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FACILITY DESIGN AND OPERATION

This Chapter provides an overview of (1) the design of the WIPP facility and associated principal structures, systems, and components (SSCs), and (2) the RH waste handling/emplacement process. Sufficient detail is provided to facilitate hazard identification and principal design and safety criteria selection.

As discussed in the General Plant Design Description[1] (GPDD), no Design Class I SSC exists at the WIPP. Design information is provided in this chapter only for those SSCs listed in Table 4.1-1 that have been designated as Design Class II, and IIIA in the GPDD. Design Class IIIB SSCs are briefly described only to the extent necessary to complete the overview of the facility design and operation. Detailed design information on each SSC may be found in the respective System Design Description (SDD). The methodology for establishing the design class and the basis for classification determination for SSCs can be found in Appendix C of the GPDD.

4.1 Summary Description

The WIPP facility is located in Eddy County about 26 miles east of Carlsbad, New Mexico, encompassing 10,240 acres (16 sections) within the site boundary (Figure 4.1-1).

The controlled zones and associated fenced-in areas are described in Chapter 2. The facility is divided into three basic groups: surface structures, shafts, and subsurface structures, shown on Figures 4.1-2a, 4.1-2b, and 4.1-3.

The WIPP facility surface structures accommodate the personnel, equipment, and support services required for the receipt, preparation, and transfer of waste from the surface to the underground. The surface structures are located in an area (approximately 35 acres) within a perimeter security fence (Figure 4.1-2a). RH TRU waste surface traffic flow is shown in Figure 4.1-2a.

The vertical shafts extending from the surface to the underground horizon are the waste shaft, the salt handling (SH) shaft, the exhaust shaft, and the air intake shaft (AIS). These shafts are lined from the shaft collar to the top of the salt formation (about 850 ft [259 m] below the surface), and are unlined through the salt formation. The shaft lining is designed to withstand the full piezometric water pressure associated with any water-bearing formation encountered.

The subsurface structures consist of the waste disposal area, the support area, and the north (experimental) area (Figure 4.1-3). The experimental area was deactivated in September 1996 (Portions of this area were re-entered for the permanent disposal of salt mined from Panel 2 and are being maintained open.

References for Section 4.1

1. U.S. Department of Energy, Waste Isolation Pilot Plant, General Plant System Design Description (GPDD).

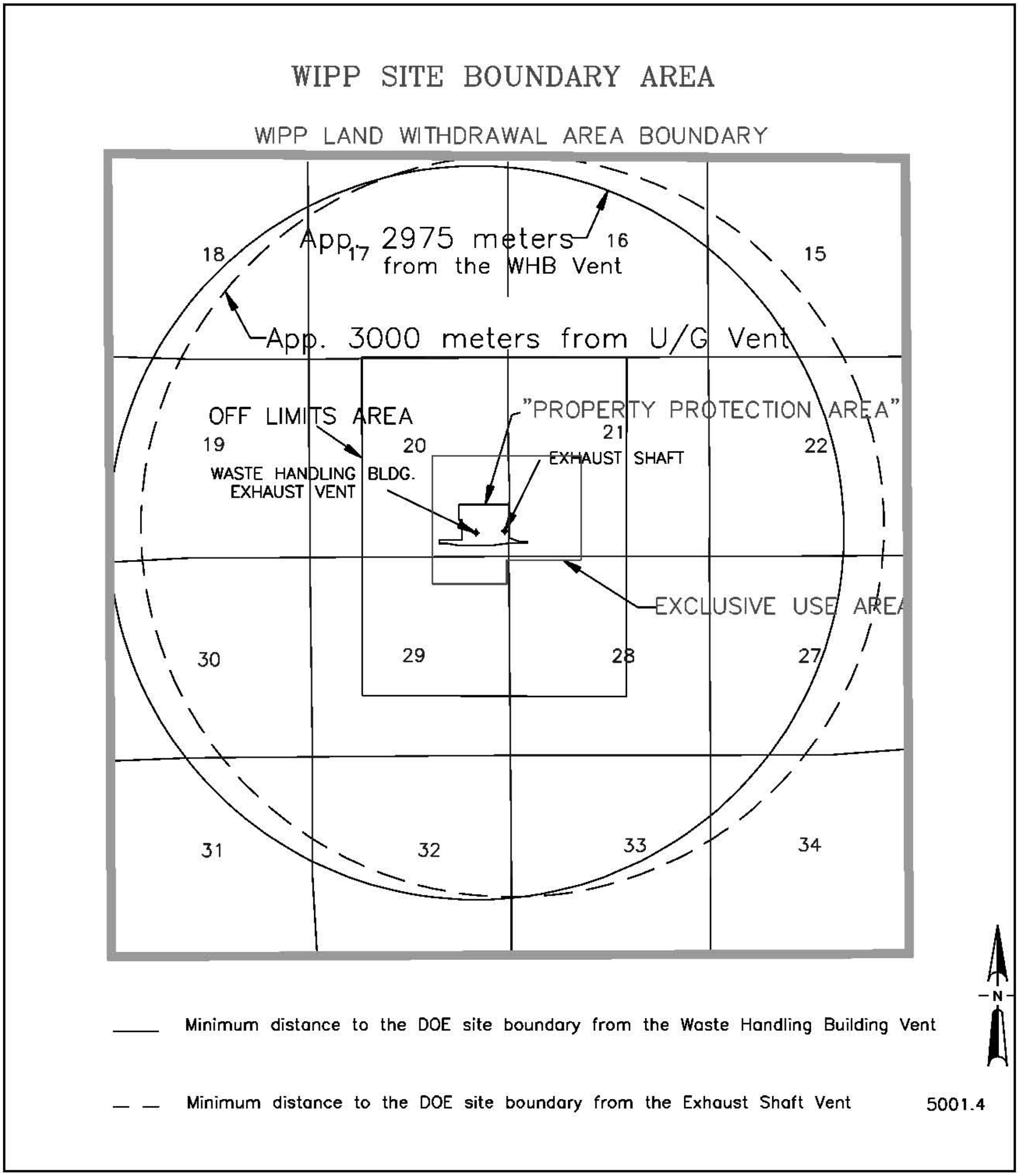

Figure 4.1-1, WIPP Site Boundary and Subdivisions

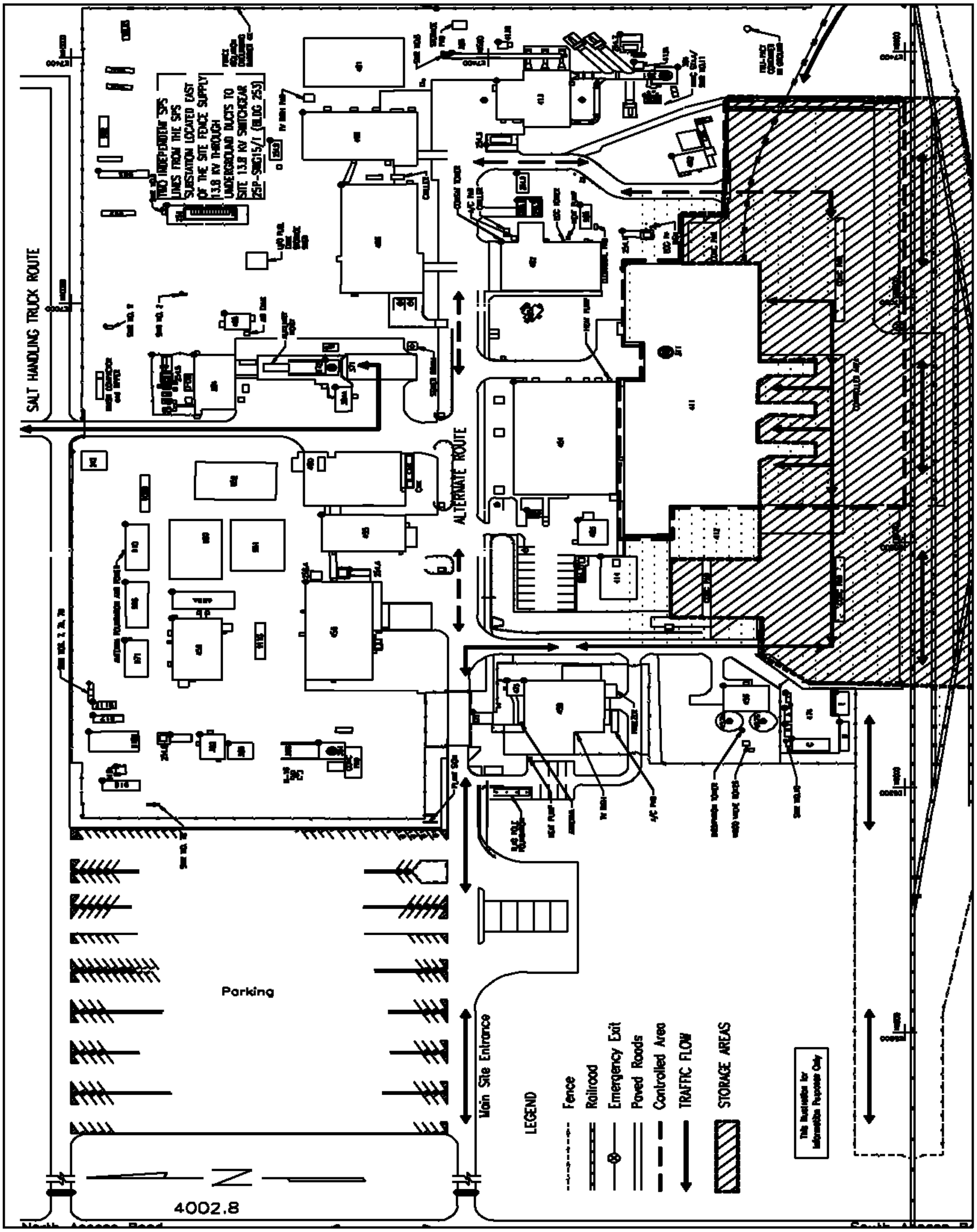

Figure 4.1-2a, WIPP Surface Structures

BLDG./ FAC. #	DESCRIPTION
242	NORTH GATEHOUSE
253	13.8 KV SWITCHGEAR 25P-SWG15/1
254.1	AREA SUBSTATION NO.1 25P-SW15.1
254.2	AREA SUBSTATION NO.2 25P-SW15.2
254.3	AREA SUBSTATION NO.3 25P-SW15.3
254.4	AREA SUBSTATION NO.4 25P-SW15.4
254.5	AREA SUBSTATION NO.5 25P-SW15.5
254.6	AREA SUBSTATION NO.6 25P-SW15.6
254.7	AREA SUBSTATION NO.7 25P-SW15.7
254.8	AREA SUBSTATION NO.8 25P-SW15.8
254.9	AREA SUBSTATION NO.9 25P-SW15.9
255.1	BACKUP GENERATOR #1 25-PE 503
255.2	BACKUP GENERATOR #2 25-PE 504
311	WASTE SHAFT
351	EXHAUST SHAFT
361	AIR INTAKE SHAFT
362	AIR INTAKE SHAFT/HOIST HOUSE
363	AIR INTAKE SHAFT/WINCH HOUSE
364	EFFLUENT MONITORING INSTRUMENT SHED A
365	EFFLUENT MONITORING INSTRUMENT SHED B
366	AIR INTAKE SHAFT HEADFRAME
371	SALT HANDLING SHAFT
372	SALT HANDLING SHAFT HEADFRAME
384	SALT HANDLING SHAFT HOISTHOUSE
384A	SALT HOIST OPERATIONS
411	WASTE HANDLING BUILDING
412	TRUPACT MAINTENANCE FACILITY
413	EXHAUST FILTER BUILDING
413A	EFFLUENT MONITORING ROOM A
413B	EFFLUENT MONITORING ROOM B
414	WATER CHILLER FACILITY & BLDG
451	SUPPORT BUILDING
452	SAFETY & EMERGENCY SERVICES FACILITY
453	WAREHOUSE/SHOPS BUILDING
455	AUXILLIARY WAREHOUSE BUILDING
456	WATER PUMPHOUSE

BLDG./ FAC. #	DESCRIPTION
457N	WATER TANK 25-D-001A
457S	WATER TANK 25-D-001B
458	GUARD AND SECURITY BUILDING
459	CORE STORAGE BUILDING
459A	SANDIA ANNEX
463	COMPRESSOR BUILDING
465	AUXILIARY AIR INTAKE
468	TELEPHONE HUT
473	ARMORY BUILDING
474	HAZARDOUS WASTE STORAGE FACILITY
474A	HAZARDOUS WASTE STORAGE BUILDING
474B	HAZARDOUS WASTE STORAGE BUILDING
474C	OIL & GREASE STORAGE BUILDING
474D	GAS BOTTLE STORAGE BUILDING
474E	HAZARD MATERIAL STORAGE BUILDING
474F	WASTE OIL RETAINER
475	GATEHOUSE
480	VEHICLE FUEL STATION
481	AUXILIARY WAREHOUSE
482	EXHAUST SHAFT HOIST EQUIP. WAREHOUSE
485	COMPRESSOR BUILDING
486	ENGINEERING BUILDING
489	TRAINING BUILDING
H-16	SANDIA TEST WELL (NOT IDENTIFIED)
908B	HBS TRAILER
910	ENVIRONMENTAL MONITORING TRAILER
911G	SANDIA OFFICES TRAILER

BLDG./ FAC. #	DESCRIPTION
917	AIS MONITORING
918	VOC TRAILER
918A	VOC AIR MONITORING STATION
918B	VOC LAB TRAILER
950	WORK CONTROL TRAILER
951	PROCUREMENT / PURCHASING
952	TRAILER (7-PLEX)
965	SAMPLE PREPARATION LAB
971	HUMAN RESOURCES TRAILER
982	TRAILER
986	PUBLICATIONS & PROCEDURES TRAILER
992	SANDIA CALIBRATION LAB TRAILER
993	SANDIA OFFICES TRAILER
SWR NO.1	SWITCHRACK NO. 1
SWR NO.2	SWITCHRACK NO. 2
SWR NO.3	SWITCHRACK NO. 3
SWR NO.6	SWITCHRACK NO. 6
SWR NO.7,7A,7B	SWITCHRACK NO. 7, 7A, 7B
SWR NO.7C	SWITCHRACK NO. 7C
SWR NO.8	SWITCHRACK NO. 8
SWR NO.9	SWITCHRACK NO. 9
SWR NO.10	SWITCHRACK NO. 10
SWR NO.11	SWITCHRACK NO. 11

