3.7 Electrical

Power to the glovebox excavator project structures is supplied from the existing 12.47-kV power line that provides all electrical service to the Radioactive Waste Management Complex. The line has been upgraded several times within the last 10 years and has the capacity to supply the needs of the glovebox excavator project, in addition to the loads presently supplied. The line loading subsequent to commissioning the glovebox excavator project facility will have additional capacity for a reasonable amount of future growth. The Advanced Mixed Waste Treatment Facility (AMWTF) currently being designed by BNFL will require power far in excess of the capacity of the existing 12.47-kV line. It is anticipated that the 138-kV line will be extended to the AMWTF location.

Electrical System Highlights

- Existing power line supports project
- Standby generator system is available on-site
- Distribution skid is available

Lighting is provided as necessary in the WES, the RCS, and the PGS. Most areas are illuminated with fixtures containing Metal Halide lamps. Metal Halide was chosen because of its color rendering qualities, making it an excellent choice for video illumination. Additionally, it is a High-Intensity-Discharge lamp that can deliver light to the dig face from its installed location at the top of, and outside of, the RCS. Self-contained, battery-backed fixtures specifically designed for emergency use, in accordance with NFPA 101, *Life Safety Code*, provide emergency exit lighting.

Grounding at the glovebox excavator project site posed numerous problems. After much research and consultation, a Ufer Grounding System was chosen. In place of driven electrodes, the Ufer ground, along with several plate grounds, provides adequate path to ground for proper grounding of electrical systems, electrical equipment, and fault current. A ground resistance test will be performed to verify and document the grounding system performance.

A lightning protection evaluation of the previous facility indicated the need for a lightning protection system. A thorough review and evaluation will be performed during the title design phase and, if necessary, a lightning protection system will be provided. Due to the nature of the structure, i.e., the fabric skin, a standard lightning protection system comprised of numerous air terminals and down conductors is not feasible.

Table 3-3 shows the voltages that are provided for distribution in the structure.

Table 3-3. Voltages provided for distribution in the structure.

Normal (commercial) Power	Optional Standby Power
480—3 Phase	480—3 Phase
480—1 Phase	480—1 Phase
277—1 Phase	277—1 Phase
208—3 Phase	208—3 Phase
208—1 Phase	208—1 Phase
120—1 Phase	120—1 Phase

The need for uninterruptible power or conditioned power has not been established, thus, it is not provided.

3.7.1 Load Requirements

Normal power, shown in Table 3-4, for project activities is supplied from the 12.47-kV line via the existing power distribution skid. Standby power (Table 3-5) is supplied from the 12.47-kW line when available and the loads are automatically transferred to the trailer-mounted, optional, standby generator upon loss of normal power.

In addition to the loads provided by the ISV Skid and the standby generator, the PPE Trailer and the Fire Water Riser Building are located outside the SDA and require power from another source. Although this does not affect the evaluation of the skid and the standby generator, the anticipated load must be factored into the overall load increase projected for the RWMC. The trailer has a floor area of approximately 720 ft^2, and it contains showers, which require electric water heaters, in addition to electric space heating. A conservative estimate for these activities is 20 watts per square foot. Therefore, a load of 14.4 kW must be factored into the load projection for the RWMC. This load consists of resistive space

Table 3-4. Normal power from the distribution skid is provided to these loads.

Normal Power	
WES heat	105 kW
WES lighting	9 kW
WES duct heaters (humidity control)	20 kW
PGS	5 kW
Breathing air compressor	27.1 kW
Dry fog system air compressor	51.8 kW
Instrumentation and control	10 kW
Miscellaneous loads	13 kW
Standby power loads	106.5 kW
Total	374.4 kW

Table 3-5. Standby Power from the trailer-mounted standby generator is provided to these loads.

Standby Power	
WES lighting	25 kW
WES ventilation	22.5 kW
WES Heat	25 kW
Instrumentation and control	25 kW
Miscellaneous loads	9 kW
Total	106.5 kW

heating and resistive water heating, and will be a unity power factor. The load is 14.4 kVA. The Fire Water Riser Building requires lighting, heat, and miscellaneous 120-V loads. The total load for the building is estimated to be 6 kW.

Under normal operating conditions, both normal and standby power are supplied from the power distribution skid. At a minimum, normal power supply is capable of supplying the total normal and standby power required. The normal power supply is capable of supplying 482.5 kVA, which includes a 25% growth factor. The 500-kVA transformer mounted on the skid is sufficient to handle the anticipated load plus future growth.

3.7.2 Main Power Supply

The 12.47-kV line that feeds the RWMC originates at the Scoville Substation, located at the Central Facilities Area (CFA). It also feeds several small loads, including the rest area on State Highway 20, the gun range, and the Experimental Breeder Reactor 1 (EBR-1). The line transitions from overhead to underground in the northwest portion of the RWMC. The TRU Waste Characterization and Storage Facility Project upgraded the line in the early 1990s. The upgraded line was rated at 5,000 kVA. A subsequent project installed the necessary components to further increase the capacity to 8,200 kVA. Although this equipment has not been put into service, the capability of supplying 8,200 kVA exists.

