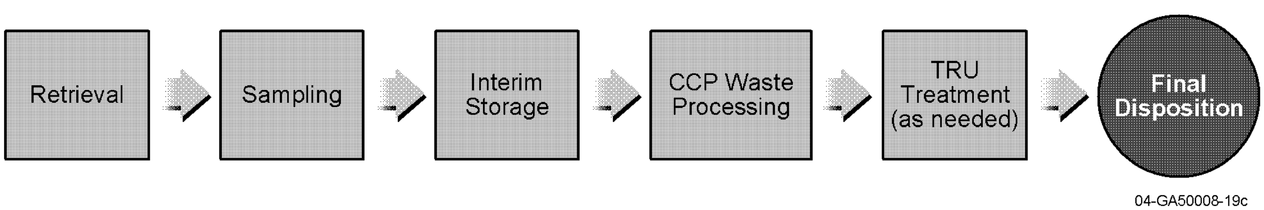

Figure 5-1. Conceptual AR Project retrieval, treatment, and disposal process.

Retrieval includes the removal and packaging of overburden, waste-zone material, and underburden. The overburden will be removed in two stages to minimize the amount of operation that must be performed with PPE and prevent contamination of the upper, relatively clean overburden layer. Waste-zone material will be retrieved, segregated, and packaged as either "soil" or "waste and soil." The packaged waste will be sampled, and the container decontaminated and transported to the Fissile Material Assay System Trailer. After the fissile material assay system verifies that the quantity of fissile material does not exceed the limits for storage, the container will be transferred to interim storage. Based on the results of sample analyses for PCBs, some containers with PCB concentrations in excess of threshold values will be transferred to WMF-628, which provides storage that is compliant with 40 CFR 761.65. In late FY 2005, the CCP is expected to be deployed at the AR Project site. The CCP will assay the waste material to determine if it is TRU or non-TRU. All TRU material will be characterized, certified, and transported to WIPP for final disposition. As part of the WIPP characterization process, some containers will require GGT. TRU material that does not pass GGT will be treated to remove VOCs using low temperature thermal desorption (LTTD). Non-TRU, non-PCB material will eventually be transported back to the retrieval site and placed in the pit. Non-TRU, PCB contaminated material will be stored until a process is available for treating it or a suitable disposal site is identified. The details of each activity are provided in this section.

5.1.1 Retrieval

Originally, about 5 to 6 ft of clean soil was placed over waste-zone material to provide an environmental protection barrier. This overburden must be removed to reach the waste zone material. Based on probing data, the first 3 to 3-1/2 ft of overburden (first layer) is most likely uncontaminated and will be stored outside of the retrieval area for return to the pit. The next 2 ft of potentially contaminated soil is also assumed to be acceptable for return to the pit, and will be managed such that removal from the retrieval area will only be necessary if the material is found to be TRU, thereby decreasing the processing cost of that material.

Retrieval Process:

- Produces two waste streams: (1) soil, (2) waste and soil
- Controls dust generation during excavation and dumping operations
- Packages waste in SWBs.

5.1.1.1 Removing the Top Layer of Overburden. After the retrieval enclosure is erected, the first 3 to 4 ft of overburden will be removed in bulk from the entire surface of Area G as a construction activity using standard excavation equipment. The overburden, which is assumed to be free of significant contamination, will be core sampled to allow outdoor storage on the east end of Pit 4. The soil will be piled on a geotextile ground cover and an ecologically compatible fixant applied to the overburden pile to reduce erosion from wind or rain. After initial overburden removal, all soil surfaces within the retrieval enclosure will be treated with the fixant to provide a hardened surface that will reduce dust caused by equipment and personnel traffic. The overburden will eventually be returned to the pit.

5.1.1.2 Removing the Layer of Potentially Contaminated Soil. The next 2 ft of potentially contaminated soil, which lies directly atop the waste, will be loaded into temporary staging containers from a predetermined part of the retrieval area where it can be excavated without the excavator having to drive directly on the waste. These containers will be moved to the sampling area where the soil will be sampled for transuranic contaminants. The sample results will be used to make return-to-pit decisions. After sampling, the containers will be staged inside the enclosure until sample results are obtained. Acceptable containers will be returned to the pit; unacceptable containers will be emptied and reloaded into SWBs for removal.

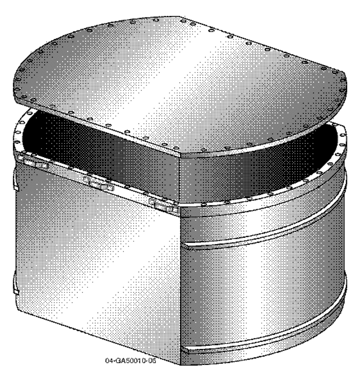

Figure 5-2. Standard waste boxes will be filled with waste material and underburden.

5.1.1.3 Retrieving Waste-Zone Material. A swath of waste zone material equal in width to that of the potentially contaminated soil will be excavated and loaded directly into TRUPACT SWBs—carbon-steel boxes approximately 71 × 48 × 36 in. high, with rounded ends (see Figure 5-2). Retrieval will begin at the west end of Area G and proceed to the east. If Area H, located directly to the east of Area G is targeted as a follow-on retrieval, the retrieval enclosure could be modified and expanded so retrieval operations could continue to the east. A digface angle of repose of about 1:1 will be maintained. Digface dust generation will be controlled using a water-based, process-compatible fixant that will be applied to exposed waste prior to and during the digging motion. Fogging will also be used to suppress any airborne contamination at the digface and enroute to the SWB. Both fixant and fog will be distributed from the excavator boom. In addition, dust suppression foam will be sprayed into the SWB as the excavator bucket is dumped. If any uncontained liquid are encountered during the excavation, they will be solidified.

Two waste streams will be created by the retrieval process, (1) waste material and interstitial soil, and (2) interstitial soil. Both waste streams will be placed in SWBs and moved from the retrieval enclosure to the airlock for sampling and decontamination. Approximately 6,600 SWBs will be retrieved from Area G. Overburden, waste-zone, and underburden retrieval will occur using two crews working 12-hour days, 7 days per week. Table 5-1 quantifies the types and ranges of materials both originally disposed and the number of estimated packages that will be generated by Area G retrieval operations.

After decontamination, both waste and interstitial soil SWBs and interstitial soil SWBs will be transported to the Fissile Material Assay System Trailer. This assay will verify the fissile gram equivalent loading in the containers to allow storage in the Interim Storage Enclosure without criticality controls. Excavation will continue into the underburden soil until sample results indicate that the remaining soil is non-TRU.

Table 5-1. Quantified breakdown of disposed and retrieved materials from Pit 4, Area G.

Material Type	Estimated Quantity of Material as Disposed (in yd^3)	Estimated Quantity in Packaged Form (in yd^3)	Sampling Requirements
Overburden (1st layer only)	3,100–3,300	NA (staged in bulk pending return to pit)	None
Potentially Contaminated Soil (2nd layer only)	2,000	540 (5 × 5 × 5 ft containers)	Radionuclides: TRU
Waste zone:			Radionuclides: TRU PCBs for both TRU and non-TRU and VOCs, SVOCs, and metals to comply with WIPP permit requirements
741 sludge	250		
742 sludge	200		
743 sludge	200		
744 sludge	25		
745 sludge	0		
Combustible	800 (incl. 50% of mixed)		
Noncombustible	1,700 (incl. 50% of mixed)		
Graphite	130		
Filters	500		
Beryllium waste	50		
Uranium roaster oxides	30		
Other generators	950		
Interstitial soil	4,400		
Total	9,235	6,510 SWBs	
Underburden	1,300–1,400	(Included in waste zone container count)	Radionuclides: TRU

Some of the 741 sludge waste drums previously buried in Area G may have had shielding to reduce the dose rates from Am-241. Current WIPP disposal requirements do not allow the shielding of this type of waste to be contact-handled waste. If the contact dose rate of any material suspected of being TRU exceeds 200 mrem/hr, it will be sized as necessary and funneled into new 55-gal drums so that it can eventually be placed in RH-TRU canisters and managed as RH TRU.

5.1.2 Sampling

The layer of potentially contaminated soil and underburden will be sampled to support short-turnaround results for return-to-pit criteria. Waste-zone material will be sampled and analyzed to support either characterization for acceptance at WIPP or return-to-pit. Samples will be taken prior to placing the lid on the SWB in the airlock in accordance with the field sampling plan. These samples will be bagged and taken out of the retrieval/airlock enclosure to the Sample Support Trailer for fissile material assay and eventual transport to INTEC or other INEEL analytical laboratories. Samples for PCB analysis for RCRA storage and return to pit may be analyzed on-site. Data quality objectives will be developed for the characterization. Sample data management will be required to meet WIPP quality requirements, since some samples will support WIPP characterization activities.

5.1.3 Interim Storage

SWBs filled with a combination of waste and interstitial soil will be stored in the interim storage enclosure (or WMF-628 if they are determined to be PCB contaminated) until they are assayed by the CCP. RCRA waste codes will be assigned to the waste containers based on acceptable knowledge and revised when laboratory analysis results are obtained. Interim storage will eventually include all SWBs initially retrieved and awaiting assay, treatment, future disposition, return-to-pit, or shipment to WIPP.

5.1.4 Treatment

TRU material that does not pass GGT will be treated using LTTD to remove VOCs (see Section 5.10 for more detail).

5.1.5 Characterization and WIPP Certification by CCP

The CCP nondestructive assay system will be used to determine if the container meets the 100 nCi/g TRU threshold for shipment to WIPP. Waste that is less than or equal to 100 nCi/g will be returned to the pit unless it is PCB contaminated, in which case it will be placed in longer term storage until a treatment or disposal path is developed. Waste containers that assay greater than 100 nCi/g will be processed using real time radiography, appropriate visual examination, head space gas sampling, and GGT prior to certified waste shipment to WIPP.

5.1.6 Return-to-Pit and Site Closure

Three processes will be performed in returning material to the pit. First, the excavator will be used to place and compact additional clean material in the bottom of the pit until a 2-ft-thick layer of underburden lies above the basalt. Second, the SWBs that have TRU contamination levels of less than or equal to 100 nCi/g and are not PCB contaminated will be returned to the retrieval area following assay, and may be filled with grout to minimize future subsidence within the pit. Third, the grouted SWBs will be placed into the pit and the excavator will be used to fill and compact the spaces between the boxes with the staged layer of potentially contaminated soil or staged clean overburden material. The pit will then be covered with a layer of clean material from the remaining clean overburden material or new material from the spreading areas, compacted, and graded consistent with an overall SDA grading and drainage plan.

Returning the SWBs to the pit will present the greatest challenge for the excavator, since the boxes will be fully loaded with material to minimize soil subsidence. Assuming an average material weight of 100 lb/ft^3, an SWB could weight 7,200 lb. Handing these SWBs at distances that will potentially exceed the excavator's normal reach increases the difficulty of placing them into the pit at the expected 27-ft maximum excavation depth. A feasible placement method will be to limit the box return to the cleaned side of the excavation and backfill any part of the excavation to an approximate depth of 17-ft. This would allow for the placement of up to a 4-box depth of SWBs. Each box would be connected to the excavator by way of a forklift end-effector (see Section 5.2.4.10) and four 10-ft lifting straps attached to the SWB lifting lugs.

5.1.7 Data Management

The AR Project will maintain data records of each SWB and its samples. Given the large number of containers to be filled (about 6,600), an electronic, web-based data management system is proposed. Data collection will be accomplished with computers and barcode readers. This must be a high quality data collection system because the results will feed the WIPP characterization and certification process.

Data for each SWB will include its retrieval location (based on a daily grid area only), contents (interstitial soil or waste and interstitial soil), and sampling and characterization results, which will include fissile material assay results, TRU assay results, PCB sampling results, and WIPP characterization and certification information.

Data of retrieval enclosure emissions will also be processed. The emissions monitor will measure the radiological contamination content of the retrieval enclosure exhaust. HEPA filters in the exhaust will remove contamination, but, in the unlikely event of a filter failure, contamination could be released to the environment. To mitigate the effects of such a failure, the emissions monitor will detect unacceptable contamination levels and initiate an alarm so that operators and radiological control technicians can take appropriate steps to control contamination. If conditions become unacceptable, the emissions monitor will not only initiate an alarm, it will also log emission data that can be checked for compliance to regulatory codes and standards. Preliminary VOC emission estimates for the AR Project are inconclusive for comparison to relevant state of Idaho toxic air pollutant standards. Therefore, VOC sampling from the Glovebox Excavator Method project will also be essential for the AR Project.

5.1.8 Process Modeling

A discrete-event computer simulation model has been developed to visualize and evaluate process operations. The model is a valuable predictive tool that provides insights and answers otherwise unavailable until after the system is built and operations are underway. It provides a solid, reliable basis for validating process throughput based on operational constraints and for estimating the overall project duration. At the conceptual design phase, the model indicates that the desired 20 yd^3 per shift is feasible, and that the complete retrieval will take approximately 28 months. As the design and process are refined, the model will be modified to update duration estimates and assess impacts to design change schedules.

The model is based on anticipated material flow paths and associated process or handling tasks. Durations for each task are user-definable. The model accepts waste zone inventory (soil vs. waste form composition) information laid out as a grid over the retrieval area. The model treats overburden soil, waste zone material, and underburden layers separately, thereby accounting for differences in the downstream packaging, sampling, and handling operations. The model can predict TRU vs. non-TRU containers, overloaded containers, and containers requiring VOC treatment.

The simulation model may also help in evaluating scenario changes, process changes, and in performing trade-off analyses. To this end, the model can be readily modified to add processing capability either in terms of additional capacity or as parallel units to existing processes. The model is animated to enhance process and material flow visualization and understanding.

5.2 Equipment Description

Various types of excavation equipment were evaluated to find the product that could best perform the operational functions required for the AR Project (INEEL/EXT-03-00908 and EDF-4025). In general, the excavator selected for the AR Project would need to have multiple motions and standard end-effectors so it could perform as a forklift and front-end loader as well as an excavator, and be versatile enough to reduce the number of motorized components within the retrieval area. This single piece of equipment should replace several currently identified movers. An additional study (EDF-4447) established three excavator styles that could potentially perform the required functions: the Badger style excavator, the Caterpillar 320C (knuckle boom), and the Gradall XL 5200 Excavator (see Figures 5-3, 5-4, and 5-5). Table 5-2 describes each operational function required for the AR Project and its equipment solution.

Figure 5-3. Badger style excavator.

Figure 5-4. Caterpillar 320C (knuckle boom) – excavator without required (-L) long reach option.

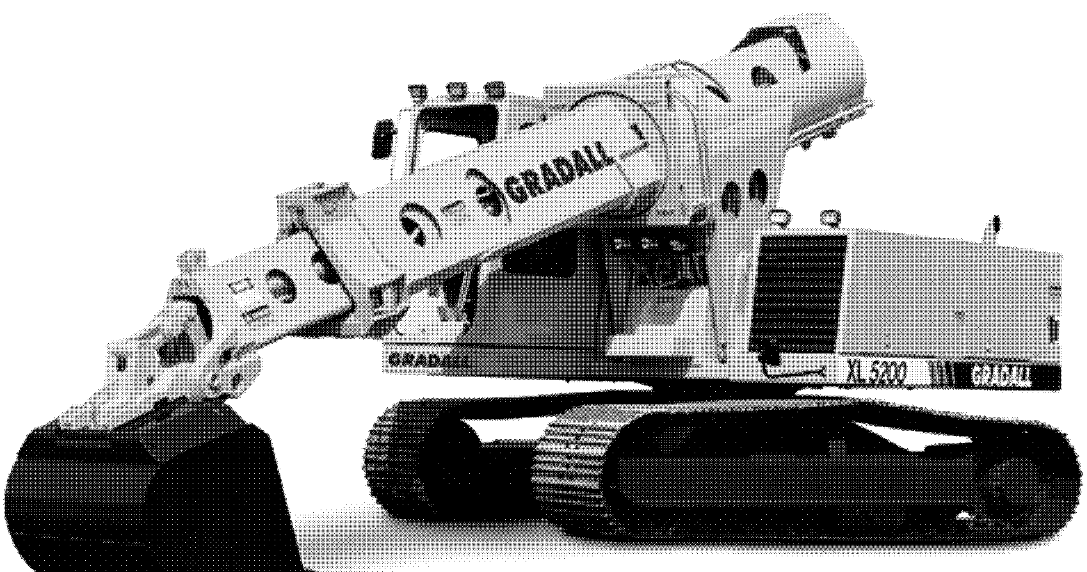

Figure 5-5. Gradall XL 5200 excavator.

Table 5-2. Required operational functions and prescribed equipment solutions for the AR Project.