4003.8

This Illustration for Information Purposes Only

Figure 4.1-2b, Legend for Figure 4.1-2a

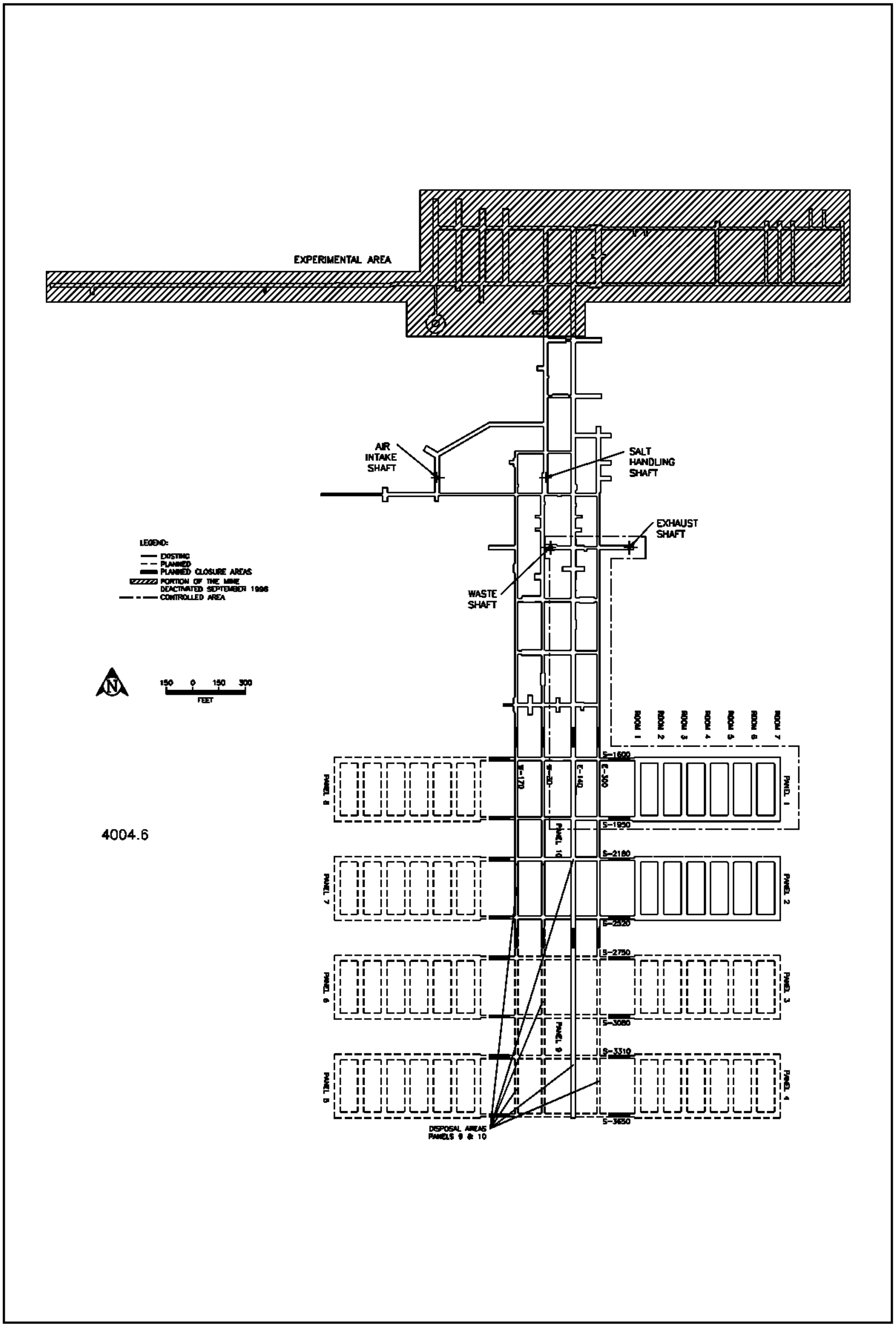

Figure 4.1-3, Planned Disposal Horizon

Table 4.1-1 Design Classes of Structures, Systems, and Components at the WIPP Facility **Page 1 of 5**

System/Component	Design Class (Note 1)	Seismic/Tornado Design Requirements	Design Class Function
PLANT BUILDINGS, FACILITIES, AND MISCELLANEOUS EQUIPMENT (SDD-CFOO)			
Waste Handling Building structure and structural components including tornado doors (Bldg. 411)	II	Design Basis Earthquake (DBE), Design Basis Tornado (DBT)	Provide physical confinement
Auxiliary Air Intake Shaft and Tunnel (Bldg 465)	II	DBE, DBT	Failure could create excess negative pressure in the waste hoist tower
Station A Effluent Monitoring Instrument Shed (Bldg 364)	II	DBE, DBT	Design Class Interface. (Houses Station A)
Effluent Monitoring Rooms A and B (Building 413A and 413B)	II	DBE, DBT	Design Class Interface. (Houses Local Processing Units (LPU)s collecting data from Stations A and B)
Station B Effluent Monitoring Instrument Shed (Bldg 365)	IIIA	Uniform Building Code (UBC)	Design Class Interface. (Houses monitoring equipment for Exhaust Filter Building duct)
Support Building (Bldg 451)	IIIA	UBC (Note 2)	Design Class Interface. (Houses Central Monitoring Room (CMR)
Exhaust Filter Building (Bldg 413)	IIIA	UBC	Design Class Interface. (Houses Exhaust Filtration System)
EFB HEPA Filter Units & Isolation Dampers	II		Failure could prevent mitigation
EFB Exhaust System	IIIA		Failure could prevent mitigation
Building 412 (Originally TRUPACT Maintenance Facility)	IIIA	UBC (Note 2)	Design Class Interface. (Structural interface with WHB)

Table 4.1-1 Design Classes of Structures, Systems, and Components at the WIPP Facility **Page 2 of 5**

System/Component	Design Class (Note 1)	Seismic/Tornado Design Requirements	Design Class Function
PLANT MONITORING AND COMMUNICATION SYSTEM (SDD-CMOO)			
Central Monitoring System	IIIA		Monitors important facility parameters
ENVIRONMENTAL MONITORING SYSTEM (SDD-EM00)			
Volatile Organic Compound (VOC) Monitoring Equipment and sub-systems	IIIA		Monitors release of VOCs
HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) SYSTEM (SDD-HV00)			
Exhaust Filtration System	II		Design Class Interface. (Control of radioactive effluent)
HEPA Filters	II		Control of radioactive effluent
Tornado Dampers	II	DBE, DBT	Control of radioactive effluent
Exhaust Systems HV02, (Bldg 411, RH HVAC), and HV04 (Station A and Bldg 413, Exhaust Filter Building HVAC)	IIIA		Design Class Interface. (Provide filtration and maintain differential pressure)
HVAC for the CMR	IIIA		Design Class Interface. (Maintains acceptable CMR environment)
RADIATION MONITORING SYSTEM (SDD-RM00)			
Stations A3, B2, C, and D1 (including the UPSs)	II	DBE, DBT	Monitors radioactive effluents
The remainder of the RMS SSCs are Design Class IIIA (except PV00 equipment which is IIIB)	IIIA		Monitors radioactive effluents
UNDERGROUND HOIST SYSTEM (SDD-UH00)			
Waste Hoist and Equipment	IIIA	(Note 3)	Failure could cause radioactive material release

Table 4.1-1 Design Classes of Structures, Systems, and Components at the WIPP Facility **Page 3 of 5**

System/Component	Design Class (Note 1)	Seismic/Tornado Design Requirements	Design Class Function
UNDERGROUND VENTILATION SYSTEM (SDD-VU00)			
Exhaust duct elbow at the top of the Exhaust Shaft	II	DBE, DBT	Design Class Interface. (Channels exhaust air to the EFB)
HEPA Filters and Isolation Dampers	II		Control of radioactive effluent
Exhaust Fans for the filtration mode	II		Design Class Interface. (Channels exhaust air through the EFB)
Exhaust System Instruments and Hardware	IIIA		Design Class Interface. (Supports Exhaust Filtration System)
(6) High Pressure Fans for Bulkhead 309 (Pressure Chamber)	IIIA		Maintain buffer zone between RMA and non-RMA
WASTE HANDLING EQUIPMENT (SDD-WH00)			
Facility Cask	II	(Note 4)	Provides permanent shielding
25-Ton Crane - Cask Unloading Room	IIIA	(Note 6)	Failure could cause radioactive materials release
Telescoping Port Shield	II	UBC (Note 5)	Provides permanent shielding
Shield Bell	II	(Note 5)	Provides permanent shielding
Cask Unloading Room Floor Shield Valve	II	(Note 5)	Provides permanent shielding
Hot Cell Shield Valve	II	(Note 5)	Provides permanent shielding

Table 4.1-1 Design Classes of Structures, Systems, and Components at the WIPP Facility **Page 4 of 5**

System/Component	Design Class (Note 1)	Seismic/Tornado Design Requirements	Design Class Function
Transfer Cell Ceiling Shield Valve	II	(Note 5)	Provides permanent shielding
Hot Cell Viewing Windows	II	(Note 5)	Provides permanent shielding
Hot Cell Transfer Drawer	II	UBC (Note 5)	Design Class Interface (Provides permanent shielding)
Hot Cell 15-ton Bridge Crane	IIIA	(Note 6)	Failure could cause radioactive materials release
Hot Cell Bridge and Trolley/PAR 6000 Manipulator	IIIA	(Note 6)	Failure could cause radioactive materials release
Hot Cell Master-Slave Manipulators	IIIA	(Note 7)	Programmatic Impact
Hot Cell Grapple Rotating Block	IIIA		Programmatic Impact
Hot Cell Grapples	IIIA		Failure could cause radioactive materials release
Shielded Insert	IIIA		Failure could cause radioactive materials release
140/25 ton crane	IIIA	UBC (Note 6)	Failure could cause radioactive materials release
Cask Lifting Yoke	IIIA		Programmatic Impact
Facility Cask Rotating Device	IIIA		Programmatic Impact
6.25 ton Overhead Fixed Hoist - Facility Cask Loading Room	IIIA		Failure could cause radioactive materials release

Table 4.1-1 Design Classes of Structures, Systems, and Components at the WIPP Facility **Page 5 of 5**

System/Component	Design Class (Note 1)	Seismic/Tornado Design Requirements	Design Class Function
Facility Cask Loading Room Grapples	IIIA		Failure could cause radioactive materials release
The Horizontal Emplacement and Retrieval Equipment (HERE)	IIIA		Programmatic Impact
Transfer Cell Shuttle Car	IIIA	(Note 6)	Failure could cause radioactive materials release
10-160B Drum Carriage Lift Fixture	IIIA		Failure could cause radioactive materials release

Notes

Note 1 See Table 3.1-2 for Basic Design Requirement and Table 3.2-3 for the Design Loads.
Note 2 The main lateral force resisting members of the Support Building and Building 412 are designed for DBE and DBT to protect the Waste Handling Building from their structural failure.
Note 3 Design loads and requirements dictated by Mine Safety and Health Administration (MSHA).
Note 4 Cask certification requirements exceed DBT/DBE.
Note 5 System completely within a Class II confinement - DBE/DBT not required.
Note 6 Designed to hold load in place in the event of a DBE.
Note 7 Supports designed to prevent manipulator from falling during a DBE.

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4.2 Facility Design

4.2.1 Surface Structures

WIPP's structures provide for the handling and subsequent underground emplacement of Transuranic (TRU) waste. Surface waste handling operations are conducted within a controlled area (CA). The normal extent of the CA for simultaneous contact handled (CH) and remote handled (RH) waste handling activities is depicted in Figure 4.1-2a. Radiological control personnel will determine specific boundary locations and posting requirements for CAs, as required by scheduled waste handling activities and radiological conditions inside the Waste Handling Building (WHB). The CA external to the WHB provides for the receipt, storage, and dispatch of truck-transported radioactive waste shipping containers. Radiological control personnel will determine specific boundary locations and posting requirements for the external CA consistent with scheduled activities.

The RH TRU waste shipments, including the transporter trailer and shielded road cask, are transferred into the WHB for subsequent operations.

The land areas around the surface buildings are designed to minimize erosion. Runoff water is diverted as necessary from the buildings, tracks, or roads and returned to the natural drainage path and into the storm water retention basins.

The WIPP facility does not lie within a 100-year flood plain. There are no major surface-water bodies within 5 mi (8 km) of the site, and the nearest river, the Pecos River, is approximately 12 mi (19.3 km) away. The general ground elevation in the vicinity of the surface facilities (approximately 3,400 ft [1,036 m] above mean sea level) is about 500 ft (152 m) above the riverbed, and 400 ft (122 m) above the 100-year flood plain. Protection from flooding or ponding caused by probable maximum precipitation (PMP) events is provided by the diversion of water away from the WIPP facility by a system of peripheral interceptor diversions. Additionally, grade elevations of roads and surface facilities are designed so that storm water will not collect on the site under the most severe conditions. Repository shafts are elevated at least 6 in (15.2 cm) to prevent surface water from entering the shafts. The floor levels of all surface facilities are above the levels for local flooding due to PMP events.

Facilities at the WIPP site have been constructed to contain or control storm water discharges; these include retention basins and storm water diversion berms. The two 180,000 gal (681,354 L) site water tanks are located at the southwest corner of the property protection area, the topography of the site includes a sloping terrain to this corner of the site. There is a catch basin to the west of the water tanks, which is designed with adequate capacity to hold the contents resulting from a failure of both water tanks.

4.2.1.1 Waste Handling Building

The WHB and its associated systems provide a facility to unload TRU waste from the incoming shipping containers and to transfer that waste to the underground disposal area via the waste shaft. The WHB is divided into the following functional areas: the CH TRU waste handling area, the RH TRU waste handling area, the WHB support area, Building 412, and the WHB mechanical equipment room. The general layout of the WHB is shown in Figures 4.2-1a and 4.2-1b, with sectional views shown in Figure 4.2-3.

The WHB is a steel frame structure with insulated steel siding, and includes portions of the building, such as the Hot Cell and Transfer Cell, that are constructed of concrete for shielding and structural purposes. The WHB acts as a confinement barrier to control the potential for release of radioactive material and is classified as Design Class II. The WHB is designed for Design Class II loads, including the Design Basis Earthquake (DBE) and Design Basis Tornado (DBT). Waste handling areas subject to potential for contamination are provided with impermeable protective coatings. The WHB Confinement and Ventilation System is discussed in detail in Section 4.4, the Safety Support Systems in Section 4.5, and the Utility/Auxiliary Systems in Section 4.6.

4.2.1.1.1 RH TRU Waste Handling Areas

The RH TRU waste side of the WHB has two major areas for handling RH waste: the RH bay and the transfer complex. The transfer complex is divided into four sub-areas designed for specific functions: the Cask Unloading Room (CUR), the Transfer Cell, the Hot Cell, and the Facility Cask Loading Room. The major areas within the RH waste handling area are shown in Figures 4.2-1a and 4.2-1b, with sectional views shown in Figure 4.2.3. Waste transport routes in the WHB are shown in Figure 4.2-2.

<u>RH Bay</u>

The WHB RH bay is a high-bay area for receiving and initial handling operations of the 72-B and 10-160B shielded road casks. A trailer carrying a shielded road cask enters the RH bay through a set of double doors on the eastern side of the WHB. For contamination control, the WHB ventilation system is designed to maintain airflow direction to the areas where postulated accidents could occur. Ventilation airflow is from the RH bay into the CUR and Hot Cell; from the CUR into the Transfer Cell; from the Facility Cask Loading Room into the Transfer Cell; and from the Transfer Cell into the Hot Cell. The RH bay houses the following equipment:

Overhead 140/25 Ton Bridge Crane

The Design Class IIIA overhead 140-ton bridge crane with a 25-ton auxiliary hoist is used for road cask handling and maintenance operations. The bridge crane is designed to stay on its rails retaining control of the load during a DBE. The crane is controlled from a control box operated from the floor of the RH Bay. The 140-ton main hoist has a lifting height of 41 ft (12.5 m), while the 25-ton auxiliary hoist has a lifting height of 42 ft (12.8 m).