Power Management records indicate the peak load experienced on the line was 1,810 kW in January, 1998. The interface agreement with BNFL indicates that 1,000 kW of power is available for their activities on the Advanced Mixed Waste Treatment Facility before installation of a substation dedicated to that facility.

The glovebox excavator project requires 366.3 kW supplied from the 12.47-kV line. The total expected load on the 12.47 kV-line will be 3,176 kW. An overall 0.9 power factor is assumed therefore, 3,529 kVA is required. The existing 12.47-kV line at RWMC has sufficient capacity to supply the anticipated glovebox excavator project load with no modifications.

The power skid was initially designed and procured for another project, but was never used for its intended purpose. It is available to supply power for the glovebox excavator project. The skid consists of a high voltage switch, a 500-kVA transformer, and a 480-V distribution panel. The distribution panel is an 800-A panel, with a 600-A main circuit breaker. Branch circuit breakers consist of one 600-A, 3-pole breaker, three 80-A, 3-pole breakers, and one 40-A breaker. Additional circuit breakers are readily available if required.

The skid is supplied from the 12.47-kV overhead line through a 15-kV mining cable routed above the ground to the skid. The transition to the mining cable is located at pole 42-129-16. This pole is equipped with fused cutouts, and it will be used for transition from the overhead to the mining cable. Additional cable is required to supply the skid at its new location.

The main feed to the WES facility uses the 600-A, 3-pole, branch breaker. The two air compressors, a 25-hp breathing air compressor and a 50-hp compressor for the misting system, are located in the vicinity of the skid and are fed from the skid. The breathing air compressor is supplied from a new 50-A, 3-pole circuit breaker, and the misting system compressor is supplied from a new 100-A, 3-pole circuit breaker.

3.7.3 Grounding

A portable power skid supplies the power for the glovebox excavator facility. The skid consists of a high-voltage, fused switch; a 12,470- to 480-V, three-phase transformer with a delta primary winding and a wye secondary winding; and an 800-A distribution panel. The National Electrical Code requires that the skid be grounded.

A portable standby generator will supply standby power to the facility. This generator must also be grounded. Soil characteristics, as well as ground penetration limits in the SDA, impart challenges for obtaining an effective grounding system to meet the requirements.

A thorough investigation of the site, the NEC, and published information on ground systems provided a limited number of options for obtaining an effective grounding electrode system under the limitations encountered at the glovebox excavator facility area. These options are presented in the following paragraphs, and a combination of the options is proposed for obtaining an effective grounding system. The final proof of the effectiveness of the installed system will be provided by a ground resistance test, to be performed once the installation is completed.

The two grounding electrodes used for the grounding scheme are plate electrodes and concrete encased electrodes. The plate electrodes consist of two plates, which are placed in the ground as deep as possible, close to the corners of the power skid. These plate electrodes are installed in accordance with paragraph 250-52(d) of the NEC. The second electrode is a precast concrete slab placed in contact with the ground in the vicinity of the ramp over the rails. Slab construction meets grounding quality specifications, and it is placed prior to ramp construction. Grounding electrode conductor runs from the concrete-encased electrode to the ground bus.

3.7.4 Optional Standby Power

Applicable codes and standards do not required a standby generator for life safety systems, however, a generator will be provided for contamination control and defense in depth. The generator is classified as an optional standby generator, as specified by NFPA 70, *National Electrical Code*. NFPA 110, *Emergency and Standby Power Systems*, is used as a guide for the design and will be recommended for use as a guide in performance of preventative maintenance activities. Emergency power for life safety systems required by NFPA 101, *Life Safety Code*, is provided by self-contained, battery-backed units intended for use in those systems.

Under normal conditions, power to the designated standby loads is provided by the normal power system. Upon loss of normal power, a start signal is sent to the generator. When adequate voltage is available at the standby terminals, the transfer switch automatically transfers the designated loads to the standby generator. After normal power has been restored, stabilized, and synchronized, the loads are automatically transferred back to normal power. The generator is shut down after the recommended cool-down time.

The generator is trailer-mounted, and generator power is supplied by a diesel engine. The assembly has an integral fuel tank. Engine block heaters are provided for the diesel engine, and the fuel is blended to accommodate temperature changes.

The breathing air compressor is provided with an air storage tank sized to provide sufficient air for safe egress of workers on breathing air in case of loss of normal power or compressor failure. Standby power is not provided for the breathing air compressor.