Operational Function	Equipment Requirements	Gradall XL 5200 Excavator Capabilities
Excavating Soil	The excavator and bucket must handle 3,350 lb of material per scoop at full extension. The equipment must also accommodate angle-of-repose excavation.	An end-effector bucket is available. The boom accommodates the required angle of repose with over 21,000 lb of bucket breakout force at the digface.
Excavating Waste	A variety of different bucket type end-effectors will be required.	A variety of standard end-effectors will meet this requirement and can be traded out in 3 to 5 minutes.
Transporting SWBs	The equipment must transport empty and filled SWBs along with associated skids or pallets.	A forklift end-effector is available to meet this need, but the lock-check valving to prevent a loss-of-fluid condition normally required on a forklift is not. This variance can be handled administratively by limiting the elevation of the SWB to a minimal lift height, to prevent if from tipping over and to reduce or eliminate the need for personnel to be around the equipment while it is lifting.
Transporting Overburden Soil Containers	The equipment must move overburden soil containers to different locations.	The forklift end-effector used to transport SWBs will be used for these containers.
Emptying Overburden Soil Containers	The equipment must dump overburden soil containers that have been verified as clean enough to return to the pit. Soil boxes will be designed so that forklift tines can slide into holding tubes and capture the box while dumping.	A forklift end-effector is available. The excavator can rotate 360 degrees to dump the overburden from the soil containers. The used excavator being considered rotates 110 degrees, but can be retrofitted to provide the 360-degree rotation. This requires adjustments or modifications to the excavator or boxes. Issues associated with a new vs. used excavators are discussed in more detail in Section 5.2.3.
Returning SWBs to the Pit	The equipment must be able to telescope out over the pit and dump SWBs where needed. This is challenging, since the boxes will be fully loaded weighing up to 4,000 lb and be handled at potential distances that exceed the excavator's normal reach.	A forklift end-effector is available. The boom can rotate 360 degrees and provides approximately 4,770 lb of lifting capacity at a 20 ft extension to a depth of approximately 14 ft. Various placement methods are being considered, such as using a second excavator on the cleaned side of the excavation to complete the SWB placement process. A used excavator could be retrofitted for the necessary placement level, and a new excavator purchased to accommodate the unique reach and rotation functions.

Table 5-2. (continued).

Operational Function	Equipment Requirements	Gradall XL 5200 Excavator Capabilities
Returning Overburden Soil to the Pit	The equipment must return overburden soil to the pit by moving and probably dumping various styles of soil bags, boxes, or loose soil where needed.	End-effectors are available to handle a variety of package styles. The 360-degree boom rotation allows the excavator to act as a front-end loader when needed.
Compacting Soil	The equipment must be able to compact the soils being placed in the pit to minimize subsidence issues.	A hydraulically driven compactor end-effector is available for purchase to meet this application, or the mounting system of the existing Glovebox Excavator Method compactor could possibly be modified and attached to the boom.
Relocating Large Objects	Large objects buried in the pit may need to be relocated for access to the soil beneath. The excavator would push or pull the large object, when exposed, to a new position.	An end-effector could be developed to aid in this effort, but will not be considered until adequate information is known about the object needing relocation.
Providing a Remote Control Capability	The equipment may need to be operated remotely given one or more of the following currently unknown conditions that limit personnel access to the equipment: the over-burden is unable to support excavator's weight; the encounter of high-radiation source drums; the encounter of high alpha contamination; and the presence of an operator inside the excavator cab.	The excavator can be purchased with a remote control option, which includes up to three cameras located on the equipment. Personnel could then operate the excavator from any location within a required distance of the enclosure.
Providing 5 Hours of Operator Air	Current projections have established the need for a manned equipment operational window of approximately 4 hours. The equipment consumables such as air supply must be sized to ensure continued operation during that 4-hour window. A 4-hour operational window establishes that a minimum operator air supply of 5 hours must be provided on the excavator. The additional 1 hour of air reserve ensures that the operator inside the excavator cab will have sufficient air.	An air supply system will be installed on the excavator to meet this requirement. Both consumables and operators will be replaced at the end of each 4-hour shift.
Providing Dust Suppression at the Point of Excavation (Fixant/Fog)	The excavator must have dust suppression capabilities during operations to allow for a continuous 4-hour shift. Dust may carry air-borne alpha contamination.	A spray system installed on the excavator can provide this function using existing hose runs within the boom and strategically placed spray nozzles.
Deploying a Gamma Detector	Gamma detection equipment will be required at the digface during excavation to detect Am.	A detector can be deployed on the boom of the excavator to eliminate the need for personnel to provide this function.

Table 5-2. (continued).

Operational Function	Equipment Requirements	Gradall XL 5200 Excavator Capabilities
Handling Intact Drums	The equipment must be able to handle any intact drums found in the pit during excavation. Drums used to house much of the waste deposited in the pit are most likely deteriorated to the point of not being viable containment. However, some may be intact or may have been filled with a grout mix that retains the drum shape.	A Gradall drum handler or appropriate bucket end-effector is available to meet this requirement.
Sizing Debris, Solids, and Intact Drums	The equipment must be able to resize large debris found in the pit during excavation. Along with drums, boxes containing waste were also buried in the pit. These boxes could contain items so large that won't fit inside an SWB without being resized. Another option being considered is to resize intact drums while still inside the pit.	A Gradall scoring and cutting end-effector is available to meet this requirement.
Handling New Drums	The equipment must be able to handle new 55-gal drums. Waste drums containing Am. will be resized and placed into new 55-gal drums for disposition to WIPP using the Am drum filling fixture and shielding system.	A Gradall drum handling end-effector is available that can place and retrieve these drums.
Handling the Am Drum Filling Fixture and Shielding System.	The equipment must be able to move the drum-filling fixture and shielding system where it is needed for packaging Am waste into 55-gal drums for shipment to WIPP.	The excavator can move this system using a forklift tool or other type of end-effector, and has multiple axis of motion to accommodate required placement positions.

5.2.1 Gradall XL 5200 Excavator

Gradall XL 5200 Advantages

- Versatility
- Multiple functionality
- Standard end-effectors
- Reduced operational risks

After careful consideration, the Gradall XL 5200 excavator was selected for the AR Project because of its capability to meet the conceptual design requirements, which include multiple motions, such as 360-degree rotation, and standard end-effectors that allow it to also perform as a forklift and front-end loader. It also provides the greatest versatility of the excavators evaluated, which reduces the number of motorized components needed for the AR Project. This in turn reduces operational risks created by unexpected waste material and soil conditions. These functional requirements are further described below.

The Gradall XL 5200 (see Figure 5-6) is a versatile telescoping boom excavator capable of many unique functions. Some of these unique functions are standard features while others are options that can be added to the base unit at the time of order. Standard design functions are:

Figure 5-6. Gradall XL 5200 Excavator, right side view.

- Low headroom (less than 15 ft) when compared to typical knuckle boom excavators
- A variety of standard end-effectors readily obtainable from Gradall
- Quick coupling attachment (3 to 5 minutes using a single wrench) to most end-effectors
- High bucket breakout force (approximately 21,000 lb)
- A 34 ft horizontal reach without additional attachments
- A 38 ft horizontal reach using a 4-ft extension with no loss in lifting capacity.

The Gradall XL 5200 excavator can also be ordered with many options that provide sufficient variability to handle the operations currently identified inside the dig area. The options supplied by the factory are:

- A 50 ft horizontal reach using a "telestick" attachment (see Figure 5-7)
- Continuous 360-degree boom rotation (see Figure 5-8), which allows the same excavator to dump acceptable soil from staged boxes back into the excavated pit and act as a forklift/front-end loader
- Increased boom hose count from 2 to 6 hoses (this project will use the maximum hose count)
- Engine compartment fire protection system (can be factory or third party installed)
- Synthetic hydraulic and engine fluids
- Auxiliary high visibility lighting
- Camera system with remote control
- Wider 6.2 psi track
- Multiple track styles that include flat, polyurethane inserts, and triple grousers
- Equipment health monitoring system
- Lexan cab windows for increased operator protection
- Additional battery

Figure 5-7. Gradall XL 5200 with telestick extended.

Figure 5-8. Gradall XL 5200 Excavator with continuous 360-degree rotation option.

- Straight boom extensions from 4 to 12 ft long
- Break-over boom extensions
- Air-conditioning (standard and extra capacity).

The AR project will require most if not all of these options available from Gradall.

5.2.2 Excavator Modifications

The Gradall XL 5200 excavator may require some modifications that may not be provided by the manufacturer as described below for use in a radioactive environment.

5.2.2.1 Operator Breathing Air System. The excavator must be able to move to any location within the retrieval enclosure at any given time, and the operator must have a clean supply of breathing air during all operations. Using a forced air supply hose to provide this breathing air to the operator would require that personnel be available to move the hose connection each time the equipment moved to ensure it did not make contact with the excavator. This would place the person(s) monitoring the hoses within close proximity to the excavator and therefore at risk of being injured.

This risk will be eliminated by mounting the breathing air supply and feed system on the equipment itself. The system design will provide approximately 5 hours of continuous breathing air to the operator. Compressed air bottles will be appropriately sized to fit within the confines of the excavator structure with a central manifold connected to the cab. Figures 5-9, 5-10, and 5-11 show areas where the air bottles can be placed within the excavator. Air supply hoses will be installed to connect the bottles with a single sealed refilling connection. Refilling will occur as necessary during the twelve hour shift.

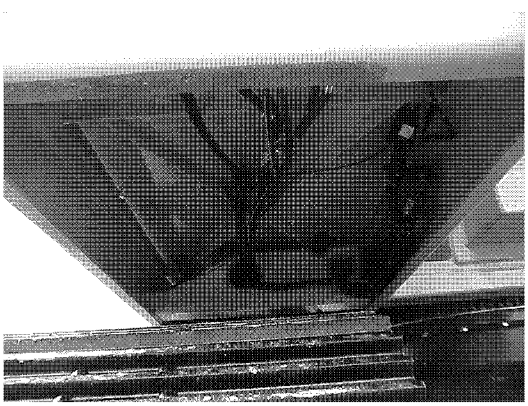

Figure 5-9. Potential air bottle location on the underside of the cab.

5.2.2.2 Dust Suppressant/Fixant Spraying System. Dust generation must be minimized during excavation to keep contamination controlled within the containment facility. The general methodology of dust control for the facility is discussed in Section 5.4.3, and part of that approach includes installing several spray nozzles on the excavator boom, near the end effector attachment. The nozzles will be designed to cover the freshly exposed soil/waste with dust suppressant as the material is excavated. The system must provide sufficient dust suppression solution to support the spraying operation for the area that is excavated during the 4-hour shifts. The Gradall XL 5200 will be modified for this functionality, but will use existing hose runs within the boom.

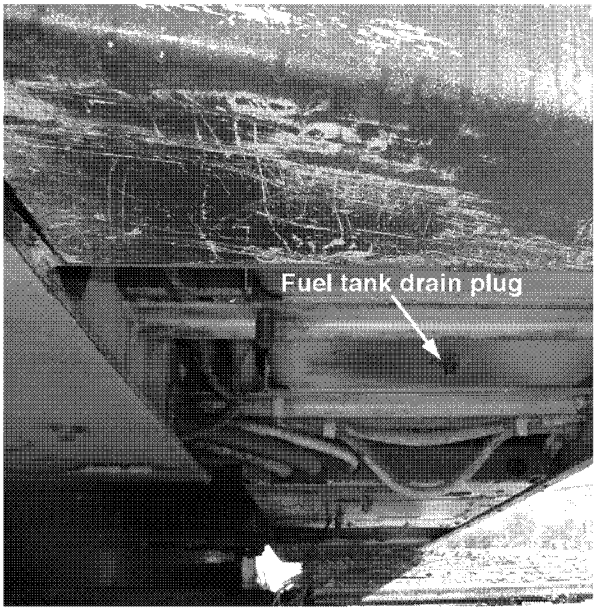

Figure 5-10. Potential air bottle location in the diesel fuel tank compartment area – under the right side of excavator.

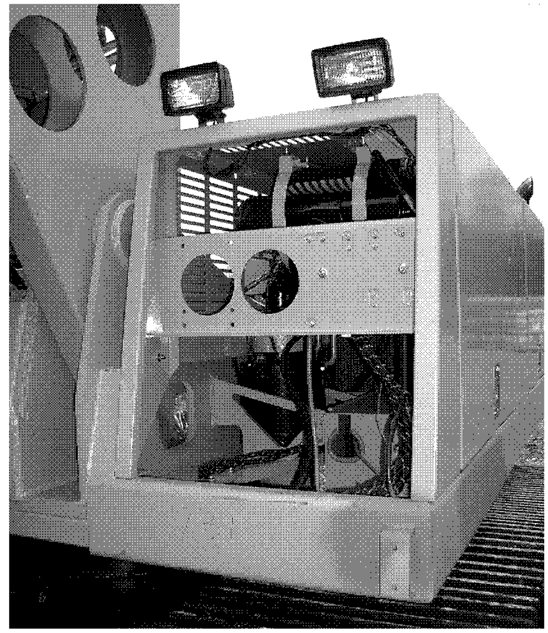

Figure 5-11. Potential air bottle location in the left front side compartment.

Modifications to the excavator will include installing a tank(s), a pump(s), nozzles, and controls for the operator to activate the spray as required. The proposed dust suppressant is Soiltac, as described in Section 5.4.3, and will be mixed with water and stored on the excavator in a tank and delivered to the nozzles with a single pump. However, there may be an advantage to keeping the water separate from the dust suppressant agent and only mixing on demand. If this is the case, there will be two tanks and two pumps. The optimal configuration will be determined during final design. The main reason for separating the two components is to simplify the process of cleaning the dust suppressant out of the spray system when the equipment is shut down. When the equipment is not in use, Soiltac must be removed from the nozzles or anywhere it is exposed to air so that it doesn't dry and plug the equipment.

5.2.2.3 Air Conditioning System. Operators will be suited in PPE and respirators, which will require additional air conditioning capacity inside the cab of the excavator to ensure the 4-hour manned operational window can be achieved. The maximum air conditioning system capacity (high cooling package) of the excavator is between 18,000 and 20,000 Btu/hr as stated by Gradall. The ventilation system will be modified as required to recirculate the cab air and condition the air inside the cab. The plenum for the excavator is located on the left side of the operator and is routed along the wall (see Figure 5-12). The cooling coil (evaporator) is located on the floor behind the operator seat (see Figure 5-13). The condensing coil (condenser) is located on top of the right-hand side of the excavator and is cooled by two electric fans (see Figure 5-14). The high cooling capacity system along with the other air control modifications being made are estimated to be sufficient for operator comfort and safety. The cab will be pressurized to protect the operator from potential high DAC levels. In addition, a new HEPA filtration system will be installed behind the cab (see Figure 5-14). This area is not used by any equipment and provides an enclosed space for a roughing filter, HEPA filters, blower fan, and needed duct work. The area is intended for storing oil filters, wrenches, a grease gun, etc. (see Figure 5-15).

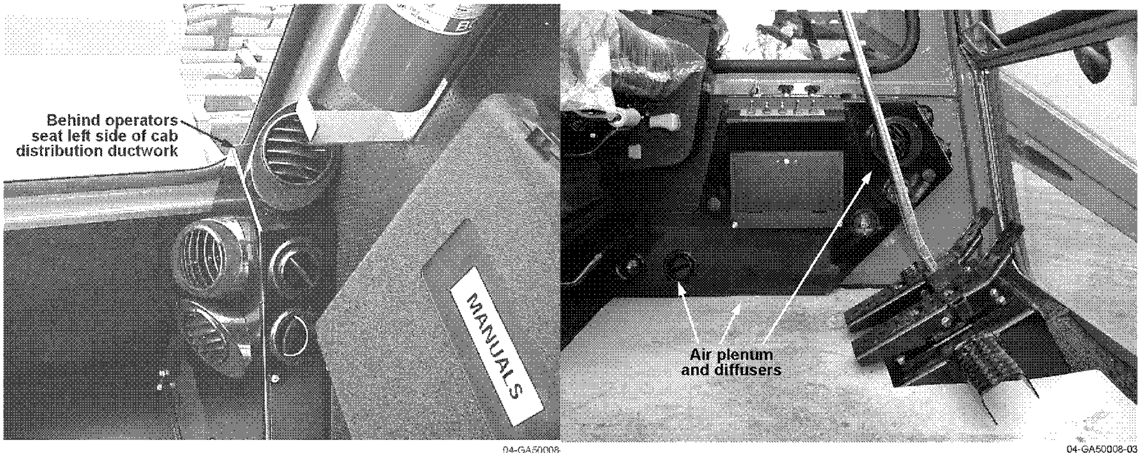

Figure 5-12. Location of air plenum and diffusers inside the cab.