Motorized Man Lifts

Two motorized man lifts are used to provide waste operations personnel elevated work platforms for access to the 72B and 10-160B casks while the casks are on their transport trailers. Waste operations personnel use the platforms to perform the initial waste handling activities of removing the impact limiters from the road casks and performing any work required for readying the casks for lifting from their trailers. After the 10-160B road cask has been off-loaded, waste operations personnel, working off the lift, remove the lid bolts.

RH TRU 72-B Road Cask

The RH TRU 72-B road cask is a stainless steel, lead-shielded cask designed to provide double containment for shipment of transuranic waste materials. The packaging consists of a cylindrical stainless steel and lead cask body, a separate inner stainless steel vessel, and foam-filled impact limiters at each end of the cask body.

The cask body (OC) consists of a 1.5 in (3.8 cm) thick, 41.1 in (104.5 cm) outer diameter stainless steel outer shell, and a 1 in (2.54 cm) thick, 32.4 in (82.2 cm) inside diameter stainless steel inner shell, with 1.9 in (4.76 cm) of lead shielding between the two shells. A 5 in (12.7 cm) thick bottom forging is welded to the OC. The OC is closed by a 6 in (15.2 cm) thick stainless steel lid and 18, 1.25 inch diameter bolts. The main closure lid has a double bore-type O-ring seal. The containment seal is the inner butyl O-ring seal, which is leak testable. The OC lid has a single vent/sampling port that is sealed with butyl O-rings. The nominal 27,900 lb (12,648 kg) OC provides a containment boundary for the payload and also acts as an environmental barrier. The OC lead shielding assures the surface radiation levels are below DOT limits.

The separate inner vessel (IV) is constructed of a 1.5 in (3.8 cm) thick bottom forging welded to a 0.4 in (0.95 cm) thick, 32 in (81.2 cm) outside diameter shell. The 6.5 in (16.5 cm) IV lid is secured by eight, 7/8-inch bolts and has a single vent/sampling port The IV cavity has a minimum diameter of 26.5 in (67.3 cm), and is 121.5 in (308.6 cm) long. The nominal 4,000 lbs (1824.8 kg) IV provides a containment boundary for the RH waste canister

The RH TRU 72-B road cask is certified by the NRC per 10 CFR 71.63(b). The general road cask arrangement, shown in Figure 4.2-4, includes impact limiters, weighing nominal 2500 lbs (1155 kg) each, at each end of the road cask which function to provide protection of the seal areas during the hypothetical transport accident events. Each impact limiter is constructed of polyurethane foam-filled stainless steel attached to the OC with six, 1.25-inch diameter bolts. The approximate total weight of a 72 B road cask with impact limiters and a fully loaded RH canister is 45,000 lbs (20,412 kg).

The impact limiters are provided with lifting lugs, allowing the use of rigging for handling. Both of the road cask lids have "bayonet" openings in the outside center for insertion of lifting fixtures. Both lids are also provided with threaded holes for insertion of lifting bolts or eyes. The shielded road cask has two transport trunnions, used for support during transport and as a mounting point for the road cask transfer car. It also has four handling trunnions, located 90° apart at the lid end, used for lifting in the RH bay and CUR, and two trunnions located at the opposite end used for rotating the cask from the horizontal to the vertical position.

RH TRU 10-160B Road Cask

The 10-160B road cask is a steel, lead-shielded cask designed to provide single containment for shipment of transuranic waste. The packaging consists of a cylindrical carbon steel and lead cask body with impact limiters at each end. The cask is designed to safely transport ten 55-gal drums of RH TRU waste in two stacked drum pallet/carriage units holding 5 drums each. The maximum transport weight of the contents is 14,500 lb (6577.1 kg)

The cask body consists of a 2.0 in (5.08 cm) thick, 78.5 in. (199.4 cm) outer diameter carbon steel outer shell, and a 1.1 in (2.86 cm) thick, 68 in (172.7 cm) inside diameter carbon steel inner shell, with 1.9 in (4.76 cm) of lead shielding between the two shells. A 5.5 in (13.97 cm) thick flat circular steel bottom plate is welded to the inner and outer shells. The lead shielding assures the surface radiation levels are below DOT limits. The internal cavity dimensions are 68 in (167.6 cm) in diameter and 77 in (195.5 cm) high. The overall length of the cask without impact limiters is 88 in (223.5 cm). An 11 gage stainless steel thermal shield surrounds the cask outer shell in the region between the impact limiters. The cask is closed by a 5.5 in (13.97 cm) thick steel primary lid, weighing 5300 lbs (2404 kg), that is attached to the cask with 24 evenly spaced 1.75 in (4.45 cm) diameter bolts. The lid closure is made in a stepped configuration to eliminate radiation streaming at the lid/cask body interface. A double silicone O-ring provides the lid to cask seal.

The primary lid has a 31 in (78.7 cm) diameter opening that is equipped with a secondary lid. The 5.5 in (14 cm) thick 46 in (116.8 cm) diameter steel secondary lid, weighing 2150 lbs (975.2 kg), is attached to the center of the primary lid with 12 evenly spaced 1.75 in (4.45 cm) diameter bolts. The secondary lid has multiple steps machined in its periphery which match those in the primary lid, eliminating radiation streaming pathways, and is sealed to the primary lid by a double silicone O-ring.

The RH TRU 10-160B road cask is certified by the NRC per 10 CFR 71.63(b). The 10-160B road cask arrangement, shown in Figure 4.2-5, includes impact limiters at each end of the road cask. The upper (lid end) impact limiter weighs 5,300 lbs (2404 kg) while the lower weighs 5,200 lbs (2358 kg). Both impact limiters extend about 12 in (30.5 cm) beyond the outside wall of the cask and are installed prior to transport so that the cask can meet all transport environment and accident conditions. Each 102 in (259 cm) outside diameter impact limiter is constructed of polyurethane foam-filled stainless steel. The impact limiters are secured to each other around the cask by eight ratchet binders. The approximate total weight of a fully loaded 10-160B road cask with impact limiters is 72,000 lbs (32658.65 kg) and has an overall length of 130 in (3.3 m). The impact limiters are provided with lifting lugs, allowing the use of rigging for handling. The 10-160B cask is equipped with four tie-down lugs welded to the outer shell. The cask also has two lifting lugs and two redundant lifting lugs which are removed during transport and reinstalled for waste handling operations. The secondary lid is equipped with three lifting lugs used to lift both lids. Both lids are covered by the top impact limiter and rain cover during transport.

Cask Lifting Yoke

The Design Class IIIA lifting yoke is a lifting fixture that attaches to either hook of the 140/25-ton crane and is designed to lift and rotate the 72B road cask by engaging its handling trunnions. Figure 4.2-6 shows the 140/25-ton overhead crane with the cask lifting yoke lowering a 72B road cask onto the 72B cask transfer car.

72B Road Cask Transfer Car

The 72B road cask transfer car is a self-propelled, rail guided structural steel car with two A-frame supports and a bottom positioning fixture designed to hold the 72B road cask in the vertical position. The point of the A-frame is designed to cradle the transport trunnions of the road cask (Figure 4.2-7), while the positioning fixture prevents the cask from moving.

The four wheeled car, weighing 3950 lbs (1792 kg) , is designed to transport the loaded 72B road cask from the transport trailer to the cask preparation station, then to the CUR. It also repeats the route in reverse for empty road casks. Each of the two front wheels is powered by an electric motor which moves the car at one of two speeds, 16.5 or 66 ft. (5.0 or 20.1 m) per minute.

10-160B Road Cask Transfer Car

The 10-160B road cask transfer car (Figure 4.2-8) is a four wheeled, self-propelled, rail guided structural steel car constructed similar to the 72B cask transfer car without the A-frame structure. The 10-160B road cask transfer car weighs 2930 lbs (1329 kg) and is designed to transport the 10-160B road cask, in the vertical position, from the transport trailer to the CUR. It also repeats the route in reverse for an empty 10-160B cask. Each of the two front wheels is powered by an electric motor which moves the car at one of two speeds, 16.5 or 66 ft. (5.0 or 20.1 m) per minute. The 10-160B road cask transfer car can be configured with an A-frame structure to support the 72-B road cask.

Cask Preparation Station

The cask preparation station is a elevated work platform designed to provide accessability to the road cask lid area to allow workers to perform unloading and shipment activities such as; radiological surveys, inspections, and minor maintenance. The cask preparation station work deck is 9 ft 6 in (2.89 m) above the RH bay floor and straddles the road cask transfer car rails.

The removal/installation of the 72B cask outer lid and installation of the inner lid lift fixture (pintle) is performed at this location.

10-160B Cask Lid Lift Fixture

The 10-160B lid lift fixture has a pintle and three one inch ball lock pins (Figure 4.2-9). A ball lock pin is inserted into each of the lid lifting lugs to attach the lift fixture to the 10-160B lid. When the 10-160B is in the CUR, the lid lifting fixture pintle is engaged by a facility grapple connected to the Hot Cell crane, then the lid is lifted into the Hot Cell. The 10-160B lid lift fixture is attached to the cask lid by using either the 140/25 ton crane or the cask preparation station jib crane.

72B Cask Outer Lid Lift Fixture

The outer lid lift fixture is used with the cask preparation station jib crane to remove the outer lid from the 72B road cask while the road cask is in the vertical position on the 72B road cask transfer car. The lift fixture is lowered by the jib crane onto the road cask and is attached to the lid.

72B Waste Canisters

The 72B cask waste (payload) canister (Figure 4.2-10) is a DOT Type A (or equivalent) container. It is a carbon or stainless steel single-shell container with an outside diameter of 26 in (66 cm), a wall thickness of 0.25 in (0.64 cm), and an overall length of 121 in (3.1 m). It has an inside diameter of 25.5 in (64.77 cm) with an inside length of 108 in (2.74 m). The 0.375 in (0.95 cm) dished head with integral WIPP standard lift pintle is attached to the shell after the container is filled with waste. The canister is vented using a suitable filter and can be direct loaded or loaded with three 55-gal (208 L) drums of radioactive waste, each with a vent filter. It has a maximum weight, including the canister and its waste content, of 8,000 lbs (3628.7 kg).

Facility Canisters

The facility canister is a carbon steel single-shell container weighing approximately 1200 to 1800 lbs (544.3 to 816.5 kg), it has an outside diameter of 28.5 in (72.4 cm), a wall thickness of 0.25 in (0.64 cm), and an overall length of 117.5 in (3.0 m). It has an inside diameter of 28 in (71 cm) with an inside length of 110.5 in (2.8 m). The dished head with integral WIPP standard lift pintle is attached to the shell after the container is filled with waste drums from a 10-160B cask. The canister can hold three 55-gal (208 L) drums of radioactive waste. Each drum is vented with a filter and can have a maximum weight of 1000 lb (453.6 kg).

10-160B 55-Gallon Drum Lift Device

A drum lift device (Figure 4.2-11) is installed on each 55-gallon drum of radioactive waste prior to the drum being placed on the drum pallet/carriage and loaded into a 10-160-B road cask. The drum lift device is similar in construction to the drum lid bolt ring and is installed on the drum just below the first chine below the lid. The lift device has two diametrically opposed wire cable loops that are used to lift the drum from the carriage. When the wire cable loops are engaged by a lifting fixture, the symmetrical construction and placement of the drum lift device allows the drum to be suspended, moved, and inserted into the facility canister.

Transfer Complex Description

The transfer complex consists of a series of rooms with concrete walls up to 54 inches (137 cm) thick, that provides shielding for the RH TRU waste canisters and drums when they are not in a road cask, shielded insert, or the facility cask. The complex is located in the north side of the RH bay of the WHB (Figure 4.2-12), and consists of the CUR, the Hot Cell, the Transfer Cell, and the Facility Cask Loading Room.

The CUR floor is at reference elevation 100’-0" and at the east end of the complex. The Hot Cell floor is 31 ft (9.4 m) wide, 57 ft (17.3 m) long, and located at elevation 123’-6". The ceiling of the Hot Cell is at elevation 156’-10". To the west of the Hot Cell between elevations 100’-0" and 124’-6" is the Facility Cask Loading Room. Above this room is the manipulator repair room and above it is the crane maintenance room. The Transfer Cell which is 10 ft (3 m) wide and 79 ft 5 in (24.2 m) long has a floor elevation of 76’-0".

Cask Unloading Room

The CUR has 54 in (137 cm) thick concrete walls to provide a shielded area for lowering loaded 72B casks into the Transfer Cell and unloading of RH waste drums from the 10-160B cask into the Hot Cell. A 140-ton concrete-filled steel shield door at the entrance to the CUR provides radiation protection for personnel outside the room during 10-160B cask unloading operations. A free-standing control panel for the CUR 25-ton crane is located in the southwest corner of the room. The CUR shield door is interlocked so that it must be closed before the Hot Cell shield plugs can be removed, conversely the Hot Cell shield plugs are interlocked so that they cannot be removed when the CUR shield door is open.

The CUR shield door is 18.2 ft (5.7 m) long by 22.0 ft (6.7 m) high by 4.0 ft (1.2 m) thick. The shield door is opened and closed, at a rate of approximately 15 ft (4.67 m) per minute, by a pneumatic cylinder/piston and when moving is supported by a cushion of air exhausting from the door bottom, the air cushion is referred to as an "air bearing". When closed, an inflatable seal is pressurized forming a partial seal between the inside of the door and the surface around the CUR door opening. When the door is closed, the exhaust air supply is removed, the loss of the air cushion causes the door to settle to the floor.

The CUR contains the following equipment.

25-Ton Crane/Cask Lifting Yoke

The CUR 25-ton crane is fitted with a dedicated lifting yoke used to lift the 72B cask from the 72B road cask transfer car, lower it through the CUR floor shield valve, and set it in the shuttle car inside the Transfer Cell. The bridge rails of the Design Class IIIA overhead 25-ton bridge crane are attached to the walls of the CUR. The crane is designed to stay on its rails retaining control of its load during a DBE. The lifting yoke lifts the road cask by engaging the road cask handling trunnions. The 25-ton crane has a lifting height of 28 ft (8.5 m).

Load cells are provided on each hoist cable to provide indication of cable overload and/or load imbalance. In addition to protecting the crane and cask lifting yoke from damage, the load cells are used to prevent inadvertent decoupling of the lifting yoke from the cask lifting trunnions.