3.7.5 Lightning Protection

Conventional lightning protection technology consists of air terminals spaced at regular intervals of approximately 20-ft around the perimeter of the building. The air terminals are connected together with a large-gauge copper wire. At one or more points, the grid is connected to ground. A structure as large as the WES requires numerous air terminals. Each of these terminals requires connection to the steel structure and penetration through the fabric. Additional fabric penetrations are required to secure the copper cables. During a lightning strike, tremendous amounts of current passes through the conductors. This results in electromagnetic fields, which cause the cable to move violently. If the cable is not securely fastened, the resulting movement could cause damage to the structure or injury to personnel standing close to the conductors. This type of lightning protection system is known as a passive, or neutral system. The air terminals are placed where lightning is most likely to strike.

To minimize the number of fabric penetrations, an active attraction system is under consideration for the WES. The system consists of early streamer air terminals, which serve to intercept lightning discharges at a preferred point, earlier than conventional lightning protection systems. The system operates by launching an upward streamer to capture and control the main lightning downleader, in preference to competing potential strike points on the structure.

3.7.6 Lighting

Interior and exterior lighting is provided for the glovebox excavator project facility. Exterior lighting is limited to area illumination in the vicinity of the power distribution skid, the optional standby generator, the air compressors, and around the personnel and equipment doors of the WES. Exterior lighting is supplied by fixtures equipped with metal halide or high pressure sodium lamps. The fixtures are controlled by switches and photoelectric cells. Fixtures equipped with metal halide lamps supply the bulk of the interior lighting. High-bay fixtures supply general area lighting in the WES. The average illumination is designed to be 50 foot-candles, with the fixtures located to optimize light in work locations. Fixtures are switched individually or in small groups to increase efficiency and provide the capability of switching off fixtures that cause glare in particular instances.

Lighting in the RCS is designed to provide an average illumination of 70 foot-candles. Fixtures are arm-mounted, square fixtures suspended above Lexan panels in the roof of the RCS. Fixtures are concentrated over the excavation area to provide adequate illumination in the dig area. Lighting calculations take into account the losses through the Lexan panels. Fixtures are switched individually or in small groups.

Lighting in the PGS is similar to the scheme used for lighting the RCS. Fixtures are of lower wattage, and the number of fixtures is adequate to supply 100 foot-candles of light on the work surface. Calculations take into account the losses through the Lexan panels. Fixtures are switched individually. In all interior locations, selected fixtures are provided with a quartz restrike system, which provides a reduced amount of illumination if a power outage or voltage dip occurs and extinguishes the primary arc.

3.8 Instrument and Control System

The glovebox excavator project instrument and control (I&C) system ensures worker safety, environmental protection, and process effectiveness. The I&C system consists of four subsystems:

- Facility monitoring and control
- Radiological, emissions, and criticality monitoring
- Fissile material and final drum assay monitoring
- Closed circuit television (CCTV) monitoring.

Each of the four subsystems is described in greater detail in the following paragraphs.

The Instrumentation and Control system of Glovebox Excavator Method will enhance safety and effectiveness of operation.

- Protect personnel from hazardous conditions
- Display operating conditions at operator control stations
- Support process improvements with flexibility and ease of changes
- Enhance operator skills

3.8.1 Facility Monitoring and Control

A programmable logic controller (PLC) is used for overall facility monitoring and control. The PLC monitors operating conditions such as pressure differences across confinement barriers and ventilation system flow. The PLC also receives inputs from hazard monitoring equipment and automatically generates predetermined outputs to ensure people and the environment are protected. For example, if airborne contamination is detected, personnel both inside and outside the WES are notified.

The PLC is capable of controlling a wide variety of electrical signal input and output modules. Engineers and technicians at the INEEL find the PLC programming language easy to use and understand, so programming support is always readily available.

Further, PLC operator interfaces are industrial hardened and have graphics that operators find easy and quick to read accurately.

Finally, the PLCs are extremely flexible. The software can be readily changed under the control of a software configuration management plan. Should the need for different inputs and/or outputs become necessary, the PLC hardware can be readily reconfigured as necessary.

3.8.2 Radiological, Emissions, and Criticality Monitoring

Based on knowledge of the nature of the waste zone material being removed in the project, radiological monitoring equipment is essential to operator safety and environmental protection. The three radiological monitoring subsystems are:

- Radiological monitoring for personnel safety within the WES
- Emissions monitoring for environmental safety
- Criticality monitoring for personnel safety in the glovebox excavator project area.

Radiological Monitoring. The glovebox excavator project design team has made an extensive effort in system, structure, and component (SSC) design to protect operators from process hazards, but potential radiation hazards still exist. For example, while there are historical records of the waste zone material that indicate the material can be handled by personnel at the gloveboxes, there is still a potential to encounter a higher than expected gamma radiation source. Should this happen, radiation area monitors (RAM) located near operator stations ensure that operator exposure is within acceptable limits. Once a predetermined exposure rate has been exceeded, the RAM will alarm, and the operator will leave the area. Support radiological personnel will determine on a case-by-case basis how to resolve these abnormal events.