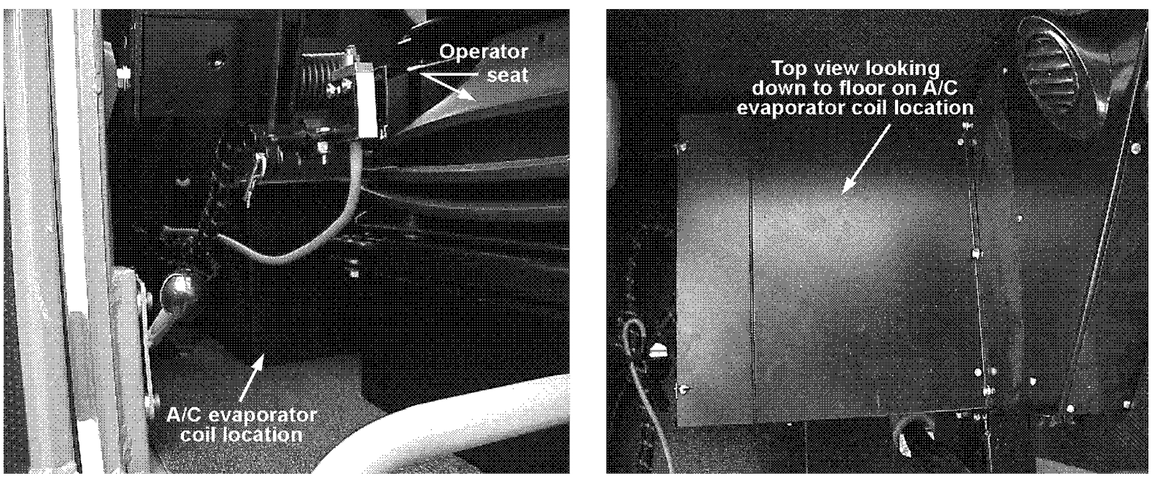

Figure 5-13. A/C coil on floor behind operator's seat.

Locating ventilation equipment here will provide close proximity to the cab and will be on the opposite side of the engine exhaust. The blower fan will be powered from the excavator electrical system. The HEPA filters will be a round 6-in. style used on glove boxes. The level of differential pressure in the cab will depend on its sealing capability.

5.2.2.4 Modified Tank Refueling with Sight Tube. Refueling the excavator must be accomplished with little chance of overfilling the tank and creating a spill. This will be accomplished by retrofitting the fuel tank with a sight tube so the person performing the refueling operation has instant feedback as to the actual tank level. The fill level sight tube will be connected to the bottom of the fuel tank (see Figure 5-10). The sight tube would be protected inside of the hydraulic valve enclosure located just to the right of the fuel tank. Figure 5-16 illustrates a sight glass and mounting location.

Other refueling options are possible, such as those used to refuel racing cars. These could also be evaluated for applicability to the project.

5.2.2.5 Smaller Fuel Capacity to Facilitate Placement of the Breathing Air System.

The need for breathing air on the excavator and the potential of not having sufficient free space could require that other spaces be created for adding air bottles. One possible location is above or below the fuel tank (see Figure 5-10 for a view of the bottom of the fuel tank). This would require resizing the fuel tank to accommodate a bottle.

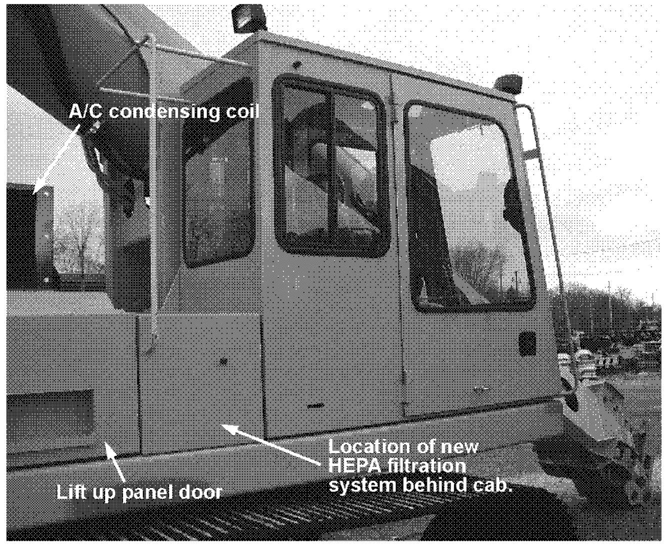

Figure 5-14. Location of HEPA filters, cab pressurization blower fan, and AC condensing coil.

5.2.2.6 Cab Modifications to Reduce Leakage.

The cab on the Gradall XL 5200 is constructed for commercial excavation use. To reduce operator exposure to potentially high DAC levels during excavation, the cab on the excavator will need to be sealed to a higher level than offered by Gradall. Cab sealing will be an engineered feature for operator protection during excavation. Several different areas described below have been identified that will need to be modified to provide protection.

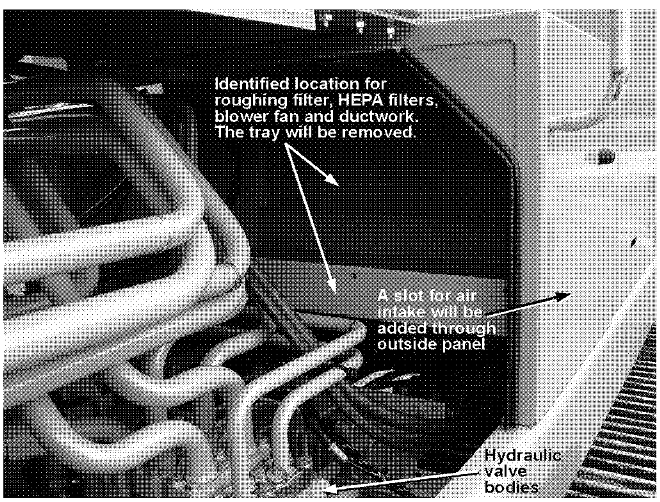

Figure 5-15. Tool and storage tray area to be removed and used for HEPA filtration system.

Since the cab is fabricated from sheet metal, there are various seams from the connecting metal. To seal these cracks, Gradall suggested a polymer lining. The cab will need to be stripped of equipment for installation. A lining used on pickup beds and chemical tanks will be applied to the inside of the cab. This lining seals the small linear cracks and provides a surface that is flexible and chemical resistant. Sound reduction inside of the cab is another benefit of this application. ArmorThane® manufactures a polyurethane spray on polymer that has been used in the agricultural, oil and gas, and mining industries for this type of application.

Windows offered by Gradall include operable sash-type safety glass. Since these windows do not seal to provide a leak tight cab, all windows that are attached and sealed to the cab will be removed and replaced with Lexan windows. Lexan windows will provide visibility for the operator, lower leakage over the operable sash-type windows, and impact resistance to breakage from object impact. Figure 5-17 shows typical views of the cab windows that will require replacement.

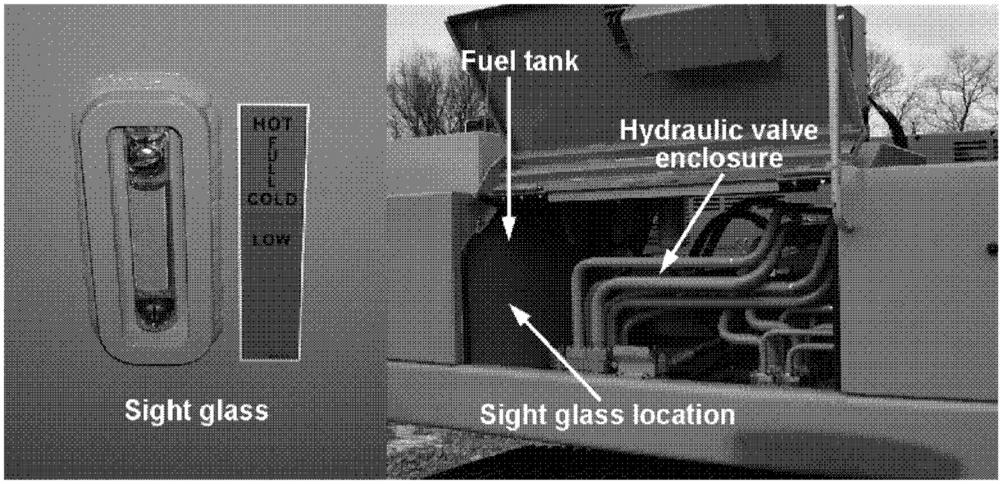

Figure 5-16. Illustration of a tank level sight glass.

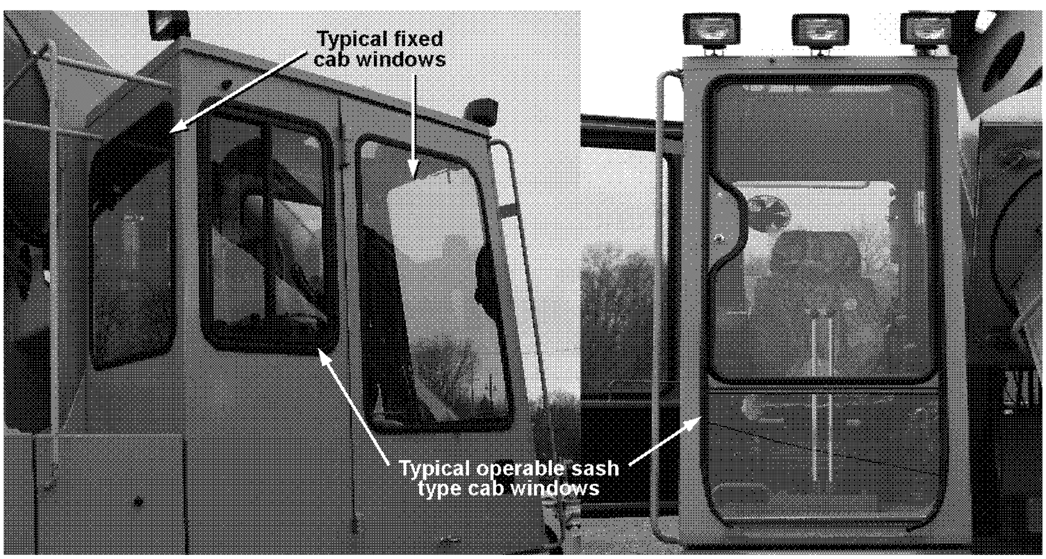

Figure 5-17. Excavator cab windows replacement, right hand and frontal views.

The floor of the cab has bolt-in type panels. In order for the floor panels to remain removable to service the excavator, the panels will be removed for silicone sealant to be applied at mating surfaces and then reinstalled.

Various cables, hoses, control levers, and latches penetrate the cab. These penetration holes will be sealed with polymer grommets and boots. Figure 5-18 shows typical locations were cables and hoses penetrate the cab and will require sealing.

Weather stripping around the cab door will require replacement, and the cab door will need to be sealed, when closed, for low leakage. Sealing the door will require replacing the factory-installed seal. The seal offered from Gradall does not provide the seal needed for the identified excavation activity. Figure 5-19 shows the typical arrangement of the cab door seal.

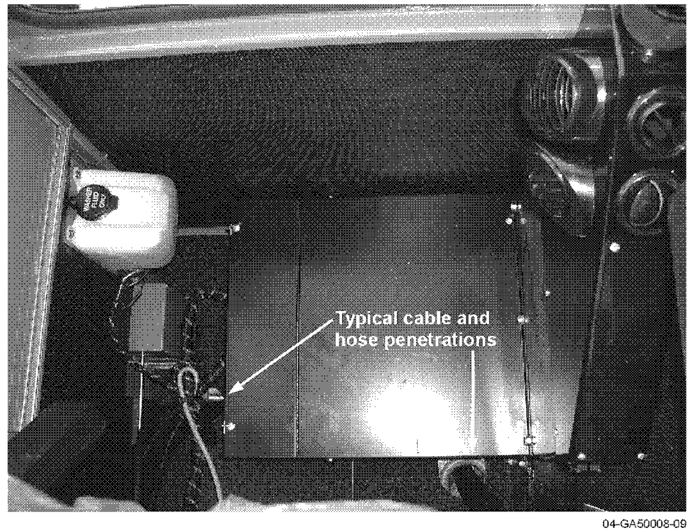

Figure 5-18. Typical locations requiring sealing for cable and hose penetrations.

5.2.2.7 Battery Operated Gamma Detection System. A gamma detection system may be needed to help identify high radiation sources, if encountered, before they are removed from the pit. The actual need for such a system must still be validated, as deployment would add some processing schedule and cost risks that may not be acceptable. Three methods for deploying detectors are addressed here, others may yet be found.

Figure 5-19. Typical door weather stripping on excavator cab.

The first method is to have a person or a piece of equipment deploy a detector at the end of a rod. This would involve placing additional personnel or equipment at the digface, which has potential interface problems with the excavation process and increases risk to workers required at the digface. Placing workers at the digface may also require some form of guardrail to ensure that personnel do not fall into the pit. Shielding may also be required to protect personnel if radiation sources are identified.

The second method is to attach a detection system to the excavator. This system would have the detector located in a way that facilitates detection while the bulk of the electronics is placed in a less hazardous location. This method would eliminate the need for another person to be at the digface performing the activity. The detector and electronics, however, may not be able to withstand the pounding vibration generated during excavation activities. This hindrance may require the detection system to be detachable during activities that could otherwise damage the detector.

The third gamma detection system is similar to one being used at Fernald (see Figure 5-20), which is deployed at the end of the excavator boom.

5.2.2.8 Increased Oil Filtration with Oil Sampling Capability. Changing excavator fluids generates a potential mixed hazardous waste. Working to increase the engine oil life to the maximum extent possible reduces the generation of such waste. Providing increased filtration of excavator engine fluids (see Figure 5-21) will achieve the maximum life.

The ability to sample the oil to ensure it is still lubricating the engine is important for guaranteeing the longevity of the excavator. A system will be installed for taking oil samples for analysis (see Figure 5-22). This will help establish when the oil needs be changed rather than changing the oil at a recommended interval. This bypass system will be designed for quick disconnect to verify that nearly zero leakage occurs during filter change out.

5.2.2.9 On-Board Fire Suppression System. The LTA-101-30 onboard excavator fire suppression system will be used for the AR Project. This pre-engineered, automatic, dry chemical system manufactured by ANSUL is capable of automatic detection and actuation and remote manual actuation. When a fire is detected the system, which operates the pneumatic actuator, is actuated either manually or automatically,

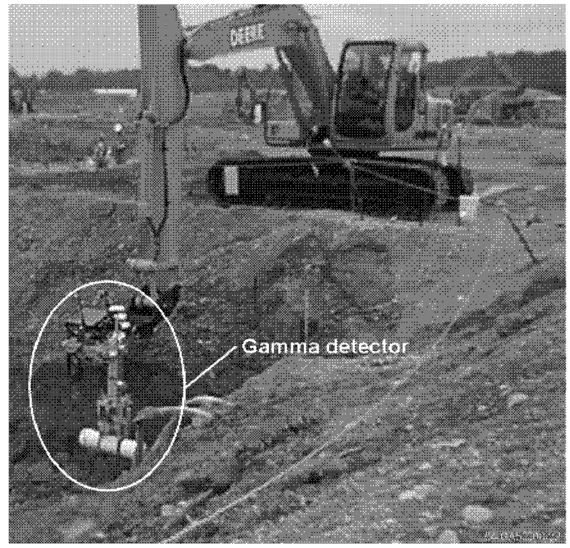

Figure 5-20. Gamma detector deployment method being used at Fernald.

Figure 5-21. Example of commercially available micro-filtration bypass system.

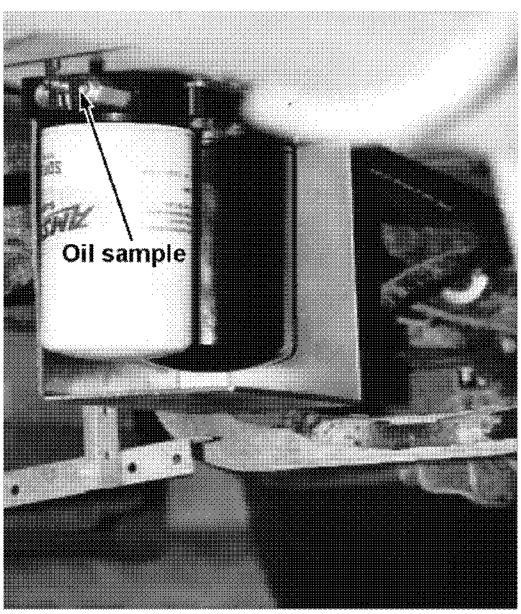

Figure 5-22. Example of commercially available oil sample location.

rupturing a sealed disc in the expellant gas cartridge. This pressurizes and fluidizes the dry chemical extinguishing agent in the agent storage tank. When the agent storage tank reaches a specific pressure it ruptures a burst disc and propels the dry chemical through the network of distribution hoses. The dry chemical is discharged through fixed nozzles and into the protected areas, suppressing the fire. When the system is activated, an interlock shuts down the excavator engine. The basic system consists of:

- Dry chemical agent storage tank(s)

- Expellant gas cartridge
- Distribution piping (hose) and nozzles
- Manual and automatic actuator
- Automatic detection system
- Various accessories.