Floor Mounted Shield Valve

The floor mounted shield valve has a valve body that is a carbon steel plate 6.5 in (16.5 cm) thick, 68 in (172.7 cm) wide and 67.5 in (171.5 cm) long (Figure 4.2-13). It is supported on four rollers which ride on two floor-mounted flat tracks. Four guide rollers mounted in the bottom of the shield keep the shield in line. The shield is positioned by a Design Class II motor-driven ball screw actuator mounted such that the shield valve body rolls under the actuator as it moves from the closed to open position (normally maintained in closed position). The motor actuator includes a brake and limit switch for valve position indication and control interlocks. The shield valve body weighs approximately 8,500 lb (3855.5 kg). The floor valve provides permanent shielding and separates the CUR and the Transfer Cell for differential pressure control. When lowering a 72B cask into the Transfer Cell, air pressure in the CUR is maintained higher than in the Transfer Cell. The floor shield valve is interlocked to other RH waste handling system components as follows:

- The floor shield valve can not be closed unless the CUR 25-ton crane hook is in the high limit position
- The floor shield valve cannot be opened when the Hot Cell shield plugs have been removed, nor can the Hot Cell shield plugs be removed while the floor valve is open.
- The floor shield valve can not be opened unless the Hot Cell shield valve and the Transfer Cell ceiling shield valve are closed.

<u>Hot Cell Complex</u>

The Hot Cell is a 54 in (137 cm) thick concrete walled room that provides a shielded location for the facilities and equipment necessary to unload the RH waste drums from their 10-160B drum carriage units; provides temporary storage for unloaded drums, provides for inspections of the physical integrity of the drums, provides for the performance of a radiological contamination survey and identification verification of each drum, provides for loading drums into facility canisters, and provides overpack facilities for 72B waste canisters. Details of the Hot Cell area are shown in Figures 4.2-14a, 4.2-14b, and 4.2-14c. A Design Class IIIA bridge mounted power manipulator operates in the Hot Cell with rails at elevation 141’-0". The Hot Cell Design Class IIIA 15-ton bridge crane operates above the power manipulator, with its rails at elevation 148’-0". The operating gallery (elevation 122’ 1") provides space for operating personnel to monitor and control all operations in the Hot Cell. Six Design Class II shielded viewing windows between the operating gallery and the Hot Cell allow nearly 100% visual observations of all operations within the Hot Cell. A Design Class II transfer drawer is provided at the radiological inspection station for collecting surface contamination assessment swipes and the transfer of the swipes from the Hot Cell to the glove box in the operating gallery.

Access to the Hot Cell from the CUR is through two shield plugs in the Hot Cell floor. The large plug is 8 ft 8 in (2.64 m) in diameter and contains a smaller concentric 2 ft 8.25 in (0.82 m) diameter plug. Both plugs must be in place before a road cask can enter or exit from the CUR. When installed, the plugs provide shielding corresponding to the level of radiation protection required by the CUR. An interlock is provided between the CUR shield door and the Hot Cell crane, and requires that the shield door be closed in order to remove the shield plugs and lower the crane into the CUR. When the shield door is closed, the CUR functions as an air lock between the Hot Cell and the RH Bay. The Hot Cell is maintained at the lowest negative pressure and air leakage is from the RH bay through the CUR into the Hot Cell. The Hot Cell has provisions for maintenance of installed equipment. Access to the Hot Cell is permitted only when RH waste containers are not present. The following equipment is installed or used in the Hot Cell:

Hot Cell 15-Ton Crane

The remotely operated Design Class IIIA overhead 15-ton bridge crane has a 32 ft (9.75 m) span and can travel about 96 ft (29.2 m) in an east-west direction. It carries a trolley which can move approximately 23 ft 10 in (7.26 m) in the north-south direction. The trolley carries a hoist which supports a Design Class IIIA grapple rotating block and facility grapple. A hook can be attached to the grapple to handle loads including loaded or empty 10-160B drum pallet/carriage units, and 55-gal drums of RH waste. The hoist has a lifting height of 64 ft (19.5 m). This crane is designed to stay on its tracks, and to maintain control of its load in the event of a DBE or electrical failure.

The Design Class IIIA grapple rotating block is an assembly in a fabricated steel housing consisting of four sheaves at the top and a gear drive connected to clevis at the bottom. The grapple rotating block is suspended from the Hot Cell 15-ton bridge crane by cables passing through the sheaves. The gear drive has a motor driven pinion that rotates the clevis yoke which normally supports a facility grapple.

The Design Class IIIA facility grapple (Figure 4.2-22) is a special lift fixture that is designed to engage a standard WIPP pintle. The facility grapple has an axially mounted electrically operated actuator that rotates a drive gear that drives three lifting lugs into or out of engagement under the WIPP pintle. In the event of a power failure when the facility grapple was engaged on a lifting pintle, the lifting lugs would automatically lock in place. The Hot Cell facility grapple is identical to the facility grapple described in the Facility Cask Loading Room equipment.

A crane hook, rated at 15-tons, is available for use with the facility grapple. The hook is attached to a handling pintle with a flange.

The mobile bridge crane operator control console is located in operating gallery. Its mobility allows the operator to select the optimum Hot Cell viewing window location to visually observe the crane operation, or the operator may elect to view a CCTV monitor while operating the crane. The bridge crane can be remotely positioned or manually winched into the Crane Maintenance Room for any necessary repairs.

Shield Plug Lift Fixtures

There are two shield plug lift fixtures, one for each size of shield plug. Both fixtures can be used with the 15-ton bridge crane to remove their respective Hot Cell shield plug, or both shield plugs can be removed at the same time using only the large shield plug lift fixture. The small shield plug lift fixture, shown in Figure 4.2-14c, resembles a tripod. It is 9 ft (2.7 m) tall with a handling pintle at the top which is engaged by a facility grapple. The legs are fabricated from 3 in schedule 40 pipe. Each leg has an engagement pin which can engage lifting lugs, on a 13 in (33 cm) radius, on the small shield plug removal adapter. A centering pin is provided near the bottom of the shield plug lift fixture to engage the shield plug removal adapter and align the fixture with the removal adapter. The fixture is lifted by the 15-ton bridge crane with the facility grapple installed. The fixture is rotated by the rotating block to allow it to engage the shield plug removal adaptor lifting lugs. The small shield plug lift fixture weighs approximately 400 lbs (181.4 kg) and has the capacity to lift approximately 10,000 lbs (4535.9 kg).

The shield plug removal adapter is a fabricated steel fixture that is attached to the small shield plug with three bolts through holes in its base plate. It has three arms, each with a lifting lug that can be engaged by the small shield plug lift fixture. The center line of the lifting lugs are each on a 13 in (33 cm) radius. The adapter has a height of 12 3/8 in (31.4 cm) and weighs approximately 160 lbs (72.5 kg).

The large shield plug lift fixture, similar in design to the small shield plug lift fixture, is 11 ft (3.4 m) tall and its engagement pins have a 39 in (99 cm) radius. It is fabricated from 3 inch schedule 80 pipe to accommodate a greater lift weight. Its three engagement pins are designed to engage the three lifting lugs of the large shield plug removal adaptor. The large shield plug lift fixture weighs approximately 800 lbs (362.8 kg) and has a lift capacity of 20,000 lbs (9071.8 kg).

10-160B Drum Carriage Lift Fixture

The drum carriage lift fixture is a pentapod with five legs and a centering guide post with a guide pin. Each leg has an engagement pin which engages a lift lug, mounted on a lifting post, on the drum carriage. The guide pin slides into the center of the drum carriage center stanchion. Figure 4.2-15a shows the drum carriage lift fixture and a fully loaded (five 55-gallon drums) drum carriage. A bottom view of the lift fixture is also shown in Figure 4.2-15a. Figure 4.2-15b shows the lift fixture engaging the upper drum carriage and the lower drum carriage. A view of a loaded drum carriage is provided in Figure 4.2-15b. The drum carriage lift fixture has a lift capacity of approximately 6500 lbs (2948.4 kg).

Viewing Windows

Six Design Class II viewing windows are provided between the operating gallery and Hot Cell. Four viewing windows are located in the north wall and two in the west wall. The window frames are cast in the concrete wall separating the Hot Cell from the operating gallery. The frames are designed so that any radiation streaming paths parallel to the optical axis are prevented. The oil shielding windows are comprised of the frame, shielding glass, cover glasses and trim frames. The cover glasses and gaskets retain the oil within the window housing. The cold side (operating gallery) is tempered glass while the hot side (Hot Cell) is non-browning glass. The oil fill provides radiation shielding and acts as a heat transfer medium. An oil expansion tank is provided as a means of keeping the window full of oil despite the temperature excursions caused primarily by exposure to radiation and the high intensity lighting within the Hot Cell.

Master/Slave Manipulators

There are four Design Class IIIA master-slave heavy duty manipulators in the Hot Cell that allow operators in the operating gallery to reproduce the natural movements and forces of the human hand. The operator must exert the same force on the master arm that he wishes to exert with the slave arm; however, the tong squeeze motion does have a mechanical force multiplication. The manipulators are mounted in the wall of the Hot Cell using a "thru tube".

PAR 6000 Bridge Mounted Power Manipulator

The Design Class IIIA PAR 6000 power manipulator is a crane mounted remote controlled arm with shoulder, elbow, and wrist pivots which can be independently driven (Figure 4.2-14c). The wrist can support various adaptor tools including a hook hand and parallel jaw hand. The manipulator is suspended from a rotation drive assembly which permits full rotation of the manipulator about its vertical axis. The manipulator is attached to the rotation drive by two locking pins which allow for remote removal of the manipulator from the rotation drive assembly.

The rotation drive is attached to the bottom of a telescoping tube which provides manipulator vertical motion. There are five square nested telescoping sections connected in such a way that movement of any one tube causes all tubes to move. The telescoping tubes have an up-down travel of approximately 15 ft (4.6 m) at a speed of 15 ft (4.6 m) per minute and have a lifting capacity of 5000 lbs (2668 kg). The telescoping tube assembly is supported by the trolley carriage which travels on a bridge assembly. The bridge can travel east-west for approximately 50 ft (15.2 m) at a speed of up to 22 ft (6.7 m) per minute, while the trolley can travel north-south for approximately 25 ft (7.6 m) at a speed of up to 15 ft (4.6 m) per minute.

The control panels for the PAR 6000 power manipulator includes the controls for bridge, trolley, hoisting, and manipulator operation. The control equipment is located in panels along the north wall of the operating gallery. The operator controls and indicators are mounted on the PAR 6000 manipulator console. The console is mounted on wheels and can be moved near the viewing window that provides the best viewing of the operation to be performed. The console includes cables that can be plugged into any one of three connection boxes mounted in the operating gallery.

Closed-Circuit Television System

There are several closed-circuit television (CCTV) high resolution cameras in the Hot Cell which can be monitored in the operating gallery. CCTV cameras are used to provide direct viewing of specific operations. Each camera system includes a camera head which is mounted inside the Hot Cell, a control unit which is located in the operating gallery, and connecting cable. The video output is directed to monitors which are located for operator convenience. Each camera is fitted with a zoom lens and has its own control unit, which is rack mounted in the operating gallery. The cameras are supported on a pan/tilt unit to provide full motion.

Shielded Transfer Drawer

A Design Class II shielded transfer drawer is used to transfer materials (radiological smear samples and small tools) from the hot cell to a glove box in the operating gallery (Figure 4.2-16). A motor driven shield plug blocks the 20 in (50.8 cm) opening in the shield wall of the hot cell. The shield plug travels 46 in (1.2 m) perpendicular to the opening.

The glove box in the operating gallery side of the shield wall has a viewing window, two glove ports, and a transfer port. A motor driven shield plug in the floor of the glove box blocks off the hot cell transfer port in the same manner as is done inside the hot cell. The glove box shield plug has a travel of 38 in (96.5 cm). The transfer drawer shield plugs are interlocked so that only one can be in the open position at any time. The transfer drawer and glove box are vented into the RH exhaust air duct.

The transfer drawer is a flat tray, roller-mounted on the drawer carriage that rolls on rails on the bottom of the opening of the hot cell shield wall. When the hot cell shield plug is closed and the glove box shield plug is retracted, the operator can pull the sample tray into the glove box.

Hot Cell Shield Valve

The Hot Cell shield valve with its Design Class II actuator is identical to the CUR floor mounted shield valve (Figure 4.2.13). This shield valve provides permanent shielding and separates the Hot Cell and the Transfer Cell. When moving waste canisters between the Hot Cell and the Transfer Cell, ventilation air flow is from the Transfer Cell into the Hot Cell. The Hot Cell shield valve is interlocked to other RH waste handling system components as follows:

- Hot Cell shield valve can not be opened unless the CUR floor shield valve and the Transfer Cell ceiling shield valve are closed.
- Hot Cell shield valve cannot be closed unless the Hot Cell crane grapple is in the high limit position
- Hot Cell shield valve and the CUR floor shield valve must be closed before the Transfer Cell ceiling shield valve can be opened.
- Hot Cell shield valve and the Transfer Cell ceiling shield valve must be closed before the CUR floor shield valve can be opened.
- Hot Cell shield valve can not be opened unless the Transfer Cell shuttle car is positioned below the Hot Cell shield valve port.

<u>Transfer Cell</u>

The Transfer Cell, located beneath the CUR and the Facility Cask Loading Room, contains the Design Class IIIA shuttle car used to move either the 72B cask or the shielded insert(used with the facility canister). The Transfer Cell also contains the 72B inner lid bolts detensioning robot, a radiological contamination swipe robot, CCTV cameras, the ceiling mounted shield valve with a Design Class II actuator, and transport system for radiological survey samples (swipes).

Transfer Cell Shuttle Car

The Design Class IIIA rail-mounted, chain-driven shuttle car (Figure 4.2-17) is designed to transfer either one 72B cask from below the CUR floor shield valve to below the Transfer Cell ceiling shield valve or one facility canister in a shielded insert from below the Hot Cell shield valve to below the Transfer Cell ceiling shield valve. The shuttle car is a steel frame structure about 20 ft (6 m) long. 6 ft (1.8 m) wide, with a 10 ft (3 m) deep pocket for holding either the 72B cask or the shielded insert.

The transfer cell shuttle car chain drive system, located at the west end of the Transfer Cell, moves the shuttle car at a speed of 10 to 31 ft (3 to 9.4 m) per minute. The chain drive system, with redundant steel roller chains (1 in wide links with a 3 in pitch), one steel roller chain can move the car, has double-chain sprockets driven by a solid shaft which penetrates the Transfer Cell wall so that the gear reducer and electric motor are located outside the Transfer Cell. The gear reducer and drive motor are connected by a triple V-belt.

Shielded Insert

The Design Class IIIA shielded insert is specifically designed to be used in the Transfer Cell to transport one loaded facility canister from below the Hot Cell shield valve to below the Transfer Cell ceiling shield valve. The shielded insert is designed similar to the 72-B road cask but has a larger inner diameter to accommodate the wider facility canister. The shielded insert will be installed on the shuttle car when loaded facility canisters, in the Hot Cell, are ready for underground implacement.