Again, the design team has invested significant effort in confinement area design to ensure containment. However, the potential risk of contamination escape from the confinement SSCs still exists. Should a most unlikely release of radioactive contamination into the operator areas of the WES occur, continuous air monitors (CAMs) detect the airborne radioactive particles and alarm. Procedures require operators to evacuate to a predetermined safe area. Again, support radiological technicians will determine how to most effectively resolve this unlikely abnormal event.

In addition to the possibility of airborne contamination, contamination may be present on an operator's skin, clothing, or shoes. Personnel contamination monitors (PCM) are available and can conduct a complete whole body survey in less than few a minutes. In addition, hand held friskers are located at key locations, such as the gloveboxes. Operators are required to frisk their hands when they remove them from the gloves to verify that no contamination has passed through the gloves onto the operator's hands.

With the RAMs, CAMs, PCMs, friskers, and supporting equipment, there is a complete system to ensure operators are protected from radiological hazards and any contamination is detected and quickly contained.

The INEEL has used the above equipment extensively. Operating and calibrating procedures already exist. Only minor modifications will be necessary to these procedures to accommodate the Glovebox Excavator Method Project.

Emissions Monitoring. Environmental protection includes HEPA filters on the ventilation exhaust from the excavation facility. While a system has been incorporated into the RCS design to control dust, contamination will inevitably be drawn into the ventilation stream. Particles in the ventilation exhaust will be removed by the HEPA filters.

To quickly detect any excess radioactive stack emissions, a stack emissions monitoring system detects any high levels of emissions. If a high level of emissions is detected, all operations will cease and appropriate actions will be taken. Support radiological support personnel will then take appropriate actions.

Criticality Monitoring. Although a criticality in the RCS and gloveboxes is extremely unlikely, it is not incredible. Therefore, a criticality alarm system (CAS) is deemed to be necessary, and designed to detect any postulated criticality within the retrieval structure.

Figure 3-38 shows several important CAS features. First, the detector enclosure actually houses three detectors. A CAS must detect the criticality, but it must also avoid costly false alarms. The three