5.2.2.10 Diesel Engine Exhaust Scrubber. The Gradall XL 5200 excavator is powered by a Cummins 6BTA5.9 turbocharged diesel engine rated at 174 peak hp at 2,100 rpm. This engine produces exhaust during operation that must be removed for two reasons. First, the diesel engine emits carbonaceous particulates that will rapidly clog the HEPA filters in the facility ventilation system. Second, noxious gas concentrations must be kept at or below safe values so that personnel working in the facility are able to use powered air purifying respirators. Three options for removing the exhaust gases and particulates were considered.

The first option is to directly vent the engine exhaust stream outside the facility. This would require designing and fabricating a powered ventilation system that attaches a hose directly to the exhaust pipe to prevent combustion products from entering the atmosphere of the retrieval enclosure. This system would require a HEPA filter on the air intake of the engine to ensure that contamination did not pass through the exhaust. It would also require a hose management system with dedicated personnel to manage the hose as the machine moves around inside the facility. This would not only restrict the freedom of movement of the excavator but would put additional personnel at risk.

The second option is to install a soot filter on the engine exhaust to remove the particulates and then to increase the facility ventilation to dilute noxious gases below acceptable concentrations. Soot filters that also have a catalyst to remove most unburned hydrocarbons (HC) and carbon monoxide (CO) are readily available. However, oxides of nitrogen (NOx) would not be reduced. The EPA limit for NOx emission for off-road equipment in this power category is 6.9 g/hp-hr. Using this emission value, an assumed average engine output of 150 hp, the facility volume of 1.77×10^6 ft^3, and the ventilation flow rate of 20,000 acfm results in a maximum steady state NOx concentration of 18.8 ppm (mole fraction as NO_2). This concentration would be reached in approximately 7 hours of continuous running after startup with zero initial NOx. For intermittent operation, it would take longer to reach 18.8 ppm. For example, if the machine operated for 4 hours, was shut down for 1 hour, and then operated for another 4 hours, the NOx concentration in the retrieval enclosure would reach 17.5 ppm, then decrease to 8.9 ppm, and then increase to 18.1 ppm. The time weighted average threshold limit value for NO is 25 ppm, but for NO_2 it is 3 ppm (ACGIH 2003). In the absence of data for the ratio of NO_2 to NO, it is conservatively assumed that a large percentage of the NOx is NO_2, especially since the CO oxidizing catalyst also oxidizes NO to NO_2. Based on these assumptions and calculations, the ventilation rate would have to be increased to 125,000 acfm to reduce the NOx concentration from 18.8 ppm to 3 ppm. The details of these calculations are recorded in EDF-4457, "Calculation of NOx Concentration in the Retrieval Tent for the Accelerated Retrieval Project at Area G of Pit 4 within the Radioactive Waste Management Complex."

The option of choice is to clean the exhaust of all offending emissions, which simplifies operations, reduces personnel risk, and avoids expensive capital equipment (ventilation components). Extengine Transport Systems of Fullerton, CA, offers an Advanced Diesel Emission Control (ADEC) system that removes particulates HC, CO, and NOx. The system consists of two units installed in the exhaust system.

- The first unit is a soot trap that filters and collects the particulates. The exhaust heat is used along with the excess oxygen in diesel engine exhaust to combust the carbonaceous particulates into CO_2. The unit also employs a fuel injector for additional heat. Additional heat is often required for machines that are not operating at a high duty cycle. The diesel is injected as needed when the exhaust back pressure detector indicates that the soot filter is becoming full. Ultra-low sulfur diesel and other fuel additives enhance this process so that 95% of particulates are removed.

- The second unit employs both selective catalytic reduction and selective noncatalytic reduction techniques with ammonia injection to remove HC, CO, and NOx. Automotive type catalytic converters do not reduce NOx in diesel engine exhaust because of the excess oxygen that is present. With the ADEC technology, the dissociated NOx does not re-oxidize. The ammonia is contained in an 8-lb low pressure (125 psig) tank that can be replaced without venting any ammonia. A single tank is expected to supply enough ammonia to operate the system for about a week, and the ammonia is completely consumed in the process so that none exits the exhaust pipe. ADEC systems have been installed on passenger buses and excavators including the Gradall XL 5200. They have been shown to reduce emissions of HC, CO, and NOx by 80%.

By removing 80% of NOx emissions, the calculated maximum facility concentration will reach 3.8 ppm instead of 18.8 ppm, based on the same assumptions as above. It is expected that NO_2 is less than 80% of the total NOx, which means the concentration of NO_2 is less than 80% of 3.8 ppm, which meets the 3 ppm limit. Specific data for the Gradall XL 5200 emissions will be determined in final design, and the exhaust gas will be analyzed after the ADEC system is installed in the machine to verify that the threshold limit of NO_2 is not exceeded. A schematic diagram of the ADEC system is shown below in Figure 5-23.

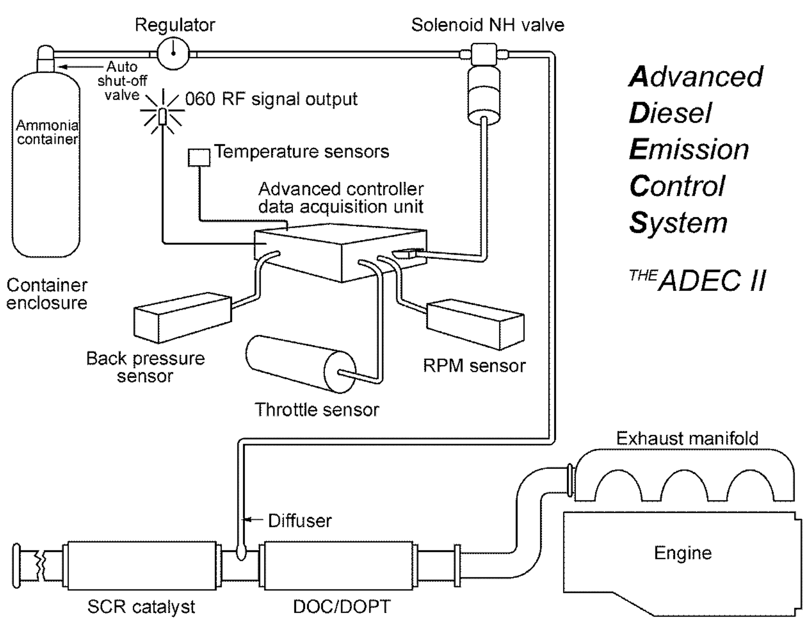

Figure 5-23. ADEC-II schematic diagram.

5.2.2.11 Chemical Compatibility. Testing performed as part of the Glovebox Excavator Method project indicated that carbon tetrachloride (present in the organic setups) is very damaging to some elastomeric compounds when it is present in high concentrations. For much of the equipment within the retrieval enclosure these concentrations are expected to be low. However, equipment located in close proximity to the digface (such as the excavator bucket and end of the boom) may see much higher concentrations of vapor, if not liquid carbon tetrachloride on occasion.

Therefore, only the hoses located in the last (farthest from the cab) section of the excavator boom will be compatible with high concentrations of carbon tetrachloride. Other excavator components such as the polycarbonate windows will be made of the standard components.

Additional operating data from Glovebox Excavator Method regarding the levels of carbon tetrachloride actually encountered will be evaluated to confirm that this approach is satisfactory.

5.2.3 Used vs. New Gradall XL 5200 Excavator

There are three options for obtaining a Gradall XL 5200 excavator: purchase a new one, purchase a used one, or purchase a combination of new and used. Each option has pros and cons. The delivery time for a new excavator would take approximately 160 days, which current schedule constraints do not allow. A used excavator can be purchased, but it would need to be retrofitted for the AR Project. A new excavator would have all the appropriate factory available options already installed at a lower cost than if they were purchased latter and retrofitted. A new excavator would also be equipped with remote operations capabilities installed at the factory. Retrofitting a remote operations system on a used excavator can cost substantially more and take significant time. Purchasing a used excavator allows the excavator to be at the retrieval site much sooner, but with potentially fewer of the needed options.

A used excavator has been chosen for purchase. If the need for remote operations is identified after retrieval operations are in progress, a new excavator will also be purchased.

5.2.4 Excavator End-Effectors

Various end-effectors will be required for the different operations performed by the excavator. Changing out an end-effector is usually as simple as loosening two nuts on the end-effector with a wrench on the bucket adapter quick-change coupling system available from Gradall. When the end-effector has additional hydraulics, they are manually connected to the extra hoses of the excavator. Hydraulic hoses from the end-effectors will consist of a stainless-steel braid with a Teflon liner rated for the working pressure of the excavator. Various end-effectors and auxiliary boom equipment will be used to excavate overburden and waste, transport it to and from the pit, and replace as appropriate. The rest of this section describes the end-effectors envisioned for the AR Project.

5.2.4.1 Bucket Adapter Coupler. Gradall offers a standard interface-bucket adapter coupling system for connecting to all end-effectors manufactured for their excavators. The bucket adapter uses two wedges that are positioned and held in place by tightening the two nuts located on the top of the adapter. To remove an end-effector it is fully curled and lowered to the ground, the two nuts are loosened, and the bucket adapter is curled out of the end-effector. To connect an end-effector, the bucket adapter is curled into the end-effector on grade, the end-effector is raised to ensure it is fully engaged, and the two nuts that position the wedges are tightened. The adapter also has a two-position pin location that allows a 135 to 165-degree rotation of the attached equipment. A hydraulically driven bucket adapter system is also

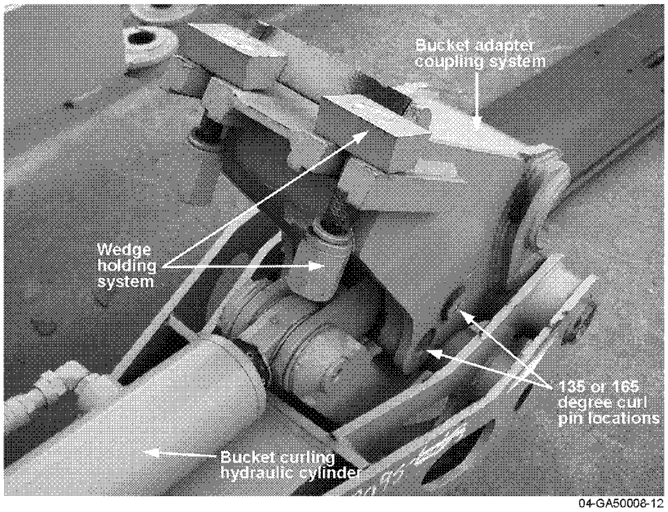

Figure 5-24. Standard Gradall bucket adapter coupling system.

available; however, this option will not be used due to the number of hydraulic hoses required for additional needed equipment (fixant spray or fogging system) and the ease of making connections to end-effectors. Figure 5-24 shows the bucket adapter, wedges, and tightening nuts.

5.2.4.2 Excavation Buckets.

Buckets will be used to remove clean overburden, potentially contaminated overburden, waste, interstitial soil, and underburden. A ditching style bucket with a 1-3/4-yd capacity will be used to remove overburden. This type of bucket ranges from 66 to 72 in. wide. Overburden soil can be removed in large quantities with little concern of contamination spread. The bucket can either be attached to the excavator backwards or the boom rolled 180 degrees for use in grading or front-end loader applications. Figure 5-25 shows a typical ditching style bucket.

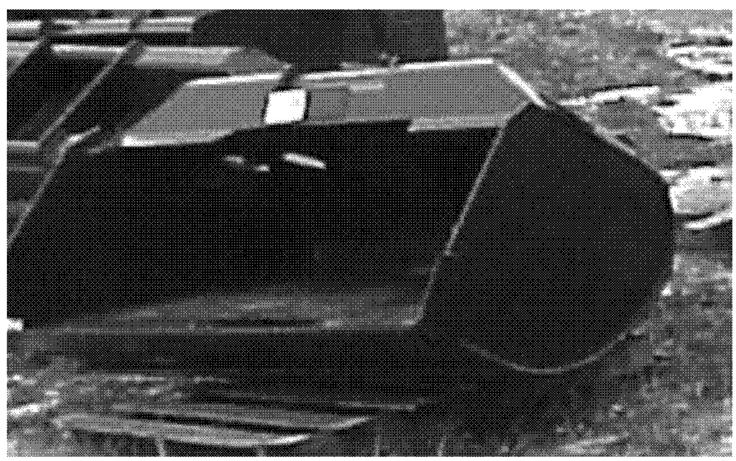

Figure 5-25. Ditching style bucket for removing overburden.

A ditching or excavation style bucket with a handling capacity of 1-1/4 yards will be used to remove waste zone material and underburden soil from Area G. This bucket will be designed to dump material into the SWBs. Figure 5-26 shows a typical ditching style bucket used for this type of operation.

A Bell hole bucket will be used to excavate waste zone material. This material requires sizing to fit into the SWBs and 55-gal drums. Bell hole buckets are shallow and wide to allow access into the bucket with either a hammer or other sizing tool. Figure 5-27 shows a typical bell style bucket with teeth, but teeth will not be needed or used in Area G. Material sizing will be completed while the waste is in this bucket. It will then be scooped out of this bucket by the waste zone bucket.

During excavation, interstitial soil will be inadvertently mixed with the waste seam. This soil will be retrieved and put into separate SWBs. The amount of this material will vary depending on the waste seam configuration. A smaller bucket will be used to retrieve this interstitial soil. Figure 5-28 shows a typical bucket that can be attached to the excavator to retrieve these soil pockets. The actual bucket size will be established in Title design.

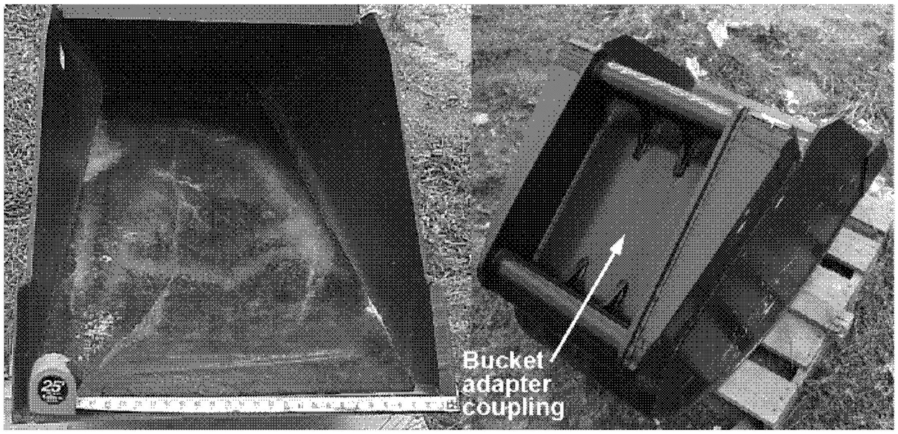

Figure 5-26. Typical ditching style bucket (front and top views) for removing and dumping waste zone material and underburden into SWBs.

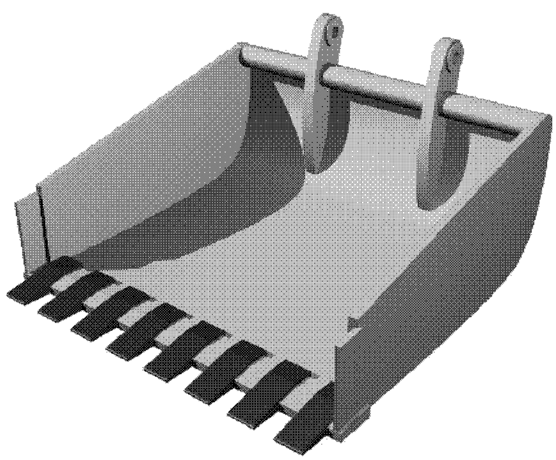

Figure 5-27. Typical bell hole bucket design with teeth.

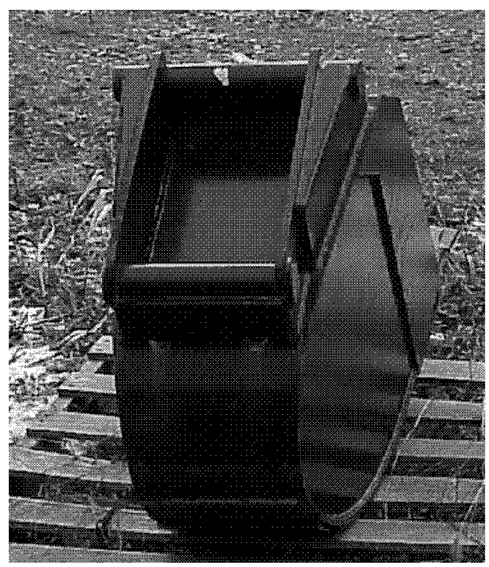

Figure 5-28. Typical small style bucket for removing interstitial soil in a waste seam.