Transfer Cell Ceiling Shield Valve

The ceiling mounted shield valve is located under the port connecting the Transfer Cell to the Facility Cask Loading Room. The shield valve is a 12 in (30.5 cm) deep steel frame which supports a 42 in (106.7 cm) square shield plate that is 11 in (27.9 cm) thick. The 8 ft (2.4 m) long frame is bolted to the Transfer Cell ceiling (Figure 4.2-13). The Design Class II electric motor-driven-screw actuator is attached to the shield plate with a clevis pin. Valve travel from full-closed to full-open position is 42 in (106.7 cm) at a speed of 3 in (7.6 cm) per second. The shield valve is normally maintained in the closed position, except during facility cask loading activities. The valve motor is equipped with torque switches that will automatically shut off power if the valve tried to close against a hanging waste canister. The shield valve provides permanent shielding and separates the Transfer Cell and Facility Cask Loading Room for differential air pressure control. Air pressure in the Facility Cask Loading Room is maintained higher than that in the Transfer Cell. The Transfer Cell shield valve is interlocked to other RH waste handling system components as follows:

- Transfer Cell shield valve cannot be opened unless the CUR floor and Hot Cell shield valves are closed. This minimizes the potential for ventilation air imbalance that could occur if the three shield valves were open at the same time.
- Transfer Cell ceiling and Hot Cell shield valves are interlocked with the shuttle car drive so that the shuttle car cannot be moved if both shield valves are not closed. This interlock prevents damage to the canister from shuttle car movement during canister transfer.

Facility Cask Loading Room

The Facility Cask Loading Room has 54 in (137 cm) thick concrete shield walls and contains the equipment needed to load RH waste canisters into the facility cask and for the subsequent transfer of the loaded facility cask to the waste hoist conveyance. An operating console located behind a shadow shield in the north portion of the room is used to control the Facility Cask Loading Room operational activities. The Facility Cask Loading Room functions as an air lock between the waste shaft and the Transfer Cell and RH bay.

Facility Cask

The Design Class II facility cask (Figure 4.2-18) is a double end loading shielded container, weighing approximately 67,000 lbs (30,391 kg). The facility cask consists of two concentric steel cylinders with the annulus between them filled with lead. The internal cylinder has a 30 in (76 cm) diameter and a 0.50 in (1.27 cm) wall thickness. The outer cylinder has an external diameter of 41.75 in (106 cm) with a wall thickness of 0.625 in (1.59 cm). The lead annulus is 4.75 in (12.1 cm) thick. The facility cask has two support trunnions located approximately mid length at 180° from each other. The trunnions are the support points of the facility cask transfer car. The facility cask has a Design Class II powered gate-type shield valve at each end for loading and unloading RH waste canisters. Both shield valves are electrically operated with manual overrides and have air operated, spring loaded pins that lock the valve gates closed during transit. The motor operated mechanism opens and closes the shield valves at a nominal rate of 4 ft (1.2 m) per minute. The shield valves are designed to support the weight of a fully loaded RH waste canister when they are closed. Although the facility cask has two sets of forklift pockets, the lower set is used for transport and lifting from the transfer car and placing it on the emplacement equipment. In either activity, the robustness of the facility cask serves to prevent any breach of the waste canister.

Facility Cask Transfer Car

The facility cask transfer car (Figure 4.2-19), is a self propelled railcar weighing 7900 lbs (3583 kg) and is powered by a variable speed electric motor which drives the front wheels at speeds up to 30 ft (9.1 m) per minute. The facility cask transfer car has two A-frame structures, each with a trunnion saddle to support the facility cask weight and transports the facility cask in the stable horizontal position. It also allows rotating the facility cask on its trunnions to the vertical position by the facility cask rotating device working jointly with the facility cask front pivot pins.

The Facility cask transfer car is designed to perform the following functions:

- Serve as the platform for the facility cask in the Facility Cask Loading Room.
- Transport the facility cask from the Facility Cask Loading Room to the waste shaft conveyance.
- Serve as the platform for the facility cask while the facility cask is transported underground by the waste shaft conveyance.
- Transport the facility cask from the waste hoist conveyance to an underground area accessible by the 41-ton forklift.

Facility Cask Rotating Device

The Design Class IIIA facility cask rotating device is a floor mounted hydraulically operated structure designed to rotate the facility cask from the horizontal position to the vertical position for waste canister loading and then back to the horizontal position after the waste canister has been loaded into the facility cask (Figure 4.2-20). Hydraulic rams are attached to the center of the connecting beams of two rotating arms. One end of each rotating arm is attached to a pivot point on the floor mounted structure. The other end of each rotating arm latches to a pivot pin on the facility cask top shield valve enclosure. The hydraulic rams extend to raise the facility cask to the vertical position and retract to lower the facility cask to the horizontal position.

6.25 Ton Grapple Hoist

The Design Class IIIA grapple hoist is mounted to the ceiling of the Facility Cask Loading Room. The hoist is gear driven by a two speed induction motor for operation at 8 and 24 ft (2.4 and 7.3 m) per minute. A torque monitoring control system is provided to indicate output torque of the motor and to furnish a signal to shut the hoist down if the load is excessive. In the event of a power failure, the grapple hoist brakes are automatically set. Figure 4.2-21 shows the 6.25-ton grapple hoist, the shield bell, and the stationary alignment sheave.

Stationary Alignment Sheave

The stationary alignment sheave (single cable pulley) is anchored to the Facility Cask Loading Room ceiling above the cask loading station. The stationary alignment sheave is used to convert the horizontal travel of the hoist cable to vertical travel of the facility grapple. The cable passes over the pulley and down to the block in the top of the shield bell. The cable then extends back to the ceiling where it is attached to the ceiling anchored tension load cell assembly. This arrangement provides a accurately positioned vertical lift for the facility grapple even though there is a lateral shift of the cable on the hoist drum. A limit switch, also part of the stationary alignment sheave, is mounted on a bracket attached to the pulley housing is used to sense the upper travel limit of the shield bell.

Facility Grapple

The Design Class IIIA facility grapple (Figure 4.2-22) is a special lift fixture that is designed to engage a standard WIPP pintle. The facility grapple has an axially mounted electrically operated actuator that rotates a drive gear that drives three lifting lugs into or out of engagement under the WIPP pintle. In the event of a power failure when the facility grapple was engaged on a lifting pintle, the lifting lugs would automatically lock in place.

Telescoping Port Shield

The Design Class II telescoping port shield (Figure 4.2-23) is mounted in the floor of the Facility Cask Loading Room, centered directly over the Transfer Cell ceiling shield valve opening. An electrical motor driven jacking system is used to raise the telescoping port shield to mate with the facility cask lower shield valve during RH waste canister transfer. The telescoping port shield has a 36 in (91.4 cm) inside diameter for the RH waste canister to pass through.

Shield Bell and Block

The Design Class II shield bell (Figure 4.2-24) is a heavy walled steel casting that is used to provide shielding from the waste canister when the facility cask top shield valve is open. The shield bell has internal cavities to house the facility grapple and the grapple support block. The grapple cavity is 18.25 in (46.4 cm) in diameter. The grapple support block cavity is a modified tee-shaped, nominally 6 in (15.2 cm) wide, to house the single pulley block and provide a path for the grapple electrical cable to pass through to the grapple. There are three penetrations with bronze bushings through the top of the shield bell, two for the wire rope that moves the facility grapple and one for the electrical cable that controls the opening and closing of the facility grapple. When not in use, the shield bell rests on the top of the facility grapple support block which is suspended from the grapple hoist. The shield bell is supported by the facility cask when the facility grapple is in use.

Underground RH Waste Handling Equipment

The underground handling and emplacement equipment consists of diesel-powered forklifts and the horizontal emplacement and retrieval equipment (HERE). Since the RH waste handling equipment is the largest equipment transporting waste in the waste disposal area, its size is used to define the minimum operating sized opening of 11 ft (3.35 m) vertical and 14 ft (4.3 m) horizontal for waste handling transport.

Horizontal Emplacement and Retrieval Equipment (HERE)

The Design Class IIIA HERE is used in the Underground to transfer a RH TRU waste canister from the facility cask into a horizontal disposal borehole. The HERE includes the following equipment:

Waste Transfer Equipment

- Alignment fixture
- Shield collar
- Leveling platform
- Staging platform
- Facility cask
- Portable power cable
- Control console
- Transfer carriage
- Transport equipment

Borehole Related Components

- Shield plug
- Shield plug carriage
- Strongback

Alignment Fixture

The alignment fixture (Figure 4.2-25) provides a reference plane for aligning the waste transfer machine with respect to the borehole to allow waste canister and shield plug installation. It is a welded carbon steel structure consisting of a base plate with three hydraulic jacks and a vertical face plate with holes for attaching and bolting the shield collar. It has two forklift pockets to facilitate its moving. The horizontal base of the fixture serves to support the front end of the waste transfer machine. It has two alignment pins located to ensure that the waste transfer machine and shield collar line-up.

The three hydraulic jacks are used to align the alignment fixture with the bore hole. The hydraulic system is powered by a hydraulic pump with a custom built 20 gal (75.7 L) hydraulic tank located on the Alignment Fixture Assembly. Each of the jacks have a maximum stroke of 10 in (25.4 cm). The alignment fixture has three tilt sensors and three proximity switches. The tilt sensors provide tilt information to permit the operator to level the alignment fixture. The proximity switches sense the gap between the shield collar and the facility cask.

The alignment fixture has four hydraulic locking clamps rated at 3600 psi (253.1 kg/cm^2), to lock the shield collar to the facility cask. The alignment fixture also has a passive fire suppression system with four discharge nozzles aimed at the hydraulic power unit and the leveling jacks.

Shield Collar

The shield collar (Figure 4.2-25) is a carbon steel device used when emplacing a waste canister and shield plug into a borehole. It is attached to the alignment fixture and inserted into the counterbore in the borehole to limit the dose rate during emplacement operations.

The shield collar is 29 in (73.6 cm) long, has an outside diameter of 44 in (111.8 cm) and has a 7 in (17.8 cm) wall thickness. A one inch (2.54 cm) thick, 62 in (157.5 cm) diameter mounting ring is welded to the outside of the collar. The mounting ring has twelve holes which are used to bolt the shield collar to the alignment fixture. The shield collar weighs approximately 6,800 lb (3084.4 kg).

Leveling Platform

The leveling platform is a steel frame 300 in (762 cm) long, 113 in (287 cm) wide, and 24 in (61 cm) high on which the components to operate and interface with the alignment fixture and staging platform are located (Figure 4.2-25). The front end of the leveling platform has two holes that sit on the alignment fixture alignment pins. A motor driven hydraulic pump operates a hydraulic jack, which is located at the rear of the leveling platform. The jack is used to align the waste transfer machine (leveling platform, staging platform, and transfer carriage) axis with the alignment fixture.

Three sets of rails are mounted on each side of the leveling platform. The rails provide a mounting surface for the staging platform. The staging platform positions the front face of the facility cask against the shield collar at a speed of 6.7 in (17 cm) per minute.

Staging Platform

The staging platform is a steel frame 288.5 in (732.8 cm) long that rests on roller bearings which engage and ride on the rails of the leveling platform. The staging platform supports the facility cask and transfer carriage, and has a hydraulic ram providing linear motion to the transfer carriage. The transfer carriage rides on two 123.5 in (313.7 cm) long rails bolted to the top of both sides of staging platform. The staging platform requires a regulated compressed air supply to operate the facility cask lock pins. Figure 4.2-25 shows the staging platform.

The following control devices are mounted on the staging platform: A <u>tilt sensor</u> used to monitor the longitudinal tilt of the waste transfer machine for alignment with the alignment fixture. <u>Two position detection limit switches</u> (interlocks) which are activated when the shield plug carriage is seated on the staging platform rails.

Transfer Carriage

The transfer carriage (Figure 2.4-25) is a large steel shield cylinder with its own hydraulic system that is used to push either the waste canister from the facility cask into the borehole or the shield plug from the shield plug carriage into the borehole.

The rear end of the transfer carriage houses the transfer mechanism and includes heavy wall shielding to prevent exceeding radiation dose rate limits when the facility cask top shield valve is opened. The transfer carriage housing is a steel cylinder 91.25 in (231.8 cm) long, 30 in (76.2 cm) inside diameter. The hydraulic drive system components which operate the transfer mechanism are mounted in or on the transfer carriage housing. The transfer mechanism and grapple are used to emplace the waste canister and shield plug into the borehole.

The transfer carriage has roller bearings which ride on the rails on the staging platform. The transfer carriage drive system, which positions the front of the housing against the facility cask during waste canister emplacement, is mounted on the staging platform. During shield plug emplacement, the transfer carriage is retracted to provide room for installing the shield plug carriage on the staging platform.

Its transfer mechanism consists of a double acting five stage, telescopic, hydraulic cylinder attached at the plunger end of the transfer carriage housing end plate. The front end of the cylinder is supported by two rollers attached to a 2.75 in (7.0 cm) thick steel plate which provides shielding and supports the grapple. The hydraulic cylinder has a 10,000 lbs min. load capacity, a 24 ft (7.3 m) stroke, and a retracted length of 70 in (178 cm). If a power failure occurs, manual means are provided to retract the transfer mechanism from a partial or fully extended position and to release the grapple.

The transfer carriage is equipped with four locking clamps to clamp the carriage to both the facility cask and shield plug carriage.

The following position sensors are mounted on the transfer carriage:

Two spring-loaded reel type mechanisms attached to multi-turn rotary potentiometers monitor the travel distance of the transfer carriage.

Three proximity metal detecting switches that activate and indicate when the transfer carriage to facility cask gap is less than 0.125 in (0.318 cm).

Two grapple mounted proximity detection switches to detect when the grapple comes in contact with the pintle of the waste canister or shield plug.

Shield Plug Carriage

The shield plug carriage (Figure 4.2-26) is a 74 in (188 cm) long, 0.5 in (1.27 cm) thick saddle which holds the shield plug in a horizontal position during emplacement and aligns the bottom of the shield plug with the bottom of the facility cask cavity. The shield plug carriage is placed on and supported by the rails of the staging platform. The shield plug carriage has two forklift pads to facilitate handling by a forklift.

Strongback

The strongback, weighing approximately 300 lbs (136 kg), is a 10 in (25.4 cm) I-beam, 72 in (189 cm) long forklift fixture with two forklift openings in the web of the beam (Figure 4.2-27) . The strongback is used to lift and handle a shield plug. Swivel hooks and shackles are bolted to each end of the strongback to allow the use of fabric slings to hold the shield plug.

Control Console

The control console for the HERE provides all the controls and information displays necessary to operate the waste transfer equipment. The console is connected by 25 ft (7.62 cm) long plug-in disconnect cables and is mounted on a moveable platform truck to facilitate relocation. The length of the cables allow locating the console a sufficient distance from the HERE to ensure radiation doses to the console operator are kept ALARA.

Portable Power Cable

The portable power cable is used to electrically connect the HERE to a 480 volt, 3 phase, 60 Hz power source.

Transport Equipment

The transport equipment consists of wheel assemblies that convert the leveling platform to a trailer like configuration used to move the waste transfer machine assembly from one location to another. The assembly can be towed by a forklift or tractor.

Shield Plugs

Shield plugs are 29 inches in diameter and approximately 70 inches long, including the pintle. The pintle is a standardized configuration, used for handling and for interfacing with the HERE.

The majority of the shielding material in a shield plug is at the end closest to the emplaced canister (away from the open end of the borehole). There are two different types of shield plugs. One uses concrete for shielding and has a High-Density Polyethylene (HDPE) jacket. The other uses cast iron for shielding and has a steel jacket.