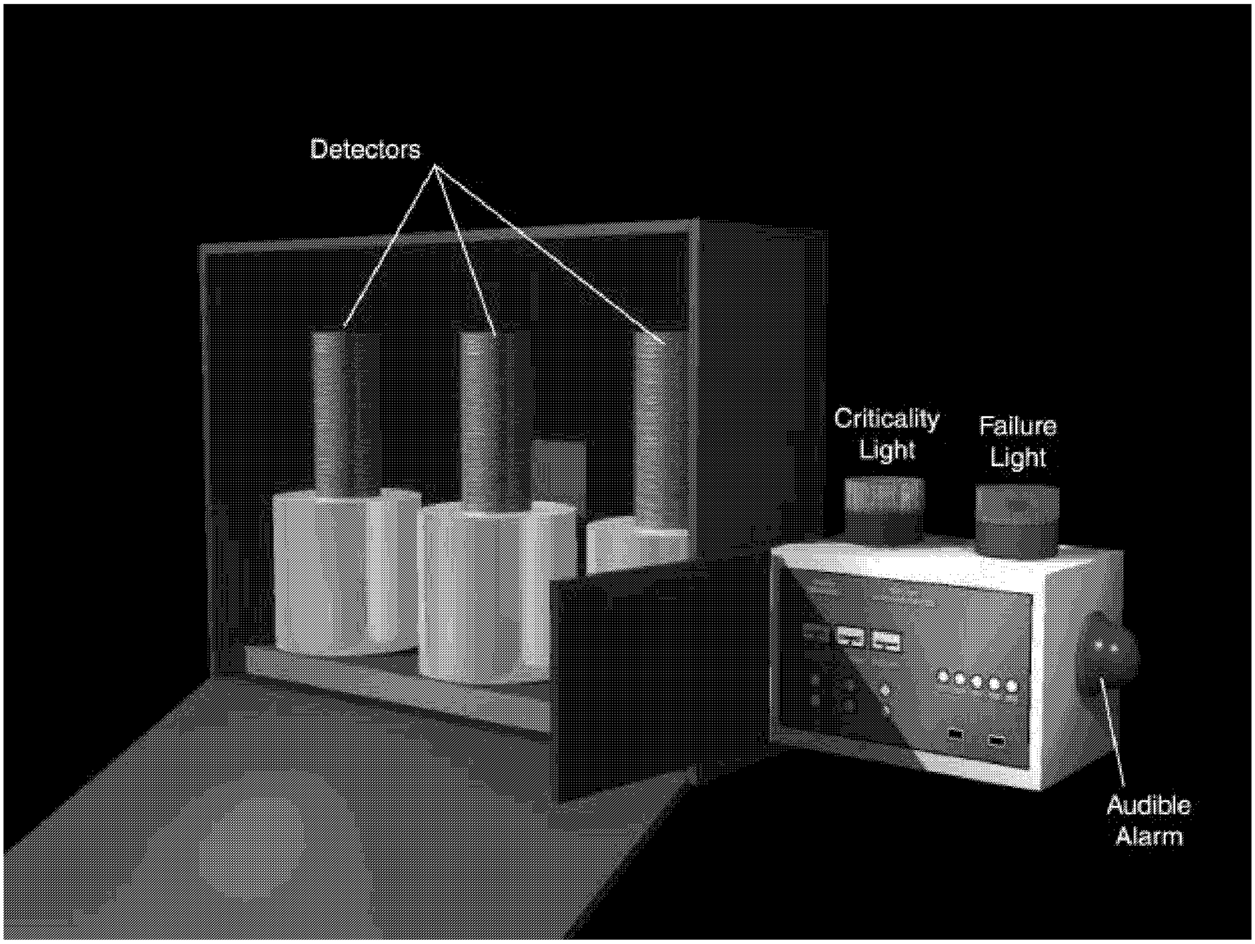

Figure 3-38. Criticality alarm system.

detectors in this system feed a voting module. At least two of the three detectors must supply a high reading to trigger a criticality alarm. These detectors are sensitive to neutrons, but are relatively insensitive to Gamma radiation.

Second, using three detectors, the voting module design provides redundancy. The system remains functional if one detector fails, and even if the detector failure mode supplies a high output signal, a false alarm will not occur. Therefore, the three-detector, voting module design minimizes costly false alarms.

Third, the CAS control console has a visual and audible failure warning signal to alert personnel to possible CAS malfunctions and avoid the dangers of a faulty CAS. The CAS control console logs all criticality events, including time, date and duration. The CAS control console can be located hundreds of feet from the detectors, out of the way of ongoing work and harsh environments. The remote location also allows personnel access to the console without exposure to a possible criticality, if necessary.

Similar CAS units have been used extensively at the INEEL, and calibrating and operating procedures exist. The glovebox excavator project will not have to purchase an expensive calibration source.

An alarm condition provides both a visual and an audible alarm signal. Should the CAS alarm, personnel in the retrieval facility evacuate immediately to a predetermined location.

3.8.3 Fissile Material and Drum Assay Monitoring

Pit 9 area historical waste records indicate the presence of fissile material. The primary element of concern is plutonium. To ensure criticality safety, fissile material content has been restricted in 55-gal drums to less than 200 grams. Figure 3-39 shows the fissile material monitoring logic.

The I&C design incorporates a fissile material monitor (FMM) into glovebox design and operation. Figure 3-40 shows the FMM in the glove box.

Glovebox operators place suspect visually unidentified combustible material into the FMM well. The detector measures the gamma spectrum of the isotopes contributing to the fissile material inventory. A gamma spectrum count of the well specimen is made and displayed, along with a running total of what has been loaded into the drum. A local FMM touch-screen warns the operator to avoid exceeding the 200-gram fissile material limit for a single drum.

After operators have filled and sealed a waste drum, a forklift operator transfers the drum to a drum assay trailer. The assay system will be capable of assaying 55- and 85-gal drums. Instruments in the trailer determine the fissile material content of the drum. This assay is necessary to ensure that the drum meets the storage criteria of the interim storage shelter.

Because of the short duration of the glovebox excavator project and the number of drums to be assayed, leasing an assay trailer (see Figure 3-41) is more cost effective than purchasing an assay system and installing a facility to house it. Further, when the glovebox excavator project is complete, the INEEL will not have to perform any decontamination and disposal, since the trailer owner will simply haul the trailer away to be reused.

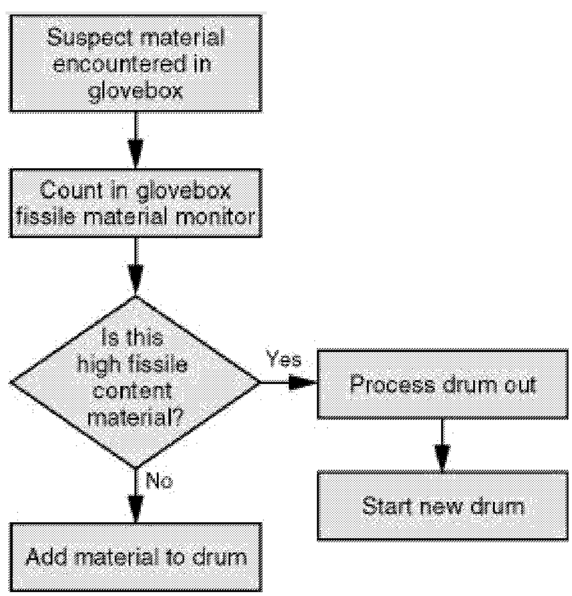

Figure 3-39. Decision process prevents fissile material in drum from exceeding limit.