An excavation jaw bucket will be required to pick up and place materials confined in 55-gal drums. This bucket is currently being used by the Glovebox Excavator Method project with great success. The jaw bucket can be used to size drum remnants and other materials and to place the materials into an SWB without having to change end-effectors. Jaw buckets, which are manufactured by Woods Wain Roy Manufacturing, have the ability to split and grapple drums or other materials. The jaw bucket has also been used to successfully size empty drums. The top half of the bucket is attached to a hydraulic cylinder so it can be opened and closed. In the closed position it functions as an excavation tool with a capacity of up to one-half yard and an opening dimension of up to 51 in. An interface coupling will be required to adapt to the Gradall bucket adapter. Hydraulic lines will be connected to the auxiliary hydraulic system located on the end of the boom. Figure 5-29 shows a typical jaw bucket and one of its functions.

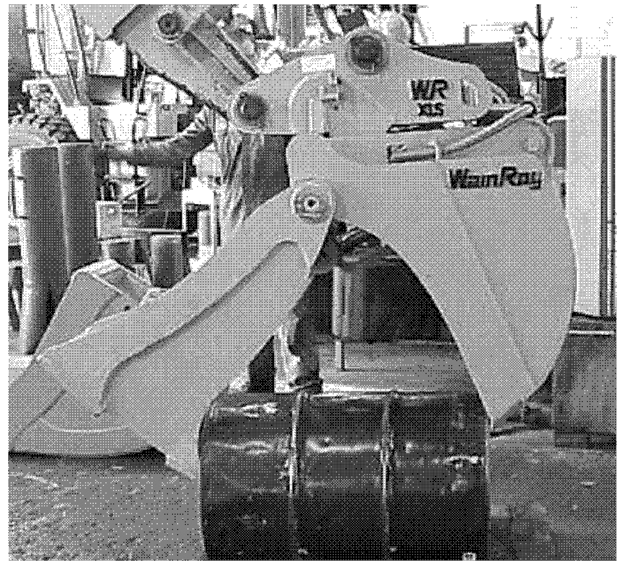

Figure 5-29. Typical jaw bucket used for multiple functions such as picking up a 55-gal drum.

5.2.4.3 Grading Blade. A grading blade end-effector is available from Gradall. This blade could be used to grade the working road base, backfill void areas, and smooth backfill returned to the pit. The grading blade couples to the bucket adapter in the same manner as other end-effectors and can be coupled for either push or pull type applications. Grading blades are manufactured in lengths up to 96 in. wide. Figure 5-30 shows a typical grading blade.

5.2.4.4 Shears. A shear end-effector will be required to reduce the size of various metal items buried in the pit. Drums may also need to be reduced in size with shears and/or other cutting device. Auxiliary hydraulics, which are required to operate the shear, are coupled to the connection on the telescopic boom section of the excavator. Figure 5-31 shows typical shear end-effector that can be attached to the Gradall XL 5200 excavator.

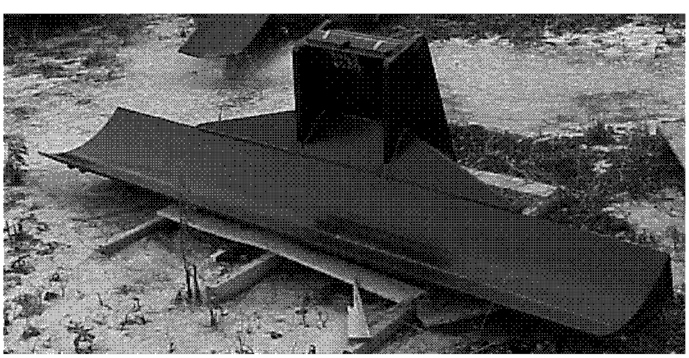

Figure 5-30. Typical grading blade used to fill and smooth soil.

5.2.4.5 Hydraulic Hammer. A hydraulic hammer end-effector will be required to size sludge drums and other waste zone materials, remove the drum ring, and size sludge that was stabilized by addition of cement. Hammer sizing will be based on impact energy class (200 to 500 ft lb is estimated to be sufficient), but may be a function of auxiliary hydraulic flow restrictions for other end-effectors. The hydraulic hammer currently being used for the Glovebox Excavator Method project is a 200 ft-lb energy class hammer providing

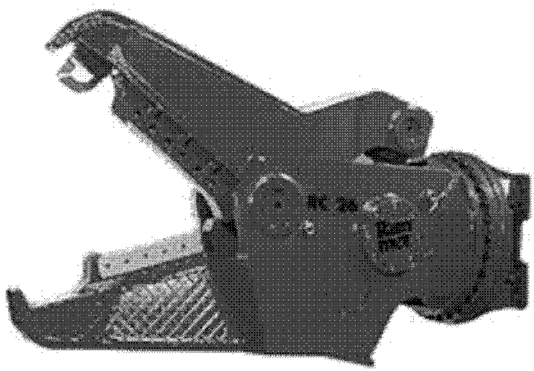

Figure 5-31. Typical shear end-effector.

satisfactory service. A silencing package will be required to reduce noise levels when in operation. Figure 5-32 shows the typical configuration of a hydraulic hammer end-effector on a Gradall excavator.

5.2.4.6 Grappler. A grappler end-effector will be used to grasp, segregate, move, and place waste zone items. The grappler uses a fixed thumb that mounts to the telescoping part of the boom assembly. The front thumb couples with the bucket adapter and opens and closes the grappler for grasping drums and other materials. Figure 5-33 shows a typical use for the grappler end-effector.

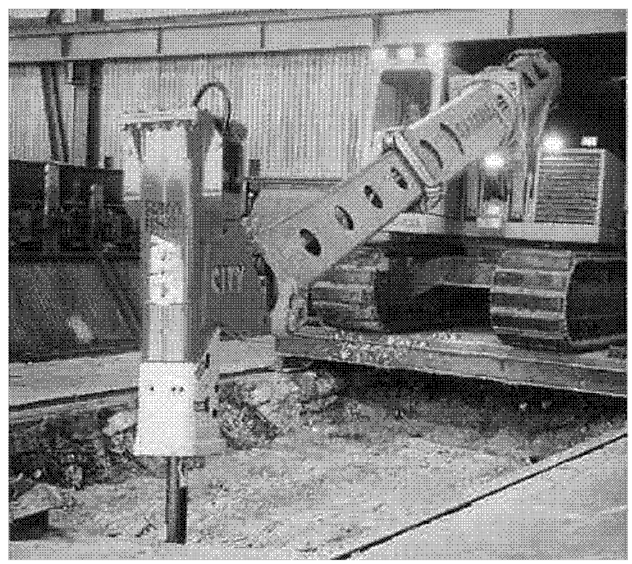

Figure 5-32. Typical hydraulic hammer end-effector attached to a Gradall XL 5200 excavator.

5.2.4.7 Ripper. A ripper end-effector will be used to remove objects from the waste seam. The ripper can be connected to the excavator in either direction and used in a pushing or pulling application. The angle of the ripper can be specified to suit project specific needs. The ripper can also be used for moving waste materials (drums, pipes, etc.) to areas where sizing can be performed. Figure 5-35 shows a typical arrangement of a ripper end-effector.

5.2.4.8 Scoring and Cutting Tool. A scoring and cutting tool end-effector will be required to score and open intact material encountered during excavation. Gradall offers a tool that provides this function. The drum scoring and cutting tool has a cutting face on one side with an additional finger protruding from the front face. The finger can be used for manipulating the excavated material so that the cutting edge can be deployed to open the item. The scoring and cutting tool has the bucket adapter interface, and can be attached for a pull or push application. The cutting face is sharpened from one side. Figure 5-35 shows the Gradall drum scoring and cutting tool. This tool is similar to one (diamond spade) already deployed in Glovebox Excavator Method.

5.2.4.9 Non-Sparking Puncture Tool. A non-sparking puncture tool end-effector will be required for venting intact drums before they are opened for waste removal. This tool, which will be developed with Gradall, will consist of a pointed aluminum rod that will couple to the bucket adapter coupling system.

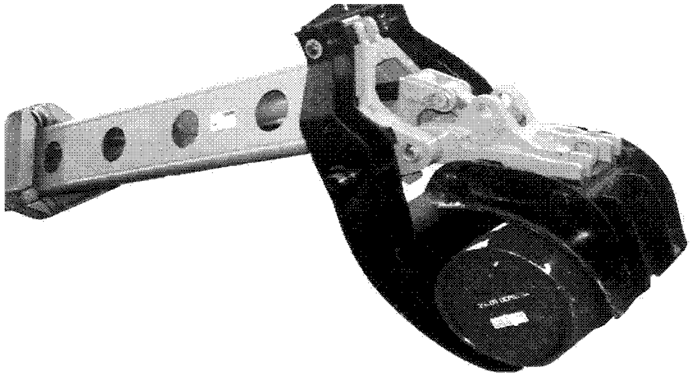

Figure 5-33. Grappler end-effector picking up a 55-gal drum.

5.2.4.10 Forklift Tool. A forklift tool end-effector with tines that can capture the various load types will be required for moving empty and filled SWBs, moving and dumping overburden soil boxes, moving skids or pallets, and returning SWBs to the pit area. Interface is also required for moving and potentially dumping soil bags. The 360-degree rotation capability of the excavator boom allows the dumping of captured SWBs. Potentially two forklift tool end-effectors will be required: a clean one to remove SWBs from the enclosure, and a dirty one to return the SWBs to pit. Gradall will develop the forklift tool; however, load/lock checks will not be installed onto the excavator. When the forklift tool is in use, personnel movements and work locations will be limited. The forklift tool will be quick coupled to the excavator using the same standard bucket adapter coupling system as other end-effectors.

5.2.4.11 Compactor/Tamper. A compactor/tamper end-effector will be required for stabilizing returned overburden soils in the pit area.

Figure 5-35. Gradall drum scoring and cutting tool.

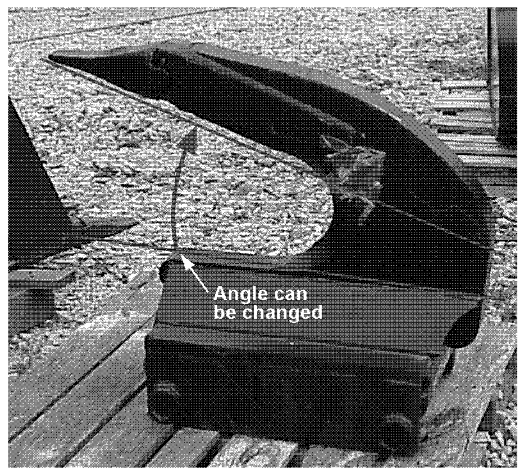

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Figure 5-34. Typical ripper end-effector.

Backfilled soils must be compacted to reduce subsidence issues in the excavated area after the waste has been removed. Soils placed around waste boxes returned to the pit, and the angle of reposed soils will need compaction. Gradall offers a coupling system mounted on the compactor to mate with the bucket adapter. Hydraulic lines will be connected to the auxiliary hydraulic lines on the end of the boom. Figure 5-36 shows recommended Gradall compactor/tamper end-effectors.

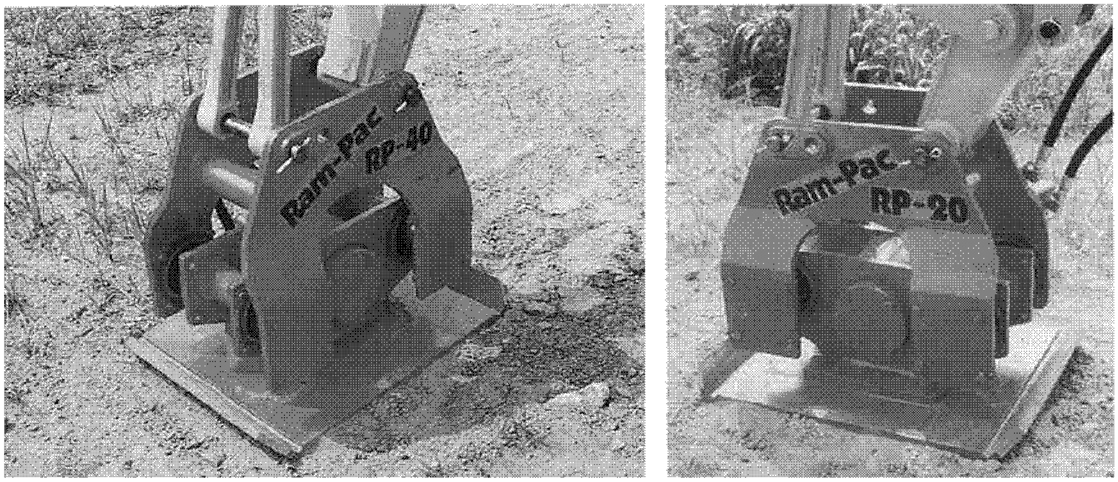

Figure 5-36. Typical hydraulic compactor/tamper end-effector.

5.2.4.12 Boom Extensions. Gradall offers three different lengths of boom extensions. These extensions connect to the telescopic portion of the boom system and increase the reach capabilities in 6, 8, and 12-ft intervals. These extensions can be installed and removed as needed for the excavation or transporting processes, and with other end-effectors as required. Figure 5-37 shows the various boom extensions offered by Gradall.

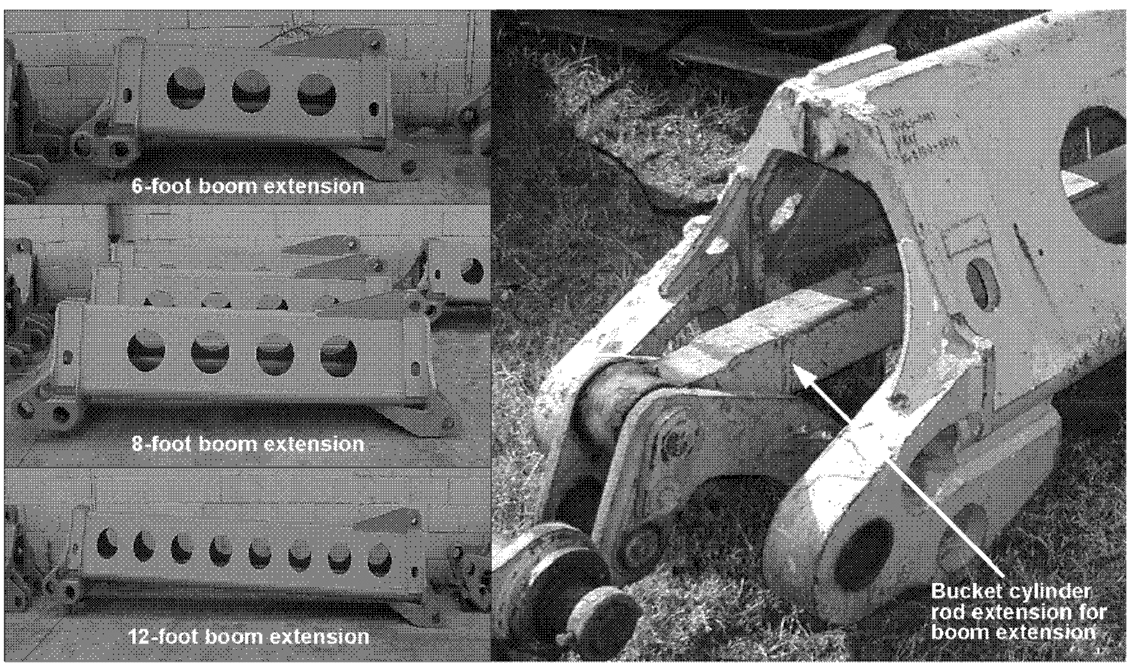

Figure 5-37. Boom extensions and equipment available for increased reach capacity.

5.2.4.13 Live Boom Extension. A live boom extension end-effector offers the flexibility of the conventional style knuckle boom excavator without the head-room height requirements. The live boom extension provides increased digging capabilities at long reaches opposed to the reduced digging capabilities at long reaches using boom extensions without it. The live boom extension uses the Gradall bucket adapter coupling system and connects to the auxiliary hydraulics to provide bucket curl functions. Versatility includes curling the boom under for reaching over objects and boom length excavation. The excavator can also dig closer to itself by curling the extension under. The live boom extension fits the 4000 (wheeled) and 5000 (tracked) series excavators. Figure 5-38 shows typical functions and capabilities of the live boom extension end-effector on a 4000 series excavator.