Concrete shield plugs have concrete shielding material at both ends. The end closest to the canister has approximately 20 inches of concrete, while the pintle end has about 12 inches. Both sections of concrete are cast in the HDPE jacket around a length of pipe that goes through the center of the shield plug. Plates are attached to the pipe to secure the two sections of concrete. Concrete shield plugs weigh approximately 2,000 pounds.

Metal shield plugs have a minimum of 5-1/8 inch thick cast iron shielding at the end closest to the canister. A pipe attached to the cast iron shielding extends through the center of the shield plug. It is also attached to the steel jacket. Metal shield plugs weigh about 1,500 pounds.

Shield plugs are transported by a forklift using the strongback and slings. Figure 4.2-28 shows the waste canister and shield plug inside the storage borehole.

41-Ton Forklift

The 41-ton diesel powered forklift has a lift capacity of 82,000 lb (37,194.6 kg) and a maximum lift height of 99 in (251.5 cm). The forklift is provided with a two range (high or low) travel selector, but does not have a speed indicator. It is used in the Underground to lift the facility cask from the facility cask transfer car and transport it at a speed of approximately 3 to 4 mi (4.8 to 6.4 km) per hour to the active RH waste emplacement room and to place it on the waste transfer machine assembly. It is also used to transport the waste transfer machine assembly. Figure 4.2-29 shows the 41-ton forklift placing the facility cask on the waste transfer machine assembly.

20-Ton Forklift

The 20-ton diesel powered forklift has a lift capacity of 40,000 lb (18,143.7 kg) and a maximum lift height of 84 in (213.3 cm). It is used in the Underground to lift and handle the waste transfer machine assembly and the alignment fixture assembly (alignment fixture and shield collar).

6-Ton Forklift

The 6-ton diesel powered forklift has a lift capacity of 12,000 lb (5,443.1 kg) and a maximum lift height of 72 in (182.9 cm). It is used in the Underground to lift and handle the shield plug carriage and the shield plug using the strongback.

4.2.1.1.2 Building 412

Building 412 is Design Class IIIA; however, the structural portions of the building are Design Class II because of its interface with the WHB. Building 412 provides space and equipment for minor scheduled and unscheduled maintenance activities and includes a 25-ton overhead crane.

4.2.1.1.3 WHB Support Areas

WHB support areas, common to both the CH TRU and RH TRU areas of the WHB, include the waste hoist support areas and the main mechanical equipment room containing the HVAC equipment.

Air locks are located on both the CH TRU and RH TRU sides of the waste hoist, including the conveyance loading room on the CH TRU side of the waste hoist and the Facility Cask Loading Room on the RH TRU side of the waste hoist. Access doors to the waste hoist are interlocked to control air flow; which is towards the waste hoist from the CH TRU loading room or from the RH TRU Facility Cask Loading Room.

The waste hoist control room provides space and equipment needed for operation of the waste hoist and controls for operating the waste hoist in either manual or automatic mode.

The main mechanical equipment room of the WHB houses the exhaust fans, HEPA filters, and the associated ducting that controls ventilation flow within the WHB.

4.2.1.1.4 Waste Handling Building Effluent Monitoring System

The WHB exhaust system is Design Class IIIA, the supply system is Design Class IIIB, and the HEPA filters and isolation dampers are Design Class II. The WHB ventilation system has a single discharge point, with most of the air coming from the WHB being processed through a prefilter and two stages of HEPA filters prior to its release to the environment. Some of the air may go down the waste shaft (Section 4.4.3.1). Station C is located downstream of the HEPA filters and provides fixed air sampling to quantify the total amount, if any, of radioactivity released to the environment.

4.2.1.2 Exhaust Filter Building

The Exhaust Filter Building (EFB), adjacent to the exhaust shaft, contains the HEPA filtration equipment associated with the underground ventilation system. During normal operations, air is pulled from underground areas, up the exhaust shaft, and discharged to the environment without the HEPA filtration units in service. In the event of an underground radiological event, airflow from the underground is diverted through the HEPA filtration to remove airborne radioactive particulates from the air stream. The underground ventilation system is discussed in Section 4.4.3.3, and the EFB layout is shown in Figure 4.2-30.

The EFB structure is classified as Design Class IIIA, the HEPA filters and isolation dampers are Design Class II. The major areas within the EFB are the filter room and support area. The filter room houses the HEPA filtration units. The support area includes two mechanical equipment rooms housing the building filtration units, the exhaust fans, the supply-air handling units, the motor control centers, and the air lock.

The EFB effluent monitoring system is composed of Station A which obtains its sample from a point 21 ft (6.4 m) below ground level in the exhaust shaft and Station B which obtains its sample from a point downstream from the EFB HEPA filtration system. Each station contains fixed air samplers operated by the WIPP, one each for WIPP, the Carlsbad Environmental Monitoring and Research Center (CEMRC), and the Environmental Evaluation Group (EEG), quantifying the total amount of radioactivity released to the environment.

4.2.1.3 Water Pumphouse

The Water Pumphouse, adjacent to the two water storage tanks (Figure 4.1-2a), contains two fire water pumps (one electric and one diesel), three electric domestic water pumps, and water chlorination equipment and chemical storage. The Water Pumphouse is an above ground steel frame and siding building classified as Design Class IIIB.

4.2.1.4 Support Building

The Support Building, adjacent to the WHB, houses general support services for activities at the WIPP facility. The Support Building is constructed of steel framing and sandwich panel siding, and is classified as Design Class IIIA. The main lateral force-resisting members of the Support Building are designed for DBE and DBT to protect the WHB from their structural failure.

4.2.1.5 Support Structures

The following support structures are designed to the Uniform Building Code (UBC), and are classified as Design Class IIIB support structures.

- Salt Handling Shaft Head Frame and Hoist House
- Air Intake Shaft Head Frame and Hoist House
- Main Warehouse Building
- Guard and Security Building
- Main Gatehouse
- Safety and Emergency Services Building
- Compressor Building
- Engineering Building
- Training Building

4.2.2 Shaft and Hoist Facilities

4.2.2.1 Shaft and Hoist General Descriptions

The WIPP facility utilizes four shafts:

- Waste Shaft
- Salt Handling (SH) Shaft
- Exhaust Shaft
- Air Intake Shaft (AIS)

These shafts are vertical openings extending from the surface to the underground disposal level as shown on Figure 4.1-2a, which shows the location of the shafts relative to surface features. All shaft construction and mining operations are in accordance with 30 CFR 57.[1]

The waste hoist system is designated as a Design Class IIIA; and, the SH shaft, the exhaust shaft, and the AIS hoist system are designated as Design Class IIIB. The waste shaft, SH shaft and AIS shaft are designed to resist the dynamic forces of the hoisting system. Shaft linings are designed based on expected hydrostatic heads in the Rustler Formation.

4.2.2.2 Shaft and Hoist General Features

The principal components of each shaft are the shaft collar (extending from above the ground surface to the top of the bedrock), the shaft lining (extending from the bottom of the collar to the top of the salt formation at about 850 ft (259 m) below the surface), and the key section that terminates the lining in the salt formation, with the remainder of each shaft being unlined.

The shaft collars are situated about 400 ft (122 m) above the historic flood plain of the Pecos River and the collar slab around the shaft, where used, is at a higher elevation than the surrounding ground.

The waste shaft, the SH shaft, and the AIS are equipped with conveyances with hoist towers constructed of structural steel. The conveyances in the waste shaft and AIS are guided by steel cables (guide ropes), while the SH shaft conveyance is guided by fixed wooden guides equipped with safety dogs. The waste shaft is equipped with catch sprags in the hoist tower to prevent the conveyance or the counterweight from falling into the shaft if the conveyance over-traveled against the upper crash beam and the hoist ropes failed.

The waste hoist and SH hoist have redundant brake systems designed so that either set of brakes can stop a fully-loaded conveyance under all conditions. In the event of a power failure, the brakes will set automatically. The AIS hoist is also equipped with two sets of brakes.

The control system for each hoist can detect malfunctions or abnormal operations (such as over-travel, over-speed, power loss, circuitry failure, or starting in a wrong location), trigger an alarm for the abnormal operation, and automatically shut down the hoist.

4.2.2.3 Shaft and Hoist Specific Features

The main purpose of the waste hoist system is for moving radioactive waste from the surface to the underground. The system can be used to remove radioactive waste from the disposal area if required. It is also used to transport personnel, material and equipment. The system supports maintenance in the waste shaft. The equipment that is part of this system is the waste hoist equipment installed in the WHB, the headframe, shaft switches, and the conveyance. The hoist systems in the shafts and all shaft furnishings are designed to resist the dynamic forces of the hoisting operations (these forces are greater than the seismic forces on the underground facilities). In addition, the waste hoist headframe is designed to withstand a DBE (the DBE is defined in Section 3.2.7). The waste hoist is equipped with a control system that will detect malfunctions or abnormal operations of the hoist system (such as over-travel, over-speed, power loss, circuitry failure, or starting in a wrong direction), will trigger an alarm for that condition and automatically shut down the hoist. The waste shaft and hoist arrangement is shown on Figure 4.2-31.

The inside diameter of the unreinforced concrete-lined upper portion of this shaft is 19 ft (5.8 m). The waste hoist conveyance (outside dimensions) is approximately 30 ft (9.15 m) high by 11 ft (3.35 m) wide by 15 ft (4.6 m) deep, and carries a maximum payload of 45 tons. The conveyance contains an upper and lower deck. During loading and unloading operations, the conveyance is steadied by fixed guides. At the underground waste hoist station, rope stretch is removed by a chairing device that supports the weight of the conveyance and payload.

The waste hoist is an electrically driven friction hoist. The 600 HP DC voltage waste hoist motor is designed for a maximum operating speed of 13.5 RPM. The motor's field is formed by wound poles, and is supplied with a constant DC current obtained from rectifying a 480 volt three-phase supply. The DC voltage magnitude and direction controls the speed and direction of the hoist. The maximum rope speed of the waste hoist is approximately 500 ft (152.4 m) per minute. There is one silicon controlled rectifier (SCR) power supply to power the hoist. The brake system can safely stop and hold the conveyance without the drive motor. Automatic control circuitry will sense electrical problems with the drive motor and stop the hoist.

There are two brakes, mounted approximately 180 degrees apart, on each braking flange of the hoist wheel. These disc brakes (four total) are spring set, and are released by hydraulic pressure. Brake switches indicate brake set, release, and wear. A redundant hydraulic power supply exists to supply hydraulic pressure to release the brakes. Each hydraulic unit has its own motor, pump, and oil reservoir. There is an automatic switch over from the primary system to the standby system if the hydraulic pressure decreases below the set point. There is no automatic switch over from the standby system to the primary system. A timed back up pressure relief path exists to set the brakes if for any reason the brake pressure is not released within a few seconds after the application of the brake set signal.

Hoisting, tail, and guide ropes are provided for the safe operation of the conveyance and the counterweight. The hoisting ropes are 1-3/8" (3.5 cm) diameter, fully locked coil bright steel ropes suitable for use with a friction hoist. The tail ropes are 2-1/4" (5.7 cm) diameter, non-rotating bright steel, with a synthetic fiber core. The three tail ropes approximately balance the weight of the six hoisting ropes. The guide ropes are 1-3/4" (4.45 cm) diameter, half-lock bright steel with internal and external lubrication and are designed to operate with minimal field lubrication only. There are four guide ropes for the conveyance and two guide ropes for the counter weight. Tension in these ropes is maintained by weights on the bottom of the ropes. The size of the weights are different to prevent harmonic vibrations during hoist operation.

A conveyance and counterweight over-travel arrester system exists to stop movement if the normal control system has failed. Four timbers are provided at the tower and the sump regions for both the conveyance and the counterweight to assist in absorbing energy to stop an over traveling conveyance or counterweight. Retarding frames rest in notches either at the top of the wood arresters (sump area), or at the bottom of the wood arresters (tower area). The retarding frames have knives that cut into the timbers if driven by the conveyance or the counterweight.

If the conveyance over-travels against the upper crash beams and the hoist ropes fail, safety lugs on the conveyance mate with pivoting dogs on the catchgear mounted in the head frame to prevent the conveyance from falling if the ropes break. The counterweight catchgear system functions in a similar fashion to stop the counterweight from falling. Each catchgear frame is mounted on a hydraulic shock absorber which absorbs energy from a descending conveyance or counterweight. Lever arms are used to raise the pivoting dogs if they are not supporting any weight.

Emergency stop buttons are provided at the Master Control Station (MCS) and at all control stations to effect an emergency stop of the hoist. These buttons are operable in all modes of hoist operation, and when pressed, will open the control power loop and set the hoist brakes. These buttons provide the most rapid means of bringing the hoist to a stop. A controlled stop button that will decelerate the conveyance before setting the brakes is located on the control panel, to the left of the MCS. The controlled stop is a slower and softer stopping action than the emergency stop.

Eleven signals, two analog and nine contact, are used during Waste Hoist operations and are transmitted to the CMR for remote monitoring. The analog signals are the hoist motor voltage and amperes. The contact signals are "Hoist Operation, Manual", "Hoist Operation, Semi-Auto", "Hoist, Abnormal Condition", "Emergency Stop", "Men Working in Shaft", "Waste on Hoist", "Personnel on Hoist", "Hoist, Up", and "Hoist, Down".

The waste hoist Signaling System consists of bells and lights activated by the operators at the MCS and the operating stations.

The SH shaft is used to transport mined salt to the surface and to provide personnel transportation between the surface and the underground horizon. It also acts as a duct for supplying air to the underground mining and disposal areas, and is one route for the power, control, and communications cables. The hoist's maximum rope speed is approximately 1,800 ft (548.6 m) per minute. The shaft inside diameter is 10 ft (3.05 m) for the steel lined portion, and 11 ft 10 in (3.6 m) for the unlined portion.

The exhaust shaft is used as the opening to exhaust air from the underground disposal areas to the surface. The inside diameter of the lined portion of this shaft is 14 ft (4.3 m). The shaft lining is unreinforced concrete. The shaft key incorporates polymeric chemical water seal rings. The exhaust shaft collar does not utilize a building or head-frame, and is sealed at the top by a 14 ft (4.3 m) diameter elbow that diverts exhaust air into the exhaust ventilation system.

The AIS is used primarily to supply the fresh air to the underground areas, and is also used for backup egress of personnel between the surface and the underground horizon. The hoist's maximum rope speed is approximately 830 ft (253 m) per minute. The inside diameter of the unreinforced concrete lined upper portion of this shaft is 16 ft (4.9 m).

4.2.3 Subsurface Facilities

4.2.3.1 General Design

The subsurface facilities are located 2,150 ft (655 m) below the surface and include the waste disposal, north, and support areas. The underground support areas contain the facilities to service and maintain all underground equipment for mining and waste disposal operations, monitor for radioactive contamination, and allow limited decontamination of personnel and equipment. The mining, north, and waste disposal areas are isolated from each other by air locks and bulkheads. Some mining construction activities may be required within an active disposal panel, however, these activities can be separated from the disposal processes and areas by schedule (time), ventilation controls, and temporary bulkheads.