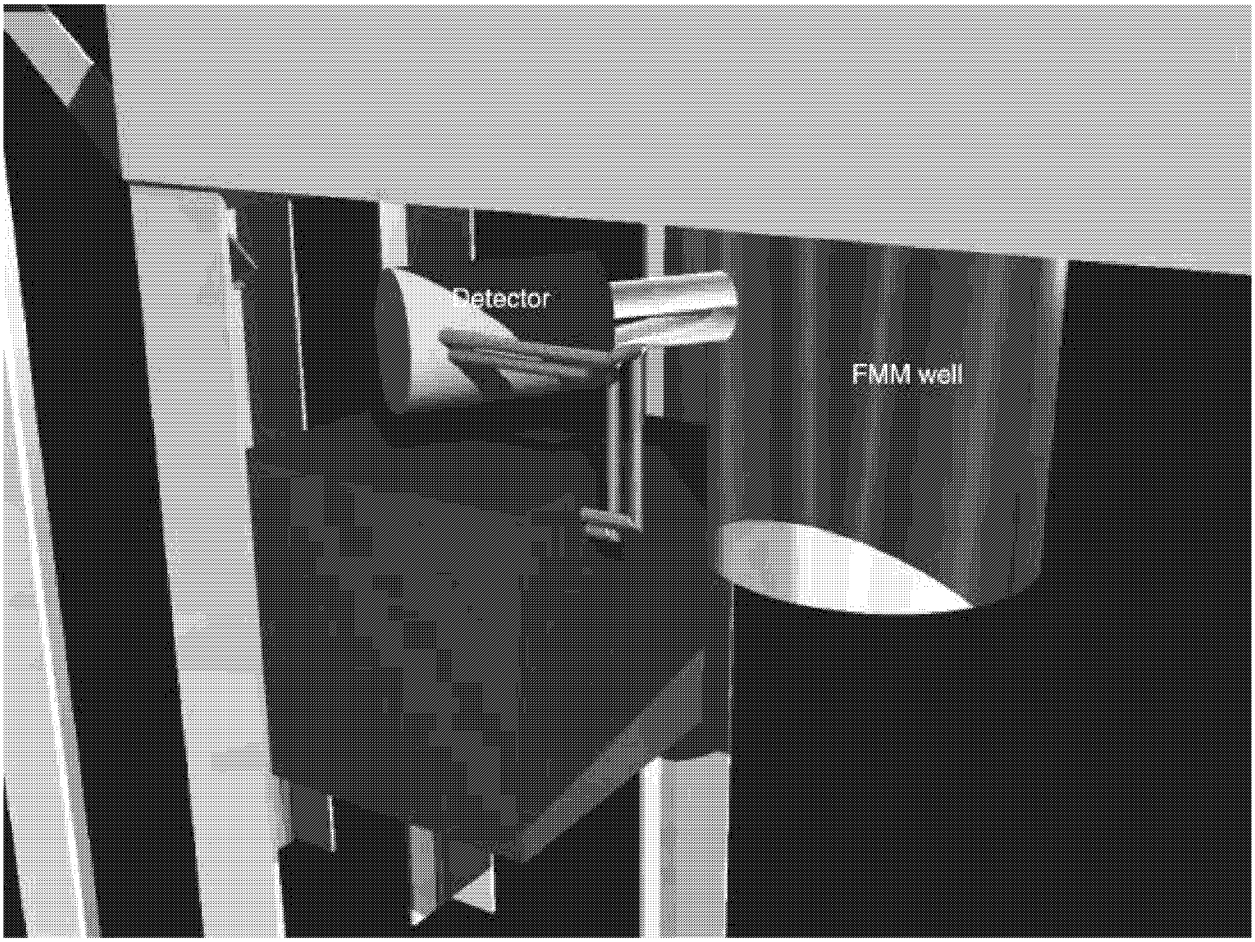

Figure 3-40. Fissile material monitoring in the glovebox.

Figure 3-41. A leased drum assay trailer with assay compartment and office cost-effectively ensure that the drum meets the storage criteria of the interim storage shelter.

3.8.4 CCTV Monitoring

CCTV monitoring is essential to RCS operations. As shown in Figure 3-42, cameras are located in the RCS.

The RCS cameras give the excavator operator a clear view of the dig area. In Figure 3-43, one can see that the operator's view is restricted as a result of RCS structures, the boom/stick, and pit blind spots. Further, due to the distance from the operator's eyes to the actual dig location, the operator lacks the fine visual resolution necessary to effectively conduct waste handling in potentially tight locations and difficult situations, making the cameras a necessity. The operator can select, aim, and focus the camera with the best view on the area of interest and the remote control allows the operator to multiply the optical image by a factor of 18 to 1. With three cameras in the RCS and a CCTV screen in the excavator cab, the operator can optically move in close to examine the waste material of interest. These images are also available at the CCTV console in the WES for support personnel to view.

The glovebox excavator project is required to maintain a data record of each waste package. Data records are maintained on paper forms, since the project is of short duration, with only a few drums for which records must be generated.