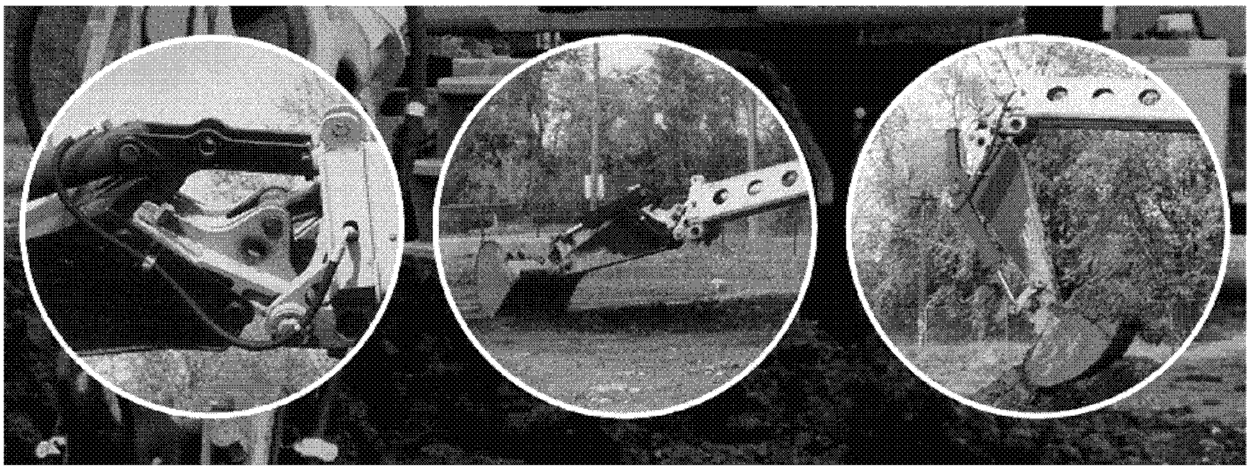

Figure 5-38. Functions of the live boom extension on a Gradall 4000 excavator.

5.2.4.14 Barrel Handler. Barrel handler end-effectors will be required to move and place 55-gal drums. Sludge drum waste will be put into barrels and moved out of the retrieval enclosure. 55-gal drums will be used in the Am Repackaging System and 85-gal over-pack drums may be used. A barrel handler will be required to handle clean drums filled with Am. Gradall offers a barrel handling end-effector for hazardous material operations that fits this application. The barrel handler features dual three-point lateral clamping with a 20 to 56 in. opening range. The clamping arms are Teflon coated to prevent metal-to-metal contact. The barrel handler uses the same bucket adapter coupling system to connect to the excavator. The drum handler is connected to the auxiliary hydraulic system for operation and will rotate through the full swing of the bucket adapter plate. The barrel handler will be used to remove filled drums and transport them to the airlock enclosure for removal from the retrieval enclosure. Figure 5-39 shows a barrel handler lifting a 55-gal drum.

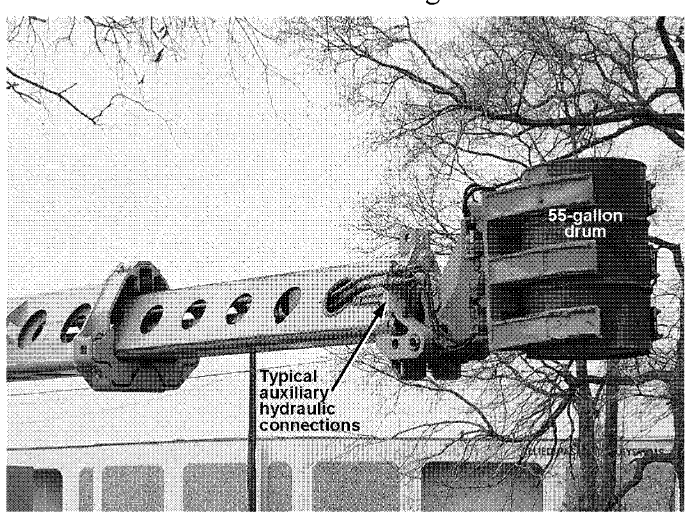

Figure 5-39. Barrel handler end-effector.

5.3 Forklift

A forklift may be advantageous for handling the SWBs in the retrieval enclosure. The process model (see Section 5.1.8) will be used in final design to determine if the excavator duty cycle will restrict its ability to move the waste boxes in addition to its other performance requirements. If a forklift is required, the preferred model is an all-terrain, 4-wheel drive, 4-wheel steering tele-handler (see Figure 5-40). This type of machine is versatile and could be used for additional functions such as dust suppressant spraying, if needed. The figure shows a 9,000 lb capacity tele-handler manufactured by JLG/Gradall. The specific one purchased for this project will be a used machine but will have similar functionality. In addition to 4-wheel drive and 4-wheel steering, the tele-handler will include options such as side shift and tilt of the fork carriage. The cab and operator seat will be modified to accommodate an operator in full PPE. Other modifications include the addition of exhaust scrubbing equipment and any other special functions such as dust suppressant spraying equipment.

Figure 5-40. Gradall G9-43A tele-handler.

5.4 Support Systems and Associated Equipment

This section describes the systems for transporting and fogging of excavated waste, Am packaging, dust suppression, and video monitoring inside the retrieval enclosure.

5.4.1 SWB Transportation and Fogging System

Three approaches to dust control are required when filling SWBs with waste zone material: the SWB must be mobile so it can be moved around within the enclosure for staging, filling, or removal; the dust must be suppressed (see Section 5.4.3) when material is dumped into it; and the contents must be weighed to ensure it does not exceed the 3,350-lb limit.

One way to meet these requirements is to design a mobile skid system that could be moved by the excavator. The skid system would include battery-powered dust suppression equipment and weighing and display equipment to provide the excavator equipment operator with the current SWB weight. An empty SWB would be placed on the skid system at the enclosure entrance, moved to the retrieval site, filled, and moved back to the entrance for removal from the enclosure. The attached dust suppression equipment could be maintained with appropriate fluids and battery packs while at the entrance. The skid could also be calibrated using a new SWB with a known weight at a location other than the actual filling location to limit potential worker exposure when performing that activity.

5.4.2 RH-TRU Packaging System

Some of the 741 sludge waste drums buried in the pit may contain Am-241 in quantities that preclude processing as contact-handled waste. When identified, these drums, or other material that is suspected to be TRU and has contact dose rates in excess of 200 mrem/hr, will need to be resized and placed into new 55-gal drums for eventual shipment to WIPP. The RH-TRU packaging system must be capable of funneling the RH, suspect TRU waste into new 55-gal drums, have built-in dust suppression capabilities or possibly portable shielding, and be able to weigh the drums. This system must also be portable so it can be moved by the excavator from the staging area to the retrieval site and back, when needed.

5.4.3 Dust Suppression Systems

Dust will be generated inside the retrieval facility by equipment tracking on the soil floor, excavating soil and waste from the pit, dumping material from the excavator bucket into SWBs, and returning soil to the pit. This section proposes methods for minimizing dust generation during these processes.

5.4.3.1 Equipment Tracking on the Soil Floor. After the top layer of clean overburden is removed from the retrieval area, the graded soil will be treated with a vinyl acrylic copolymer emulsion that binds the soil particles together so that a durable surface is available for operations. The product being proposed is Soiltac, manufactured by Soilworks, LLC in Gilbert, Arizona. After the graded soil is treated, the product will be mixed into the soil to a depth of 4 inches. When cured and compacted, a hard, dust free surface is produced that can support the operation of construction equipment. After a few months of operation, a topical spray may be reapplied to restore the surface if required. Retreatment would be applied using the Gradall fixant spraying system and the back side of a bucket or other attachment to compact the loosened soil.

5.4.3.2 Excavating Soil and Waste from the Pit. Soiltac will also be used to minimize dust while excavating soil and waste from the pit. The excavator will have spray nozzles on the boom to wet all exposed areas of waste and soil as the bucket is digging. The surface of the bucket contents will also be sprayed as each scoop is lifted. Additional spray equipment will be available to spray piles of overburden and the digface as needed. A topical application of Soiltac will produce a layer about one-fourth to one-half in. thick that will prevent dust becoming airborne in winds over 60 mph. Liberal application of the Soiltac solution as described should minimize dust generation during excavating operations. In addition, an atmospheric fogging system will be implemented above the excavation area to entrain any fugitive dust that becomes airborne. This fogging system uses water with a surfactant type of dust suppression agent added to improve its wetting capability.

Soiltac can be applied to the soil using any method suitable for applying water. The most common method is by spraying, which can be done by hand or by truck with large or small sprayers. A tractor and rototiller can be used to mix the product into the soil when needed. Initial soil floor application would be accomplished using standard application practices with reapplication being accomplished as described above.

5.4.3.3 Dumping Material from the Excavator Bucket into the SWBs. The main objective of dust suppression is to prevent dust from becoming airborne. This will not be possible when material is dumped from the excavator bucket into the SWBs; therefore, the dust that is generated must be abated.

This will be accomplished using a foaming dust suppression agent, which is more effective at capturing airborne particles than liquid spray, and does it with much less water. The product that is proposed is CDS-8040 Dust Buster, manufactured by Midwest Industrial Supply in Canton, OH. A skid-mounted mini treatment system is available from the factory that includes the air compressor and tank, chemical agent tank with metering pump, water pump, water and air flow meters, foam accumulator, gauges and controls, foam spray nozzles, and necessary tubing. This system requires 8 kVA of 3-phase 480 Vac power. The skid has a footprint of 5 × 4 ft and weighs 1,300 lb. It is designed to receive water from a 20 psi supply at 3 gpm. Therefore, a water supply for this application must be designed in-house. This is expected to be a small tank added to the skid that will be manually filled.

Fixtures to position foam dispensing nozzles will be placed near the top of the SWB. These fixtures will be designed into the SWB transportation skid discussed in Section 5.4.1. The nozzles will spray a blanket of foam over the entire top of and into each SWB such that the excavator bucket will be covered with foam when the contents are dumped. This should ensure that airborne particles captured and carried back down into the SWB. It is estimated that the total water added to the SWBs will be about one-half gal/yd^3 of soil/waste. Criticality analysis will be performed, but initial estimates are that this amount of water will have no effect.

5.4.3.4 Returning Soil to the Pit. Soil will be returned to the pit using two separate methods. Loose soil will be moved into the pit by either scooping and dumping with the excavator bucket or scraping with a grading blade installed on the excavator boom. The boxed and bagged soil will be returned to the desired locations and dumped. Both methods can generate airborne dust. The water fogging system will be used during this activity to capture the dust particles and remove them from the air. Additionally, when the excavator dumps or pushes soil into the pit, its spray equipment can be used to minimize dust generation. When dumping, containers will be carefully turned over to minimize soil agitation and kept as close as possible to the surface to minimize the falling velocity and distance. The excavator will be handling the containers when they are dumped, so its spray system can used to help minimize dust generation in this process, as can manual spraying, if required.

5.4.4 Video Monitoring System

A video monitoring system will be used to monitor the AR Project inside the retrieval enclosure for three important reasons. First, the video system will allow support personnel such as Operations, Industrial Safety, Radiological Control, and Safeguards and Security to monitor inside retrieval operations without actually entering the enclosure. This promotes ALARA and avoids the time and materials needed to suit-up for entry. Second, the video system will record the waste being removed. This will likely be necessary for security purposes and a visual record of the waste removed and loaded into the SWBs. Third, the video system will make it possible to remotely operate the equipment, should operating conditions require it.

The video system would likely consist of four stationary cameras, two mobile cameras, and a central receiving station. The stationary cameras will be wireless, battery operated units set on stands with weighted bases. With these features, the cameras can be moved about the retrieval area without relocating supporting cabling. A central receiving station would be set up in a clean area outside the retrieval enclosure to send control signals to the camera's pan, tilt, and zoom actuators, and to display the camera video transmissions. In addition, the central receiving station would also record the images on either VHS cassettes or DVDs. The mobile cameras will likely be mounted on the excavator and be monitored and controlled from the central receiving station. The mobile cameras will receive power from the excavator electrical power system while the stationary cameras will have batteries that will need to be swapped out and recharged on a periodic basis.

5.5 Site Development

Site activities performed to develop Area G for AR Project retrieval operations will include provisions for access to the site for both construction and operations. The project site and adjacent construction areas are to be filled with pit-run gravel and leveling course to accommodate the roads, enclosures, structures, and equipment required to perform pit excavation and associated operations. Site preparation actitivities will include:

- Upgrading existing roads and constructing new access roads, ramps, and parking areas with gravel base and leveling course
- Preparing gravel pads for the new enclosures and support structures
- Designing and constructing proper drainage away from all new enclosures and structures and modifying the existing storm water drainage system
- Preparing the needed utility systems
- Modifying the existing fence to control access to the new site.

5.5.1 Site Location

The project retrieval site is located within the SDA and designated as Pit 4, Area G. Area G lies parallel to and south along the existing SDA east-west access road (refer to Figure 1-2 in Section 1). The storage site will be north of Area G between Pad A and Pit 3 (see Figure 5-41). A new road will provide access between the the retrieval operations and storage site. Treatment and CCP operations will be sited to the south of the storage enclosures, between Pad A and Pit 3.

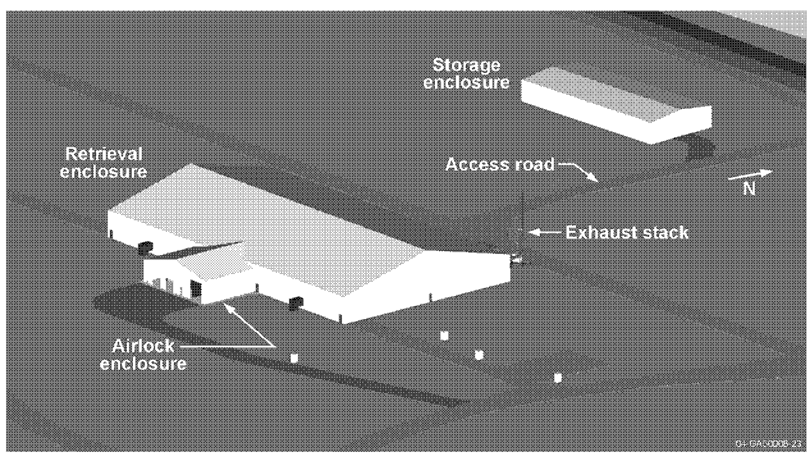

Figure 5-41. Selected retrieval enclosure concept for Area G.

5.5.2 Description of Existing Site

Area G comprises an approximately 202 × 110 ft area within Pit 4. Area G is bound on all sides by waste pits (Pit 6 to the west and Pit 10 to the south) or trenches to the north. Based on probing data, the depth to basalt in Area G is anticipated to range from 16 to 28 ft. An existing unit with three wells belonging to the Organic Contamination in the Vadose Zone (OCVZ) project is located to the southwest of Area G. An existing 15 kV ductbank feeding the OCVZ unit bisects Area G. There are six existing probes located in the northeast corner of the retrieval area.

5.5.3 Power

Currently, a 12.5 kV overhead line that originates at the Scoville Substation feeds the RWMC. An extension of this line has been located along the northern perimeter of the SDA. From this overhead line, an underground feed has been routed into the SDA to support the OCVZ project. A four-compartment pad-mounted switch has been located on Pit 4 to support two different areas with 12.5 kV electrical power. Because of its location, it will likely be moved to permit the construction of the retrieval enclosure. Once the pad is relocated, the current switch will be replaced with another configuration that has an additional switch to feed AR Project operations. The two current 12.5 kV feeds to the two OCVZ locations will have to be rerouted around the retrieval enclosure. A 15 kV mining cable will be routed from the switch to a skid mounted load center, which will be located near the AR facilities.

Given the relatively small electrical loads required for the storage enclosure and the limited access to normal electrical power at the SDA, the electrical feed to the storage enclosure come via mining cable from the main load center in the retrieval enclosure until treatment and CCP operations are online.

5.5.4 Communications

Presently, the area west of the main RWMC facility is not equipped with any capability for voice or data communications. The likely voice and data service to this area will be a combination of traditional cabling with wireless initiatives covering the work areas.

Traditional cabling will likely connect Area G via overhead placement through the current SDA phone line, with junction/terminal backplanes periodically placed for access. The backplanes would connect the enclosures via wireless or tank-grade cabling to provide for I-NET network access, FTS telephone service, and security and safety alarm or monitor placement as required.

5.6 Retrieval/Airlock Enclosure

To provide protection from the weather and control contamination, a retrieval and airlock enclosure (see Figure 5-42) will cover Area G during retrieval operations.

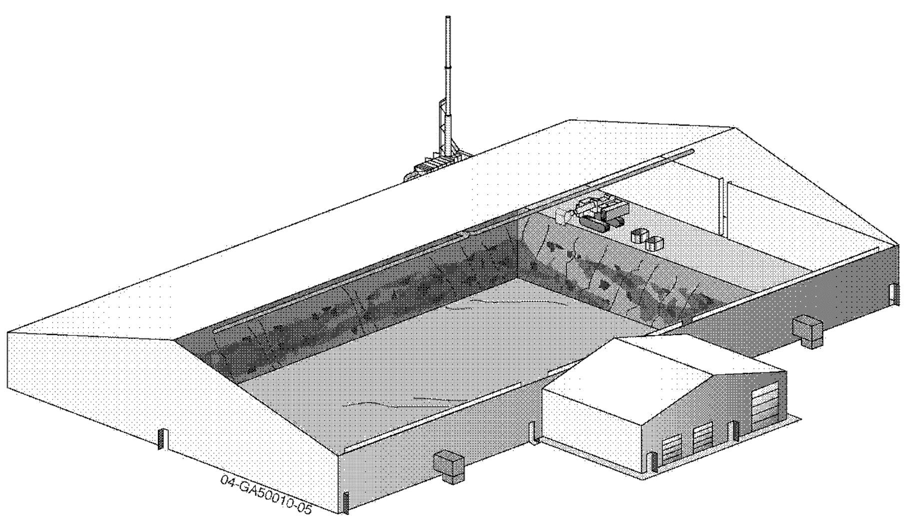

Figure 5-42. The retrieval enclosure will cover Area G during operations.