The underground support facilities and their ventilation flows in the shaft pillar area are shown on Figure 4.2-32.

The support facilities on the disposal side provide a maintenance area, a vehicle parking area with plug-in battery charging, and a waste transfer station.

The support facilities on the mining side consist of a vehicle parking area, electrical substation, welding shop, a warehouse, offices, materials storage area, emergency vehicle parking alcoves, a diesel equipment fueling station, and a mechanical shop.

An experimental area, separate from the other areas of the underground repository, contained areas for evaluating the interaction of simulated waste and thermal sources on bedded salt under closely monitored, controlled conditions. The experimental area was deactivated in September 1996. The deactivation was accomplished by the construction of two light weight cementitious block walls. The walls are located just north of the N780 drift in the E300 and E140 entries. The light weight cementitious walls not only serve as a barricade preventing access, but also isolate and prevent any measurable ventilation from entering or exiting the deactivated area. (Portions of this area were re-entered for the permanent disposal of salt mined from Panel 2 and are being maintained open).

Underground mining procedures and cavity dimensions incorporate the results of the salt creep analysis in DOE/WIPP 86-010, Waste Isolation Pilot Plant Design Validation Final Report.[2]

The mining area fuel dispensing room is in an alcove off the mining exhaust entry. This fuel dispensing room provides a location and pumping facilities for a portable fuel tank. The portable diesel tank hoisting and lowering is done through the waste shaft, or the SH shaft as required. An automatic dry chemical fire suppression system, with main and reserve tanks, is provided in the fueling area. Any fire generated smoke and fumes would be exhausted directly to the exhaust ventilation system.

4.2.3.2 TRU Waste Disposal Area

The disposal area (Figure 4.1-3) provides space for 6.2 x 10^6 ft^3 (1.76 x 10^5 m^3) of TRU waste material in TRU waste containers of which up to 2.5 x 10^5 ft^3 (7.08 x 10^3 m^3) can be RH TRU waste. This area also includes the four main entries and the cross-cuts that provide access and ventilation. Figure 4.2-33 shows a typical waste container disposal configuration.

The ribs (pillars or walls) of the disposal rooms and entries are used for storing RH TRU waste canisters. Although RH TRU waste and CH TRU waste can be disposed in the same rooms, all RH waste emplacement in a room must be complete before CH waste can be emplaced in that room.

The amount of TRU waste in each panel/room is limited by thermal, structural, and physical considerations, and emplacement is designed not to exceed 10 kW/acre. Based on current design and thermal constraints, a spacing of approximately 30 in between centers for RH TRU waste canisters has been specified, and a shield plug provides shielding between the canister and the room.

Typically main entries and cross cuts in the repository provide access and ventilation to the disposal area. The main entries link the shaft pillar/service area with the disposal area and are separated by pillars. Typical entries are 13 ft (4.0 m) high and 14 to 16 ft (4.3 to 4.9 m) wide. Each of the panels labeled Panels 1 through 8 will have seven rooms. The locations of these panels are shown in Figure 4.1-3. The rooms will have nominal dimensions of 13 ft (4.0 m) high by 33 ft (10 m) wide by 300 ft (91 m) long and are separated by 100 ft (30 m) wide pillars.

If waste volumes disposed of in the eight panels fail to reach the stated design capacity, the DOE may choose to use the four main entries and crosscuts adjacent to the waste panels (referred to as the disposal area access drifts) for disposal, as follows:

E-300 will be mined to be 16 ft (4.9 m) wide and 13 ft (4.0 m) high
E-140 is mined to 25 ft (7.6 m) wide by 13 ft (4 m) high
W-030 and W-170 will be similar to E-300.

Presently, only the construction of these areas is planned. The above drifts extend from S-1600 to S-3650 (i.e., 2,050 ft [625 m] long). Crosscuts (east-west entries) will be 20 ft (6.1 m) wide by 13 ft (4 m) high by 470 ft (143 m) long. The layout of these excavations is shown on Figure 4.1-3.

Panel 1 is the first panel to be used for waste disposal, and was excavated from 1986 through 1988. Its rooms and access drifts have been rock-bolted to assure stability. Panel 1 has been re-bolted with threaded bar resin anchors. In addition, Room 1 has been supplied with a supplementary roof-support system consisting of rock bolts, steel channel sets, and a wire-mesh and lacing system. The DOE intends to mine panels in the following order:

Final ½ Panel 10 (access drifts for Panels 1,2,7, and 8)
Panel 2
Panel 9 (access drifts for Panels 3,4,5 and 6)
Panel 3
Panel 4
Panels 5 through 8

At normal operating (waste throughput) rates, rock bolting in Panels 2 through 8 may only be required locally (i.e. spot bolting). Rock fixtures used at WIPP comply with 30 CFR 57, [1] Subpart B. Each ground control support system installation is individually assessed and evaluated. As a result they vary from time to time and place to place.

A discussion of the design life of underground disposal rooms is included in Section 4.3.9. An evaluation of the effective life of the underground rooms in Panel 1 was performed during April 1991, by a panel of geotechnical experts. The panel members concluded that if no additional remedial measures were taken, the rooms in the panel would likely have a total life of seven to eleven years from the time of excavation using the installed roof support system, consisting of patterned mechanically anchored rockbolts. Experience in Panel 1 confirmed the conclusion of the expert panel.

Plans call for bolt systems installed in the future to equal or exceed the bearing characteristics of the bolts used in the primary pattern in Panel 1. The configuration of Panel 2 through 8 will be similar to Panel 1, therefore; the performance of these rooms should be similar to those in Panel 1. Supplementary support systems will further extend the effective life of the rooms, should they be required. A detailed discussion of initial and supplementary support systems is included in Section 4.3.9.

The support system will be subjected to longitudinal and lateral loading due to the rock deformation. The anchorage components may undergo lateral deformation due to offsetting along clay seams or fractures and increasing tensile loading. Rigid, non-yielding support systems are not designed to accommodate salt creep; however, they do respond to creep and continue to provide support during ductile behavior. Yielding support systems are currently being evaluated in the WIPP underground. These systems are designed to yield at predetermined loads, and provide support over their prescribed yield interval without maintenance. Preliminary data indicate that the design and performance of some of these systems are clearly superior to rigid systems in their ability to respond to salt creep while maintaining adequate ground support.

Because the disposal area access drifts must remain open and operational for a much longer period than any panel, they will require additional consideration from time to time. They are subject to regular and systematic inspection and evaluation, and appropriate ground control measures will be implemented whenever necessary.

The DOE will ensure that any room in which waste will be placed will be sufficiently supported to assure compliance with all laws and regulations. Creep and rock failure in WIPP excavations progress slowly. As a result, many years pass before any operationally significant instability could occur. This long period allows more than sufficient time for whatever actions are appropriate, such as additional monitoring, installing supplementary support, or taking other managerial and operational actions. Support is installed to the requirements of 30 CFR 57,[1] Subpart B. Random checks are conducted by Quality Assurance/Quality Control personnel as each system is installed. Geotechnical monitoring, design, analysis, and planning are performed in addition to regulatory inspections, maintenance, and construction, as discussed in detail in Section 4.3.9.

The underground facilities ventilation system will provide a safe and suitable environment for underground operations during normal WIPP facility operations. The underground system is designed to provide control of potential airborne contaminants in the event of an accidental release or an underground fire.

The main underground ventilation system is divided into four separate flows (Figure 4.2-32): one flow serving the mining areas, one serving the northern areas, one serving the disposal areas, and one serving the Waste Shaft and station area. The four main air flows are recombined near the bottom of the Exhaust Shaft, which serves as a common exhaust route from the underground to the surface. The underground confinement/ventilation system is discussed in detail in Section 4.4.

4.2.3.3 Panel Closure System

Chapter 10 discusses the Closure Plan that describes the activities necessary to close the WIPP facility. The Closure Plan describes several types of closure. The first type is panel closure, which occurs as underground panels are filled. Secondly, final closure at the end of the Disposal Phase is described.

Following completion of waste emplacement in each underground panel, disposal-side ventilation will be established in the next panel to be used, and the panel[3] containing the waste will be closed. A panel closure system will be emplaced in the panel access drifts (Figure 4.1-3). The panel closure system is designed to meet the following requirements that were established by the DOE for the design [3]:

- The panel closure system shall consider potential flow of VOCs through the disturbed rock zone (DRZ) in addition to flow through closure components.
- The panel closure system shall perform its intended functions under loads generated by creep closure of the tunnels.
- The panel closure system shall perform its intended function under the conditions of a postulated methane explosion.
- The nominal operational life of the closure system is 35 years.
- The panel closure system for each individual panel shall not require routine maintenance during its operational life.
- The panel closure system shall address the most severe ground conditions expected in the waste disposal area.
- The design class of the panel closure system shall be IIIB (which means that it is to be built to generally accepted national design and construction standards).

- The design and construction shall follow conventional mining practices.
- Structural analysis shall use data acquired from the WIPP underground.
- Materials shall be compatible with their emplacement environment and function.
- Treatment of surfaces in the closure areas shall be considered in the design.
- Thermal cracking of concrete shall be addressed.
- During construction, a QA/QC program shall be established to verify material properties and construction practices.
- Construction of the panel closure system shall consider shaft and underground access and services for materials handling.

The final panel closure design[3] was prepared with the assumption that there would be no backfill in the disposal rooms. With the inclusion of backfill, the design has been re-examined, and it has been determined that the changes are insignificant for several reasons. First, the backfill has no effect on the gas generation rate so that the values used in the design for gas generation and methane buildup remain the same. Second, the quantity of backfill is sufficient to fill one-tenth of the void volume in the room. This results in more rapid pressurization of the room; however, the effect is small and will only be important after the facility is sealed. Third, the reduced volume will result in a faster concentration buildup of methane. This would not result in a revision of the design. Instead, it would change the criteria for installing explosion walls.

The design for the panel closure system calls for a composite panel barrier system consisting of a rigid concrete plug with or without removal of the DRZ, and either an explosion-isolation wall or a construction-isolation wall. The design basis for this closure is such that the migration of hazardous waste constituents from closed panels during the operational and closure period would result in concentrations at the WIPP facility well below health-based standards. The source term used as the design basis included the average concentrations of VOCs from CH waste containers, as measured in headspace gases through January 1995. The VOCs are assumed to have been released by diffusion through the container vents, and are assumed to be in equilibrium with the air in the panel. Emissions from the closed panel occur at a rate determined by gas generation within the waste and creep closure of the panel. Due to the relatively small amount of RH waste (approximately five percent of the total waste volume), VOC emissions from RH waste are assumed to contribute insignificantly to total VOC emissions. This design meets the environmental performance standard.

Figures 4.2-34 and 4.2.35 show diagrams of the panel closure design and installation envelopes. DOE/WIPP-96-2150[3] provides the detailed design, and the design analysis for the panel closure system. The panel closure design is such that components can be added or removed, or their shapes adjusted depending on the particular ground conditions at the time of installation. For example, in DOE/WIPP-96-2150[3], Option A represents the likely closure of panels less than 20 years old at the time of final facility closure, and whose entries are sufficiently intact such that DRZ removal is not needed. These would likely include Panels 6 through 8.

Option B represents the preferred option for panels that will be closed for more than 20 years prior to final facility closure, and whose entries are reasonably intact at time of closure. These will likely be Panels 2 through 5. Option C may be desirable for panels whose entries require DRZ removal, and whose closure precedes final facility closure by less than 20 years. This is the likely configuration of the closure for Panels 9 and 10. Finally, Option D may be appropriate for panels whose entries require significant removal of the DRZ, and whose closure will precede final facility closure by more than 20 years. Panel 1 is the most likely candidate for this type of closure.

The 20-year limit in the design selection process is based on what the DOE believes to be conservative analytical results that indicate methane, being generated by waste degradation at the rate of 0.1 mole per drum per year, will not reach flammable concentrations for at least 20 years. As part of the decision making process on design selection, an investigation of the DRZ would precede the selection of the concrete component and the specification of the amount of excavation that is needed. The investigation could be done using geophysical methods (such as ground penetrating radar) or drill holes. Drill holes can be investigated using video cameras or "scratchers." The DOE considers the 20-year criterion is still appropriate, since the design report shows that it takes 25 years to reach explosive limits. A ten percent reduction in this time is still beyond 20 years. Furthermore, the chances that methane will be generated initially are minimized by the fact that the closed panels will be initially oxic and may remain so for a long time after facility closure.

The DOE believes that design Options A through D will function adequately as panel closures, given the current state of knowledge about gas generation, the understanding of the DRZ, the expected characteristics of the waste, and the inability of monitoring techniques to accurately detect extremely small concentrations of VOCs. However, in the event sufficient information is collected that allows the DOE to make less conservative assumptions regarding these items, designs A through D may provide significantly more protection than is actually needed. Consequently, the DOE has retained as a design concept, Option E, which is simply the explosion wall portion of Options B and D. Option E represents a significantly simpler panel closure system that the DOE would use if either of the following criteria are met:

- Gas generation rates are smaller. Current (unreported) work being performed by Sandia National Laboratories indicates that microbial gas generation rates under humid conditions are close to zero, and/or

- The average headspace concentrations are less than the averages used in the calculations. As new wastes are generated, the use of organic solvents is expected to drastically be reduced.

Condition 1 of the Certification Decision Final Rule [4] requires that the DOE implement the Option D panel closure system at the WIPP.

References for Section 4.2

1. 30 CFR 57, Safety and Health Standards - Underground Metal and Nonmetal Mines, 8th edition, 1994.

2. DOE/WIPP 86-010, Waste Isolation Pilot Plant Design Validation Final Report.

3. DOE/WIPP-96-2150, Detailed Design Report for an Operational Phase Panel-Closure System, U.S. Department of Energy, Carlsbad Area Office, Carlsbad, New Mexico.