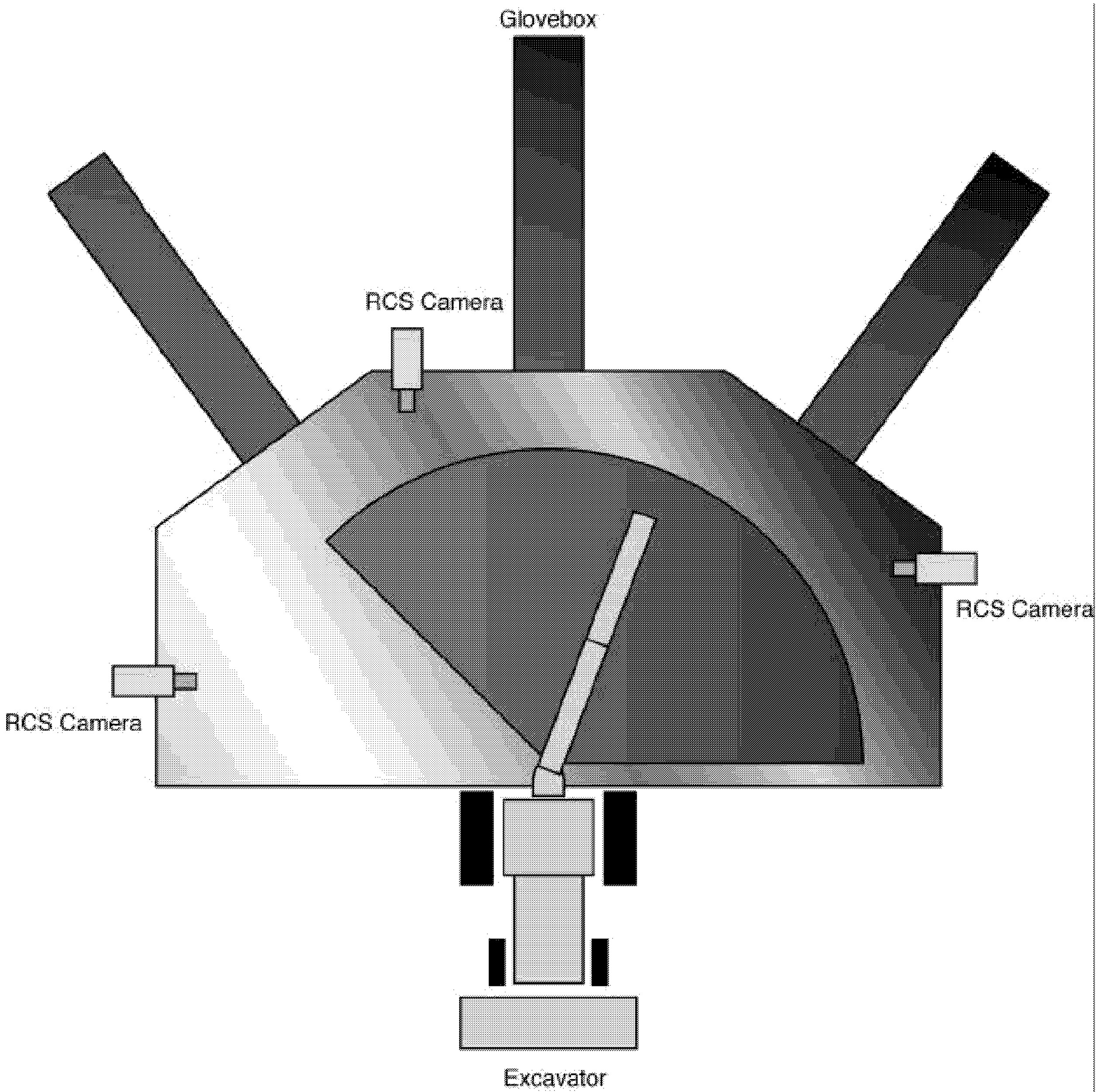

Figure 3-42. RCS cameras give the excavator operator a clear view of the dig area (camera locations are approximate).