5.6.1 Layout and Architectural Design

The conceptual layout and architectural design of the retrieval/airlock enclosure (WMF-697) for the AR Project will provide space for retrieval operations, personnel access, waste container processing, and clean container staging. It will also provide weather protection for retrieval operations, container transfers, and personnel access. All retrieval operations will take place within the retrieval and airlock enclosures. Major mechanical and electrical equipment supporting the waste retrieval operations will be housed outside of the enclosures. The support systems that supply ventilation will be housed outside and adjacent to the retrieval/airlock enclosure.

5.6.1.1 Architectural Design. The retrieval enclosure dimensions are approximately 170 × 288 ft with 20-ft-high minimum interior clearance at the eaves. The enclosed retrieval area will have sufficient space to house retrieval excavator operations and waste container movements. The number and location of personnel exit doors will comply with the fire safety analysis. The retrieval enclosure will be tall enough to accommodate the required mobility of the excavator. The airlock enclosure will be sized to accommodate the construction of smaller herculite contamination control rooms for container sampling, closure, and decontamination operations and personnel ingress and egress. The airlock will have a 14 × 16-ft overhead door for large equipment access through the airlock into the retrieval area. The retrieval enclosure will have a 26 × 10-ft opening into the airlock for processing containers out of the retrieval area. The retrieval enclosure will be designed with expandable end bays to accommodate expanded retrieval operations into Area H, if targeted as a follow-on activity.

5.6.2 Structural Description

The retrieval and airlock enclosures will be supported by a prefabricated steel or aluminum framing. The retrieval enclosure perimeter foundation frame will be set on existing grade, leveled to obtain a perimeter seal. The airlock enclosure foundation frame will be set on a 4-in.-thick concrete pad. The framing will be covered with a commercially available fabric-tensioned enclosure consisting of an outer fabric membrane and an inner fabric membrane.

The retrieval enclosure structural frames will be designed to support snow and wind loads in accordance to the loading requirements of the DOE-ID AE Standard. The frames will also support negative pressure loading imposed by the enclosure ventilation system. The design will include an anchoring system to resist the horizontal or uplift forces imposed by the snow and wind loads. The anchoring systems for the retrieval enclosure may include soil anchors, precast concrete blocks, earthen berms or combinations of these. The airlock enclosure will be anchored to a 4-in.-thick, cast-in-place concrete pad.

5.6.3 Fire Protection

Standard, cartridge operated 20 lb portable fire extinguishers will be located around the perimeter of the facility. Several large (125 lb) wheeled units will be provided to cover the digface. They are equipped with 100 ft of hose. These will be repositioned as necessary.

5.6.4 Heating, Ventilation, Exhaust System, and Stack

The retrieval area will be heated by indirect-fired propane duct heaters to prevent ground freezing and for personnel comfort. Propane storage tank(s) will be installed at the job site and piped to the duct heaters. The size, location, and configuration of tank(s) will take into consideration requirements of the

NFPA and refueling opportunities. The airlocks will be heated by electric radiant space heaters for personnel comfort. Indoor design temperatures will consider PPE worn by personnel.

Exhaust ventilation provides a slight negative pressure inside the enclosure relative to the outside. A smoke test at the face of the roll-up door (frequency to be determined) will be performed by operations to ensure inward airflow.

5.6.4.1 Propane Tanks and Piping. Approximately four 1,000-gal propane tanks will be located at the SDA near the retrieval enclosure, based on the location of breathing air inlets. Propane will be piped to the retrieval enclosure to supply propane to the retrieval area heaters. The tanks will be located 25 ft. (minimum) from the retrieval enclosure and a minimum of 3 ft. from each other in accordance to NFPA 54, "National Fuel Gas Code," NFPA 58, "Liquefied Petroleum Gas Code." The piping will consist of a painted carbon steel, and the fittings will be welded to prevent leakage. The tanks will be ASME code stamped and have pressure relief devices and piping in accordance with the NFPA and ASME. The tanks and piping will be protected in accordance with the NFPA and, at minimum, will have Jersey Barrier or equivalent. Access will be provided for tanker fueling of the propane tanks and will be per the NFPA. Only qualified persons trained in proper handling and operating procedures will be allowed to transfer LP-Gas to and from propane tanks.

5.6.4.2 Retrieval Area Heating. An in-direct fired, draw-through, power-ventilated, LP gas-furnace will be used to heat the retrieval area. The in-direct fired heat exchanger will prevent the propane, flame and combustion products from entering the ventilation air stream and retrieval area. The heater will have an integral power vent system that provides metered combustion air. The heater will also have a spark-ignited intermittent pilot and a single-stage 24-volt gas valve. Each unit will have all the required limit and safety controls including a vent pressure switch, which verifies power vent flow prior to allowing operation of the gas valve. The heaters will be installed in accordance with the NFPA 54, "National Fuel Gas Code" and NFPA 70, "National Electric Code."

An exhaust fan with two series of dioctylphthalate (DOP) in-place testable HEPA filters will be used to exhaust the enclosure. Exhaust inlets will be located on the bottom of the north end of the enclosure to provide a sweep of air across the digface. The exhaust system will also prevent VOC build-up at the ridge of the roof. Inlet filters in the air feed to the indirect-fired propane heaters that service the retrieval area will be American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) 52-76 filters. No filters will be provided for airflow into the airlocks, as this will occur when the outside roll-up doors are opened.

An exhaust stack of sufficient height to ensure worker safety and a proper emissions monitoring configuration will be provided. The stack will be placed on a concrete base and structurally supported as required. To comply with ARARs, the ventilation system will have an emissions monitoring system to sample and record possible releases of radioactive substances. This system will extract a sample that is proportional to the total stack flow. This flow is filtered and the amount of radioactive material is quantified. Using this quantity, along with the total stack flow and the total sample flow, the total quantity of radioactive substances released to the environment can be determined.

5.6.5 Power and Lighting

As discussed previously, electrical power will be delivered to Area G via a 12.5 kV underground line and above ground switch. One compartment of this switch will feed a 15 kV mining cable, which will terminate at a central skid-mounted, main load center. At this load center, the 12.5 kV feed will be reduced to 480/277 Vac. From the main load center, the 480/277 Vac electrical power will be distributed to various loads that use 480/277 Vac and to local load centers for further reduction to 208/120 Vac for fans, heat, lighting, and various equipment uses. The electrical power distribution system will make extensive use of flexible cords and cables as opposed to conductors in conduit to reduce cost, support operations, and permit relocation of the AR facilities.

The AR Project will not have standby power. Emergency power for life safety systems will be provided by self-contained, battery-backed units intended for use in these systems as required by NFPA 101, "Life Safety Code."

Determining the grounding system for the project required major considerations. First, the soil characteristics and ground penetration limits at the project site presented challenges in obtaining an effective grounding system to meet requirements. Second, the grounding system must be relocatable, since the entire AR Project complex will likely be moved to other locations in the SDA. To address these two considerations, a grounding system similar to that of the Glovebox Excavator Method project will be used. Materials will consist of four precast concrete slabs with internal electrodes. One slab will be located at each corner of the enclosure structure. In addition to grounding electrodes, these slabs can also serve as ballast. The electrodes will be connected with a grounding electrode conductor. This grounding electrode conductor will be bonded to the metal framework of the enclosures and to the secondary of the load center transformers.

The lightning protection system will likely be similar to the one used on the Glovebox Excavator Method facility. A series of air terminals will be located along the top ridge of each enclosure. These air terminals will be mounted on base plates and bonded to the enclosure trusses.

Lighting in the retrieval enclosure will be both fixed and mobile. Adequate fixed lighting will be installed to permit operators to safely walk throughout the retrieval enclosure. This fixed lighting will be initially located within the retrieval enclosure and remain in place during the entire retrieval operation. To facilitate relocation, the lighting may be fastened to the metal framework of the enclosure or located on stands. Either way, electrical power will be supplied to the lighting using flexible cable. Additional mobile lighting will be provided as necessary to assist in excavation, retrieval, and container handling operations. Fixed lighting will also be located in the airlock enclosure. Some lighting will be provided with battery backup to facilitate egress.

5.6.5.1 Load Requirement. Table 5-3 contains a listing of the anticipated loads for the AR Project along with estimated power requirements for each load. Not all of these loads are likely to operate simultaneously. The heating, which is actually two 12 horsepower fans for gas heaters, will not operate in warm weather and each support trailer will not likely require a full 25 kVA. However, because the transformers normally come in certain standard sizes, a 500 kVA unit is anticipated for the main load center. As final design progresses, a 300 kVA unit may be adequate. The downstream load centers are expected to be in the 35 to 75 kVA range.

5.6.6 Radiation Exhaust Monitoring

To comply with ARARs, the ventilation system will have an emissions monitoring system to sample and record possible releases of radioactive substances. This system will extract a sample that is proportional to the total stack flow. This flow is filtered and the amount of radioactive material is quantified. Using this quantity along with the total stack flow and the total sample flow, one can readily calculate the total quantity of radioactive substances released to the environment.

Table 5-3. Normal power for the AR Project.

Load	Power (kVA)
Retrieval enclosure ventilation (1 × 50 hp motor)	50
Retrieval enclosure heating (2 × 12 kVA units)	24
Retrieval enclosure lighting (6 × 1 kVA)	6
Retrieval enclosure instrumentation (2 kVA allowance)	2
Emission monitoring system (4 kVA, Mfr info)	4
Airlock lighting (3,000 ft^2 × 2 w/ft^2)	6
Airlock equipment (3,000 ft^2 × 1 VA/ft^2)	3
Foaming system (1 × 8 kVA unit)	8
Scrubber system (1 × 10 kVA unit)	10
Support trailers (8 × 25 kVA)	200
Treatment (combined package estimate)	120
Storage enclosure lighting (92,000 ft^2 × 0.25 w/ft^2)	23
Storage enclosure ventilation (1 × 8 hp motor)	8
Storage enclosure equipment (2 kVA allowance)	2
Total	466

5.7 Storage Enclosures

Storage enclosures will be used to store SWBs awaiting analysis, SWBs awaiting transfer to WIPP, and possibly grouting operations of SWBs intended for return to the pit.

5.7.1 Layout and Architectural Design

The storage enclosures are designed to provide weather protection and storage of stacked SWBs containing waste retrieved from Area G. Each storage enclosure (see Figure 5-43) will have sufficient space to house staged SWBs awaiting sample analysis, stored SWBs intended for transfer to WIPP, and possibly, grouting operations of SWBs intended for return to the pit. These commercially available, standard tensioned fabric structures are approximately 65 × 150 ft with 20-ft-high minimum interior clearance at the eaves.

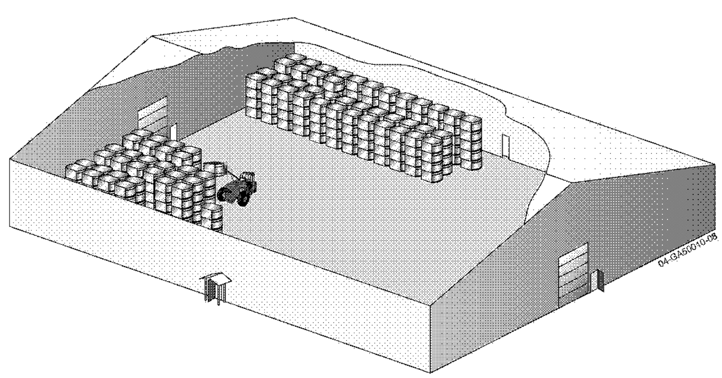

Figure 5-43. Storage enclosures will be used to store SWBs and possibly house grouting operations.

The major mechanical and electrical equipment supporting the storage operations will be housed outside of each enclosure. The number and location of personnel exit doors will comply with the Life Safety Code (NFPA 101).

5.7.2 Structural Description

Each enclosure will be constructed of a prefabricated steel or aluminum frame covered with an outer fabric membrane. The perimeter foundation frame will sit on existing grade, leveled to obtain a weather seal. The interior floor will consist of compacted crushed gravel bed graded to drain moisture away from contents stored inside each enclosure. Each storage enclosures structural frame will be designed to support snow and wind loads in accordance to the loading requirements of the DOE-ID AE Standards (DOE-ID 2004). An anchoring system will be provided to resist the horizontal or uplift forces imposed by the snow and wind loads. The anchoring systems may include soil anchors, precast concrete blocks, earthen berms, or combinations of these.

5.7.3 Fire Protection

Portable fire extinguishers will be provided throughout the storage enclosure; automatic fire detection will also be provided.

5.7.4 Ventilation

The storage enclosures will be ventilated as required to prevent lower exposure limit levels of VOC accumulation. Air inlets will be filtered with ASHRAE 52-76 filters. Exhaust filters will not be provided.

5.7.5 Power and Lighting

Electrical power for each storage enclosure will be used to primarily support lighting and ventilation. The fixed lighting will be similar to that of the retrieval enclosure (see Section 5.6.5). The lighting may be fastened to the metal framework of the enclosure or located on stands. Either way, the lights will be supplied with flexible cable. For better illumination, the equipment that is used to transport the SWBs will have onboard lighting. A limited number of receptacles will be positioned within the storage enclosure to support operations and maintenance activities.

Storage enclosures will get power from the main load center of the retrieval enclosure area due to the relatively small electrical loads required and the limited access to normal electrical power at the SDA.

5.8 Support Trailers

Miscellaneous trailers will be setup near Pit 4 to support AR Project activities. These will include a men's change trailer, women's change trailer, sample support trailer, operations support trailer and fissile material essay system trailer. Each trailer will have its own power distribution panel, receptacles, phone systems, and lighting. Trailer functions and uses are described below.

5.8.1 PPE Change Trailers

Separate men's and women's change trailers will provide an area where workers can don and doff PPEs. These units will have space for PPE storage and lockers for the workers.

5.8.2 Sample Support Trailer

The sample support trailer will house the sample fissile material monitor, sample glovebox, sample storage refrigerator, and storage cabs for summa canisters.

5.8.3 Operations Support Trailer

The Operations support trailer will have offices for the AR Project coordinator, Radiological Control (RadCon), Industrial Hygiene, and Environmental, Safety, and Health (ES&H) workers. This unit will also house the monitors for visual observation of retrieval activities in the enclosure and have minimal lab capabilities. Workers can use this trailer to perform daily paperwork and onsite miscellaneous lab functions.

5.8.4 Fissile Material Assay System Trailer

This area will be setup for nondestructive assay and examination operations.

5.9 Fissile Material Assay

Material that is contaminated with TRU at levels less than or equal to 100 nCi/g and has PCB contamination below threshold levels will be returned to the pit. However, conversations with a number of suppliers have indicated that the design, procurement, testing, and demonstration of an assay system that measures the concentration of TRU in SWBs with sufficient accuracy is not feasible, given the schedule of the AR Project. Therefore, at a minimum, the material that is retrieved from Area G must either be assayed to ensure it can be stored in a critically safe manner, or it must be stored in a critically safe geometry, which will require a very large storage area. These same suppliers also believe that a less precise system could be developed that would ensure the fissile content of the SWBs is below acceptable limits (less than 380 g per container, including measurement uncertainties). Various technologies have been proposed, ranging from active/passive neutron interrogation to gamma spectroscopy; each technology has advantages and disadvantages. Common to all the technologies, however, is the fact that the retrieved material is not similar to any of the better segregated and characterized waste streams that have been previously encountered in other stored waste processing campaigns. In particular, the containers are larger, the waste matrices are less characterized, and they are quite dense. Procurement specifications will be written to both establish the accuracy requirements and specify demonstration testing to be performed to ensure the requirements are met.

5.10 VOC Treatment of TRU Material

TRU material that fails GGT will require treatment before it can be shipped to WIPP (see Figure 5-44). One waste type that has been disposed of in Area G is know to present problems during GGT. It has been assumed that LTTD of this waste will be sufficient to reduce gas generation to acceptable levels for transportation to WIPP. The development work for the process will be started in FY 2005 (at the earliest) to confirm that removal of VOCs will be sufficient to pass GGT and establish the design basis for the system. This development work is expected to take about 6 months, and will be followed by design and procurement of the system. Containers that have failed GGT will be stored until this system is available.

> Development work for the VOC treatment system will begin in fiscal year 2005, at the earliest; system design and procurement will the development activities.