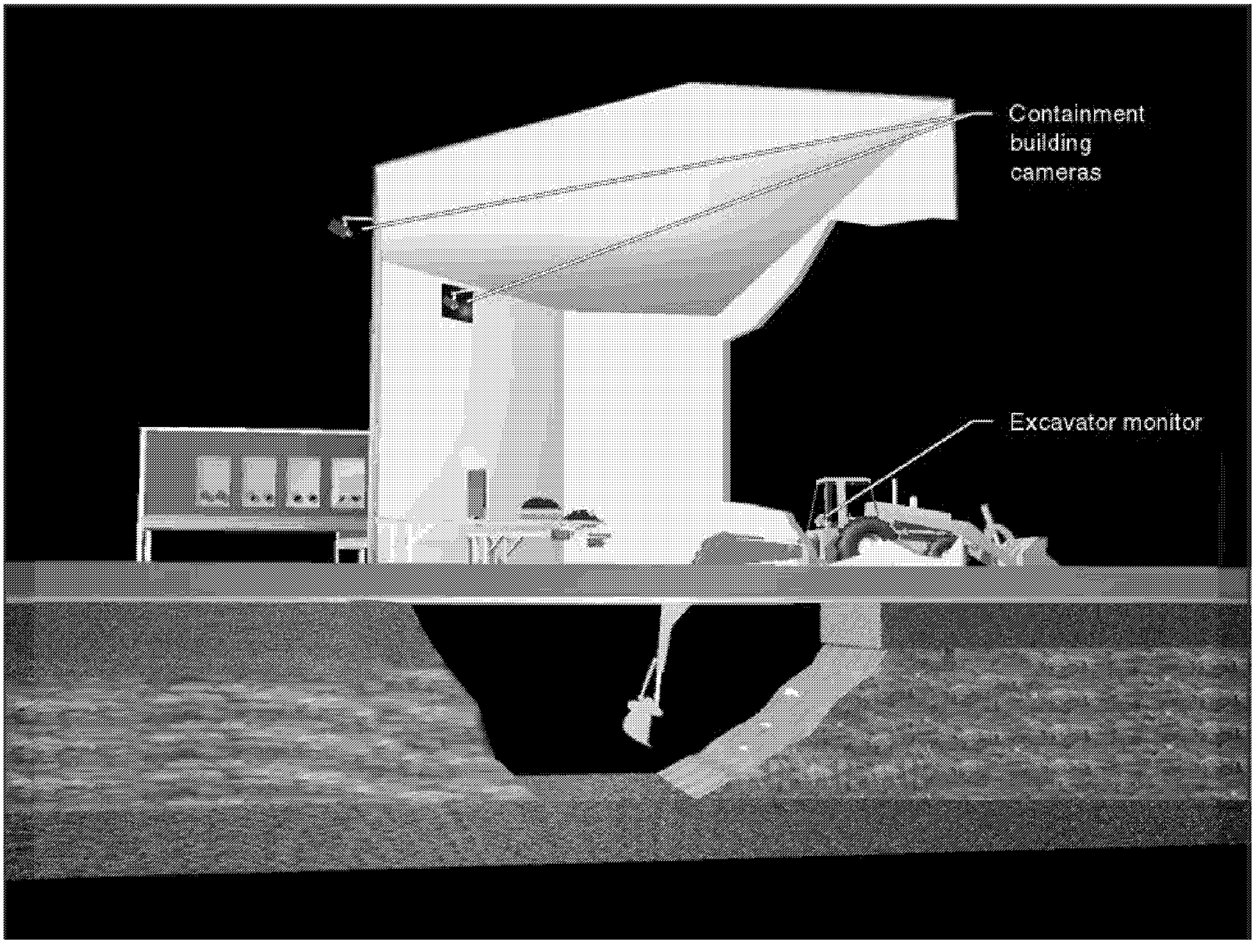

Figure 3-43. A combination of strategically located cameras and monitors allows the operator to see in those areas with restricted visibility.

3.9 Design for DD&D

During the detailed design phase, consideration will be given to the following to facilitate DD&D:

- Planning for proposed decommissioning method or a conversion method leading to other uses.
- Including features that will facilitate decontamination for future decommissioning, increase the potential for other uses, or both.
- Sizing and arrangement of interior corridors to accommodate decontamination and decommissioning of the facility, including equipment required during decontamination.
- Using modular, separable confinements for radioactive and other hazardous materials to preclude contamination of fixed portions of the structure.
- Locating exhaust filtration components of the ventilation systems at or near individual enclosures so as to minimize long runs of internally contaminated ductwork.

- Eliminating material handling configurations where material can collect, especially dead-end piping.

- Using materials that reduce the amount of radioactive and other hazardous materials requiring disposal and that are easily decontaminated.

- Implementing designs that ease cut-up, dismantlement, removal and packaging of contaminated equipment from the facility (e.g., removal and dismantlement of gloveboxes, air filtration equipment, vessels, equipment, and ductwork).

- Using lifting lugs on large tanks and equipment.

3.10 Long-Lead Procurement/Staged-Construction Subcontracts

The accelerated Glovebox Excavator Method Project construction schedule is accomplished by procuring long-lead time equipment and constructing site systems and facility structures before completing the final design. This standard method of staged design and construction is accomplished by carefully defining equipment and system interfaces, which are fixed when the early equipment procurements and construction subcontracts are initiated.

Long-Lead Procurement Items

- Packaging and glovebox system
- Excavator
- Fissile material monitoring system
- Weather enclosure structure
- HEPA filter housing
- Retrieval confinement structure

Long-lead equipment will be provided as Government-Furnished Equipment (GFE) to the facility construction subcontractor just in time for installation. The site systems and structures subcontracts will be completed just in time for the facilities construction subcontract to begin. The construction schedule is shortened because key equipment and the early stages of construction are provided in parallel with the final design.

The project PDSA will be approved before major procurements, which reduces the risk of introducing late design changes. Long-lead procurement items are shown in the box above.