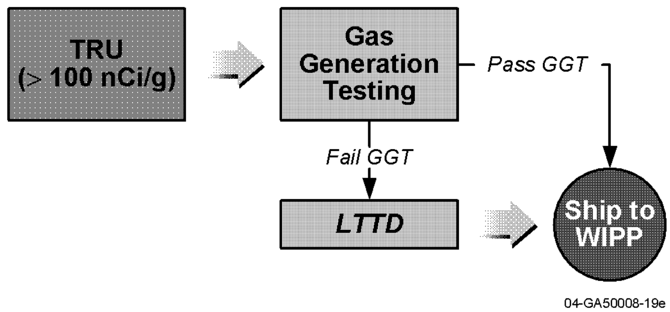

Figure 5-44. TRU waste that fails GGT will be treated using LTTD.

5.10.1 Waste Composition

An inventory of the waste buried in Area G indicates that about 700 drums (5,300 ft^3) of organic setups (also called 743 sludge) and special setups (744 sludge) were placed in the pit. These organic setups are a mixture of organic liquids that were stabilized with calcium silicate. The solidified material has been described as having the consistency of paste or grease (DOE-ID 1982). The organic liquids were a mixture of Texaco Regal Oil; carbon tetrachloride; 1,1,1 trichloroethylene; and other volatile and semivolatile organic contaminants. Data developed for the geographic area of Pit 9 at the SDA indicated that the composition of the organic setups is as shown in Table 5-4. Each 55-gallon drum was estimated to contain about 30 gal of organic wastes (roughly 375 lbm). Other sources (INEEL 1999) indicate that as much as 37 gallons of organic liquid were added to a drum.

Table 5-4. Composition of the organic setups expected in Area G.

Compound	Approximate Weight Percent In Organic Setups
Carbon tetrachloride (CC_{14})	40%
Trichloroethylene (C_2HC_{13})	10%
Tetrachloroethylene (PCE) (C_2C_{14})	11%
Trichloroethane (TCA) (CH_3CC_{13})	9%
Texaco Regal Oil	10%
Calcium silicate	20%

Data from the 3100 m^3 Project indicated that as many as 53% of the stored containers of the organic setups exceeded the total gas generation rate shipping criteria for transport to WIPP. The actual chemical interactions of this waste are not well understood but it is expected that the VOCs are contributing to the excessive gas generation. It is currently being assumed that removal of the VOCs will be sufficient to reduce the gas generation rates to acceptable levels. If more organic material must be destroyed to pass GGT, a much higher temperature, more complex treatment system will be needed.

5.10.2 Treatment Process

A variety of treatment technologies could be used to treat waste containers that have failed GGT, including incineration, high temperature thermal desorption, LTTD, chemical oxidation, and bioremediation. Each of these technologies was evaluated to determine a treatment technology for Area G. The incineration and high temperature thermal desorption would destroy any combustible material in the waste, remove all VOC contaminants, and destroy PCBs and other organic compound with higher boiling points, such as the Texas Regal Oil. However, these technologies were eliminated because the associated systems are complex, expensive, difficult to permit, and will likely encounter more community resistance. Bioremediation was eliminated because the development is expected to be a protracted effort. Consequently, LTTD was selected as the treatment technology for the waste failing GGT. The LTTD system is expected to remove the VOC contamination from the waste. However, LTTD does not destroy the VOCs themselves, meaning an additional treatment step will be required. LTTD will not remove PCBs to any appreciable extent and will not remove the Texaco Regal Oil. The LTTD process is described in the rest of this section.

Material will be retrieved from the disposal area and packaged in SWBs. SWBs that fail GGT will be transferred to the LTTD treatment area, which will be located near the retrieval site. Connections for air supply and exhaust from the SWBs will be made using the 3/4-in. national pipe thread fittings that are located on the sides of the SWBs (normally for filtered vents). Strap-on heaters (similar to the flexible heaters used for heating 55 gallon drums) will be attached to the SWB to provide a source of heat. The SWB and its contents will be heated to about 250°F. This will take an undetermined number of days.[b] Heating the contaminated material to about 250°F is expected to evaporate the organic contaminants in the waste to an extent that the container will pass GGT.

The VOCs in the organic setups have boiling points spanning that of water, so some of the water contained in the material will also be evaporated. The VOC and water vapors will be swept from the SWB in a low volume flow air stream using a regenerative blower. The regenerative blower provides relatively high vacuums and relatively high flow rates and the reduced pressure will increase the evaporation rate. The lines from the SWB will be heat traced to prevent condensation of the water or VOCs. The flow from the SWB will be filtered using a single HEPA filter to remove particulate contamination (especially the transuranic contaminants) from the stream to prevent contaminating the downstream equipment. The actual quantity of VOCs contained in the SWB is uncertain because the contents of the SWB will probably be a mixture of organic setups, soil, drum debris, and possibly other debris as well. Assuming the entire inventory is available, there is over 200,000 lbm of VOCs. Distributing this inventory over the estimated number of SWBs containing VOCs (380, assuming a mass of soil equal to the original mass of content Code 3 containers is also contaminated), results in over 530 lbm of VOCs per SWB. Note that only the TRU fraction of these SWBs will require processing. In reality, some unknown fraction of these organics has escaped to the environment. If half of the inventory remains, there is about 100,000 lbm of VOCs to treat. Assuming that half of the SWBs are TRU and that each of the SWBs takes 5 days to heat to 250°F, and arbitrarily setting the number of SWBs being

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b. Calculations performed for 55-gallon drums of these organic setups indicated that the time needed to raise the centerline temperature to 80°C (176°F) was on the order of 4 to 30 days, depending on the pressure. Heat transfer in the SWB is expected to be even worse if the matrix consists of soil, waste, and pockets of air, as is likely. A more efficient heating method using heated augers to both mix and heat the material would provide much better heating and reduced process batch times, but was rejected due to the additional material handling that would be required. Other heating methods, such as microwave, were also rejected as more complex than necessary.

processed at one time to 10, the operating duration for this process would take 190 days. Assuming half the VOC inventory remains, the required throughput, in VOC mass, is 530 lbm per day.

Several technologies are available for treating the VOC and water vapor stream from the SWBs, including:

- Some form of oxidation, probably catalytic oxidation, as is being used in the OCVZ project
- Adsorption on granulated activated carbon (GAC)
- Condensation and collection for offsite treatment.

If half of the VOCs are to be treated, direct adsorption on the GAC is not an attractive option, due to the large amount of GAC that would be generated (probably on the order of 10,000 ft^3). The catalytic oxidizer is a more capital cost intensive option as compared to simply condensing the vapors and treating them off site. The OCVZ project is currently using such an oxidizer, but the estimated concentrations of VOC contaminants from the SWBs are higher than that system can handle. Using the OCVZ systems may be reevaluated as more data regarding the actual contamination levels in the retrieved waste becomes available from Glovebox Excavator Method. For the purposes of this conceptual design, the condensation and collection of the vapors option has been used.

Thus, after the initial filtration step, the VOCs and water vapor will pass to a condenser where the organics and water will be condensed and collected in a tank. The majority of the organics are relatively insoluble in water so they are expected to separate, under gravity, to produce a tidy organic stream that will be collected in drums for offsite treatment. The HEPA filter upstream of the condenser is expected to reduce the level of radioactive contamination substantially, so they may even be suitable for disposal at commercial sites. The organic phase will be pumped to a holding tank, from which it can be pumped to suitable containers.

It is assumed that the condensed water could contain up to 1% of the incoming organics, so the aqueous condensate will be pumped to an adsorption system consisting of two beds in series. A Bonifiber bed would be used as an initial sorption step to separate organics from water. Bonifibers will adsorb 25 times their weight in organics, such as oil and similar organics, but are not suitable for halogenated organics. A GAC filter will be used to remove halogenated organics from the water. For the low flows anticipated in this application, canisters of activated carbon can be used. The spent carbon will also be sent off site for processing.

After passing through the GACs, the remaining air and water vapor pass through a final two-stage HEPA filter and blower and are exhausted out the stack.

It must be noted that this design is based on a number of assumptions regarding the quantity of VOCs remaining and the extent of the contamination. Data from the Glovebox Excavator Method project will be very valuable in helping to establish the expected process conditions of the retrieved waste.

Finally, development work is required to verify container heat-up rates, that desired VOC removal can be attained to allow containers to pass GGT, and provide better estimates for processing times.

5.10.3 Treatment System Construction

The LTTD system consists of several skid-mounted units that will be fabricated and tested off site, shipped to Area G, and constructed at a location near the retrieval area. The site preparation for this system is minimal. A concrete pad will be constructed for placing the equipment skids. Electrical power and potable water will be provided at the edge of the pad. A simple steel structure will be provided to support a steel roof for limited protection from the elements.

5.11 TRU Waste Management Approach

The AR Project will undertake activities necessary to develop the capability to ship retrieved pre-1970 buried TRU waste to WIPP. Implementing this capability ensures compliance with DOE Order 435.1-1, "Radioactive Waste Management Manual," and ensures that legacy waste is not created that will have to be dealt with in the future.

The AR Project TRU waste management approach includes the characterization and disposition of retrieved TRU waste. TRU waste management in this project includes numerous issues that require solutions. The project is developing an aggressive plan to work these issues early; DOE support at all levels is required to secure a favorable resolution. This section discusses the AR Project's approach to complying with regulations concerning retrieval and characterization of TRU waste, dispositioning the retrieved TRU waste, and resolving the various issues associated with TRU waste characterization and disposition.

> The AR Project is developing an aggressive plan to ensure that TRU waste retrieved from Area G is shipped to WIPP in compliance with regulations.
>
> Accomplishing this plan will depend on successfully resolving the following issues:
>
> - Waste stream assignment
> - Regulatory compliance risks
> - Availability of nondestructive examination and assay systems
> - Sampling approach
> - Centralized characterization project.
>
> These issues are being worked early in the process to assure resolution.

The key objectives of the TRU waste management approach will be to achieve the following:

- Develop approaches that comply, or can be negotiated, with WIPP on characterization of buried TRU waste
- Develop required acceptable knowledge for any waste contained within defined retrieval areas
- Minimize the degree of segregation of TRU waste required during retrieval operations
- Establish a sampling approach that can be implemented at the digface vs. sampling after packaging
- Perform assessment of nondestructive examination and assay systems to ensure disposal can be achieved
- Use the national WIPP CCP capability to perform characterization, certification, and transportation functions.

5.11.1 Compliance Approaches for Characterization of TRU Waste

Retrieval and WIPP characterization of buried TRU waste presents unique challenges new to the WIPP regulators and the waste generator. The need to limit worker exposure and maintain a high level of operational throughput must be balanced against WIPP regulator characterization requirements. The three major WIPP compliance approaches being developed are:

- **Waste Stream Definitions after Retrieval.** The waste streams, as disposed, are not the waste streams that will be retrieved. Commingling occurred during disposal and subsequent 30 year weathering and storage. Additional commingling will occur during retrieval. Full segregation into original waste streams is not possible. However not performing a limited segregation could result in increased characterization costs. For instance, if a test category waste (waste containing VOCs) is not identified, then potentially all TRU material within a retrieval area could be classified as test waste and require expensive and time consuming GGT.

  Although retrieval by the excavator can really only achieve segregation into two forms (interstitial soil and waste and interstitial soil), acceptable knowledge could be used for a defined retrieval area to determine summary category groups and test category waste for a specified batch from a defined retrieval area. Confirmation of the waste stream occurs using sampling results, RTR, and visual examination (VE). This approach has not been used before and will require WIPP regulator approval.

- **Solids and Soil Sampling.** To increase efficiency, sampling before packaging is desirable. A pit sampling strategy that addresses commingled soil and solids before packaging has not been performed before. Coring or sampling the retrieved waste is expensive and time consuming. Possible sampling strategies include preretrieval coring, collection during retrieval, or collection from each waste container.
- **Waste Characterization and Waste Stream Confirmation.** Technologies will be identified that best meet WIPP objectives and regulator acceptance for waste characterizations and waste stream confirmation. The ability to characterize limited segregated material is unknown. The ability to determine prohibited items, waste material parameter contents, and waste material parameter weights is uncertain. In addition, the ability to assay varying densities at the levels required by WIPP requires further investigation. It is not known how the regulatory community will accept the technological limitations that may exist.

5.11.2 Waste Disposition Approach

The characterization of retrieved pre-1970 buried TRU waste for disposition at WIPP presents unique challenges. The focus has been on stored, post-1970 waste forms that are containerized, well segregated, and for which characterization systems have been developed. The current regulatory compliance documents for WIPP do not specifically address the unique issues associated with buried TRU waste. These issues include presence of commingled waste forms, loss of original containment resulting in repackaging of waste, and availability and capability of nondestructive examination (NDE) and nondestructive assay (NDA) systems to characterize intermixed dense waste forms.

Near-term activities will be focused on developing acceptable knowledge for generators of waste disposed in areas that will be retrieved. This will include the Rocky Flats Environmental Technology Site, INEEL, and other offsite generated waste. This acceptable knowledge information, coupled with the results from the Glovebox Excavator Method project, will provide the means to develop technically defensible approaches to addressing WIPP requirements in the areas of waste stream assignment and development of sampling approaches that are performed at the retrieval site (as opposed to after repackaging). This information will also support other evaluations including verification that waste forms are compatible with the TRUPACT-II shipping container and the development of a waste certification strategy.

The existing INEEL ICP TRU programmatic documents and procedures will be expanded to include development of a quality assurance project plan and several procedures to support sampling during AR Project startup and performance of the initial retrieval. A WIPP quality surveillance is planned at the end of FY 2004 to provide increased confidence that methods used to segregate retrieved waste and samples taken during retrieval operations will comply with WIPP requirements.

The national WIPP CCP mobile capability for performing waste characterization, certification, and transportation functions will be used as an alternative to establishing INEEL capability. This approach will result in a faster, more cost-effective approach than attempting to reestablish an INEEL certified program. During FY 2004, evaluation of CCP capability will be completed and a statement of work completed to allow implementation and fielding of the CCP capability at RWMC in FY 2005.

An assessment of information management needs will be completed. This assessment will address data collection, review, validation, and reporting functions necessary to qualify waste for shipment to WIPP. This assessment will also integrate with planned or existing CCP capabilities. The assessment will consider a wide range of possible information management approaches including a full paper system, semi-automated system, and fully automated system. Consideration for the life-cycle management of the records will be addressed in the assessment. Additional considerations will include expected retrieval production rates, waste volumes, certification, and transportation service providers.

5.11.3 Issues Associated with Characterization and Disposition of Buried Transuranic Waste

The following issues must be addressed to prepare the buried TRU waste retrieved from Area G for disposal at WIPP.

- **Waste Stream Assignment.** The assignment of waste streams for the volume of pit waste must be based on acceptable knowledge gathered from past generator records and then confirmed through waste characterization techniques such as RTR, VE, headspace gas sampling and analysis, solids sampling and analysis, and radioassay. Because of expected commingling of the retrieved waste, the delineation of the waste into the assigned waste streams by segregation and confirmation techniques will require regulator approval.
- **Regulatory Compliance Risks.** The overall approach for assigning a limited number of waste streams at a hierarchy that is above the waste matrix code level may be contrary to the intent of the WIPP Waste Analysis Plan (WIPP 1989), and it is unknown whether this strategy will be accepted by WIPP regulators. Additionally, compliance with the WIPP contact-handled WAC and Waste Analysis Plan currently requires identification of waste material parameter weights, including estimates of cellulosics, rubber, and plastics. The commingled nature of the waste may technically preclude the use of RTR and/or VE to determine these parameters with any reasonable confidence.

The ongoing development of acceptable knowledge for pre-1970 Rocky Flats waste and planned evaluation of RTR capabilities will provide the information necessary to address this concern.

- **Availability of Nondestructive Examination and Assay Systems.** The availability of NDE and NDA systems for examination of SWB is uncertain. The heterogeneity of the waste may also reduce the effectiveness of available NDE and NDA systems for the required qualitative and quantitative measurements.
- **Sampling Approach.** Proposed sampling methods have not been previously attempted at other sites nor approved by WIPP regulators. Because of expected commingling of waste streams, the representation of the various sampling locations will be uncertain.
- **Centralized Characterization Project Availability.** The INEEL currently lacks the equipment and resources necessary to fully characterize and certify TRU waste for shipment to WIPP, and would therefore require the assistance of the WIPP CCP. Because of the uncertainty of the expected needs and demands for TRU waste characterization and certification services throughout the DOE complex, the availability of CCP to support the Area G retrieval schedule is uncertain.

5.11.4 Summary

Significant issues related to the characterization of TRU waste retrieved from Area G for acceptance at WIPP need to be resolved. Waste characterization activities are significant contributors to cost and schedule. Unfavorable outcomes of these issues could result in characterization cost contributing to 50% or more of project cost and adding several years to the schedule. The project is developing an aggressive plan to work these issues early, but will need DOE support at all levels to secure a favorable resolution.