4. Federal Register, May 18, 1998, Part III, Environmental Protection Agency, 40 CFR Part 194.

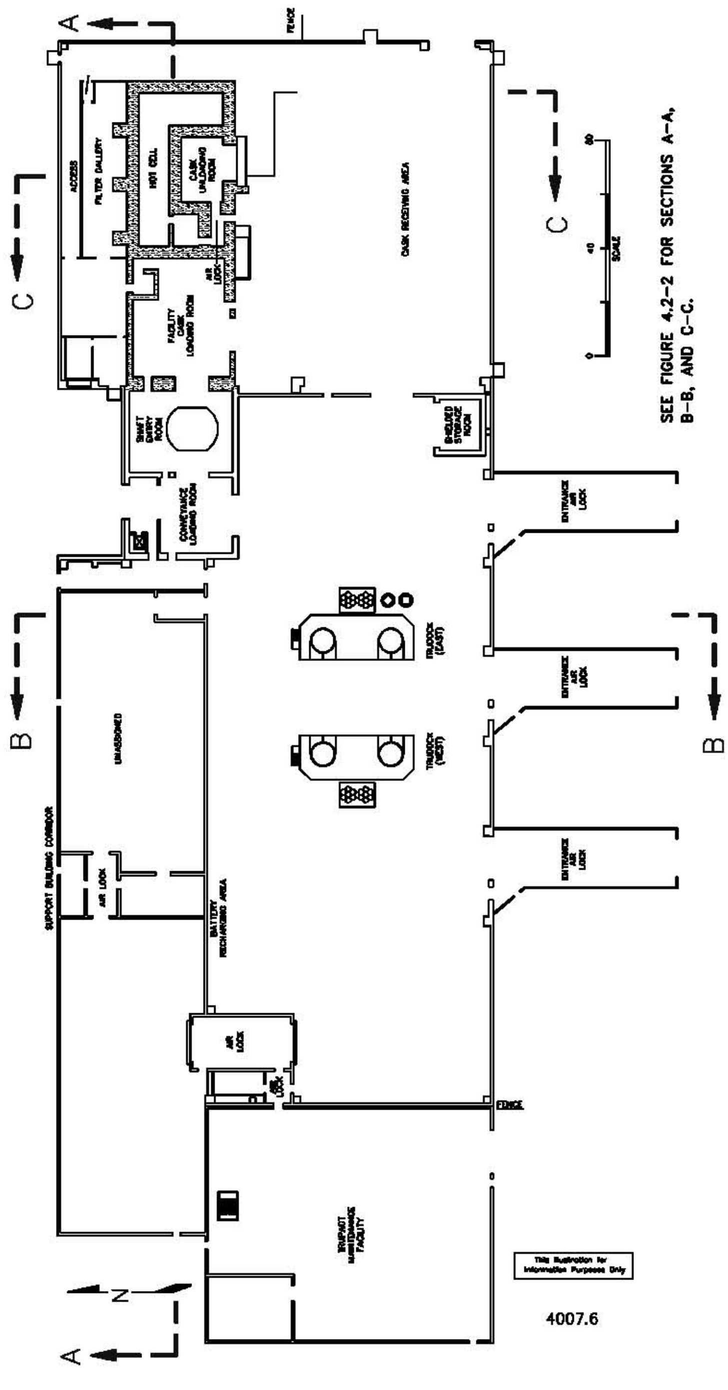

Figure 4.2-1a WHB Plan (Ground Floor)

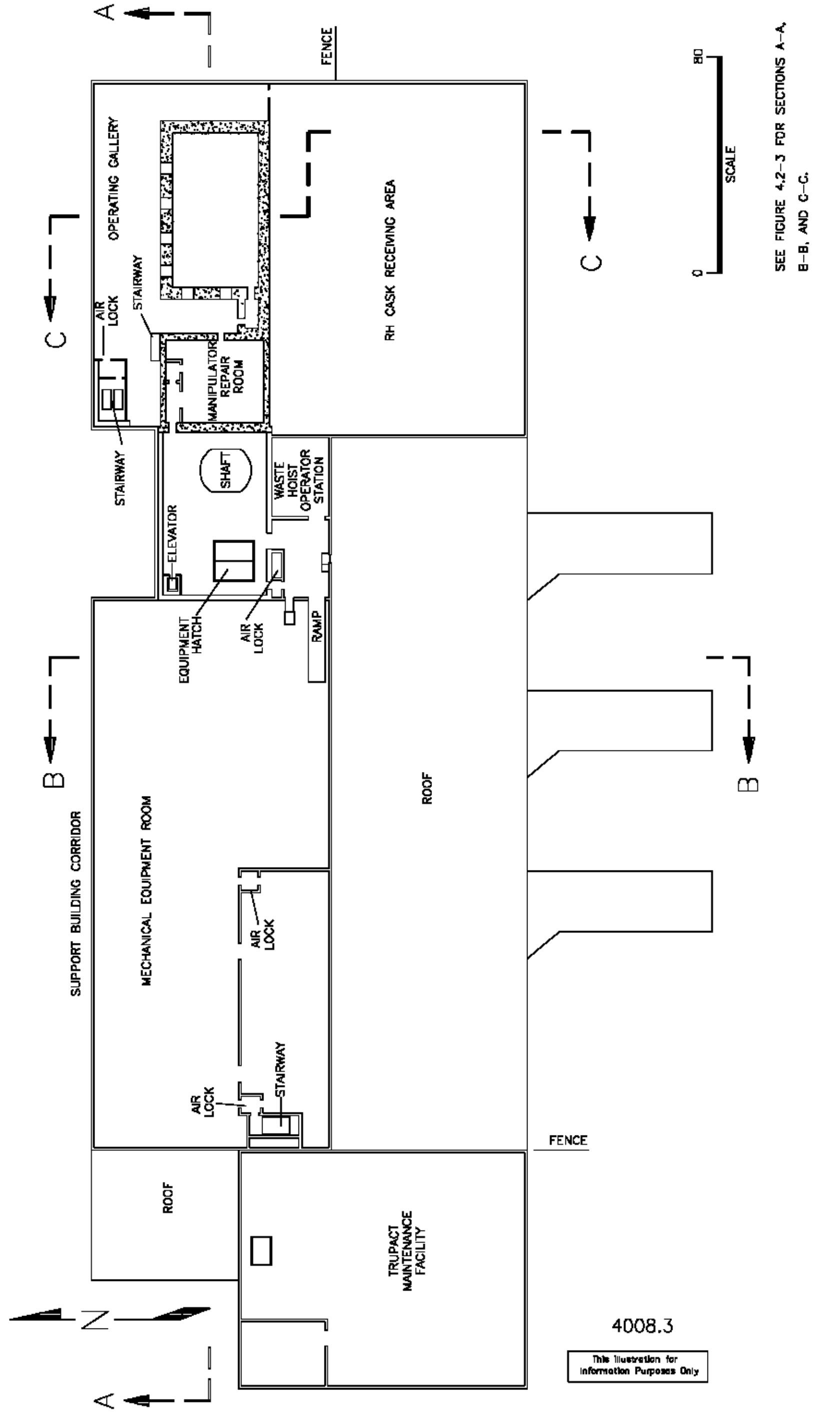

Figure 4.2-1b WHB Plan (Upper Floor)

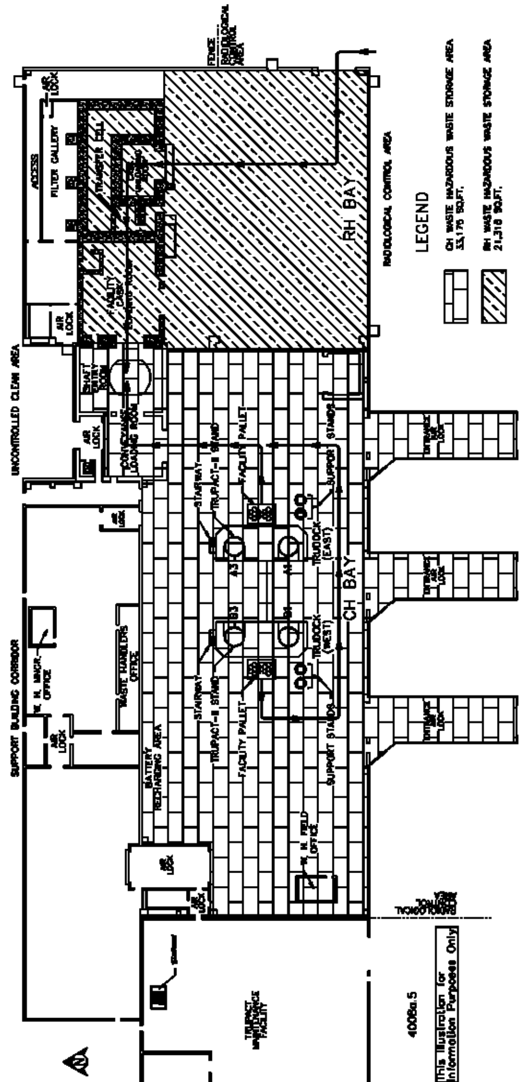

Figure 4.2-2 Waste Transport Routes in the WHB

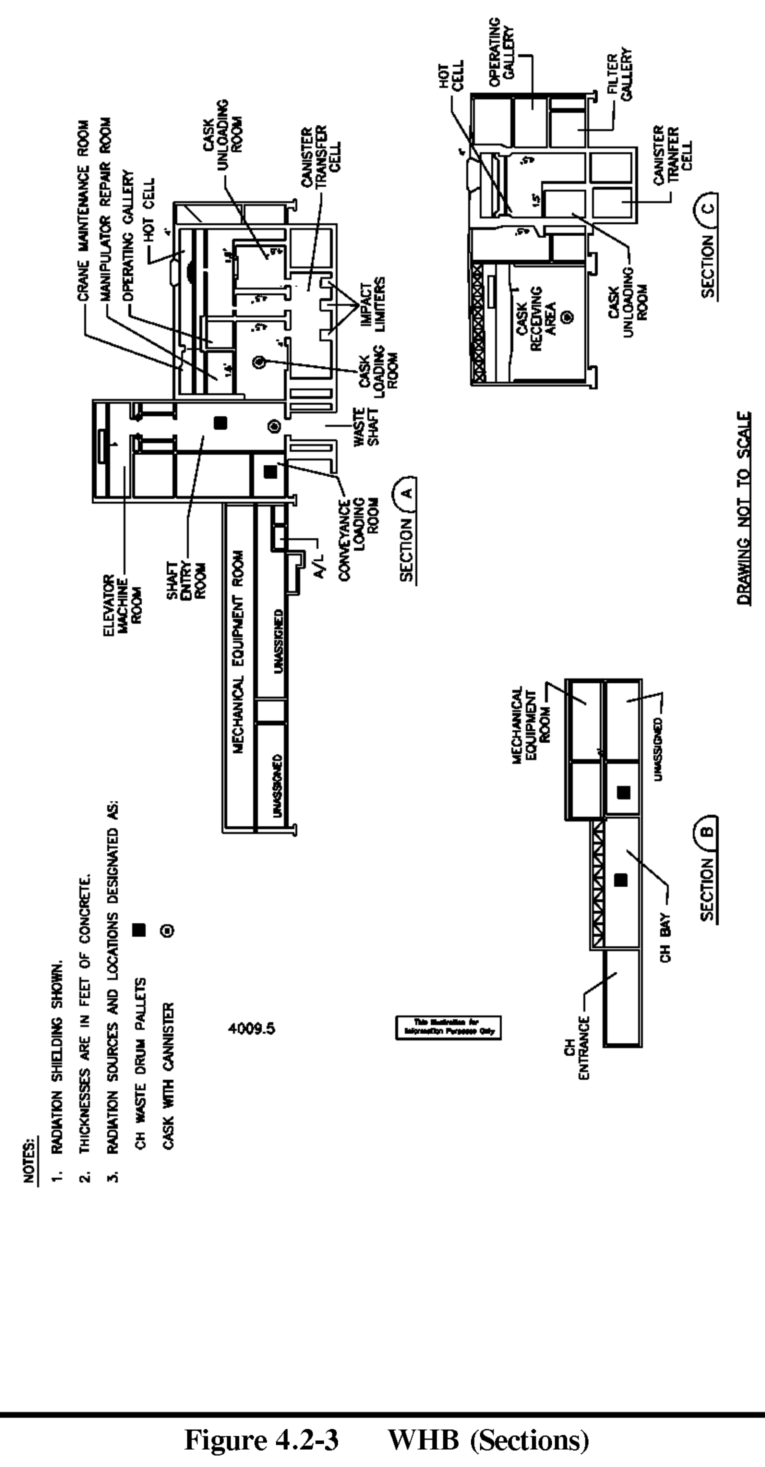

Figure 4.2-3 WHB (Sections)

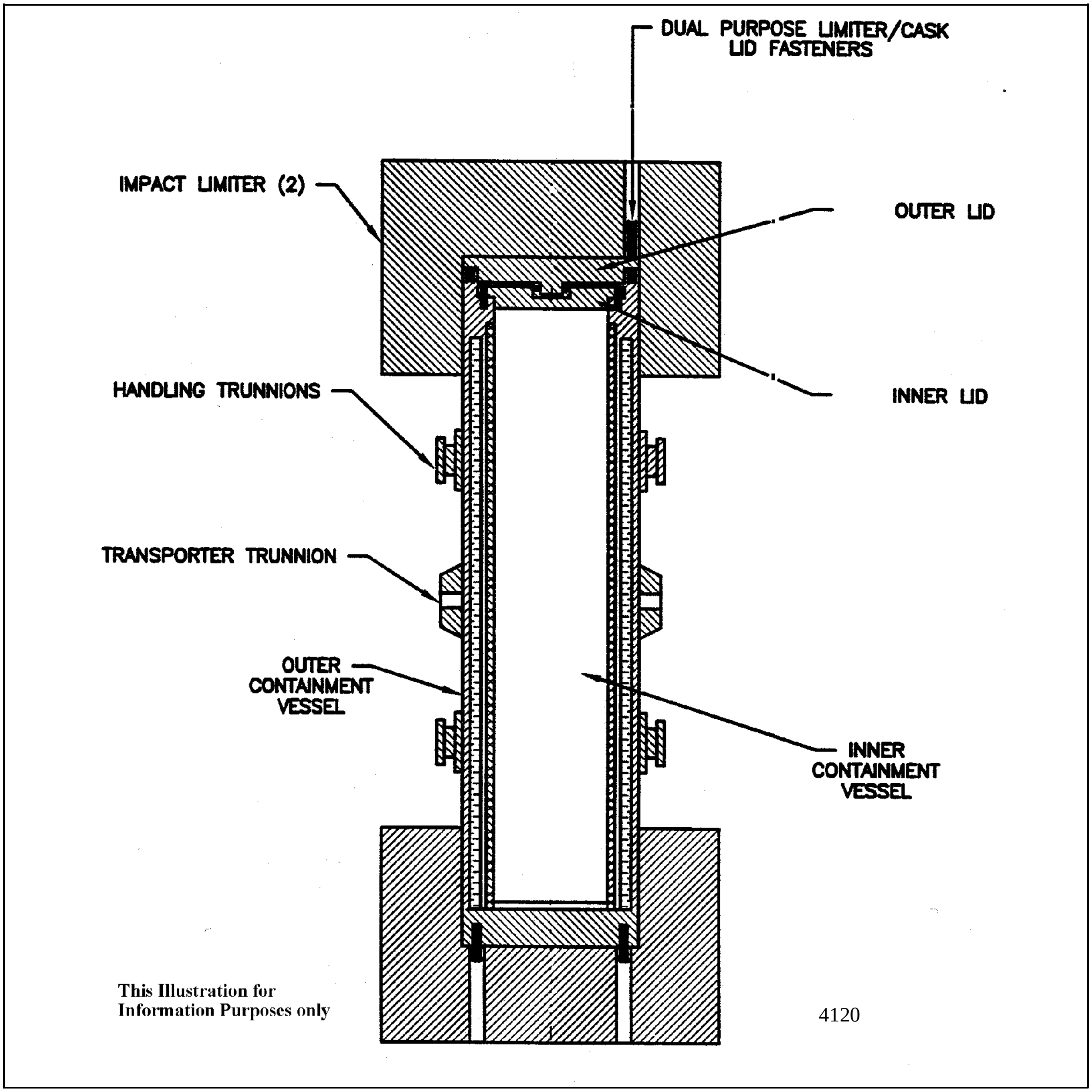

Figure 4.2-4 RH TRU 72B Road Cask

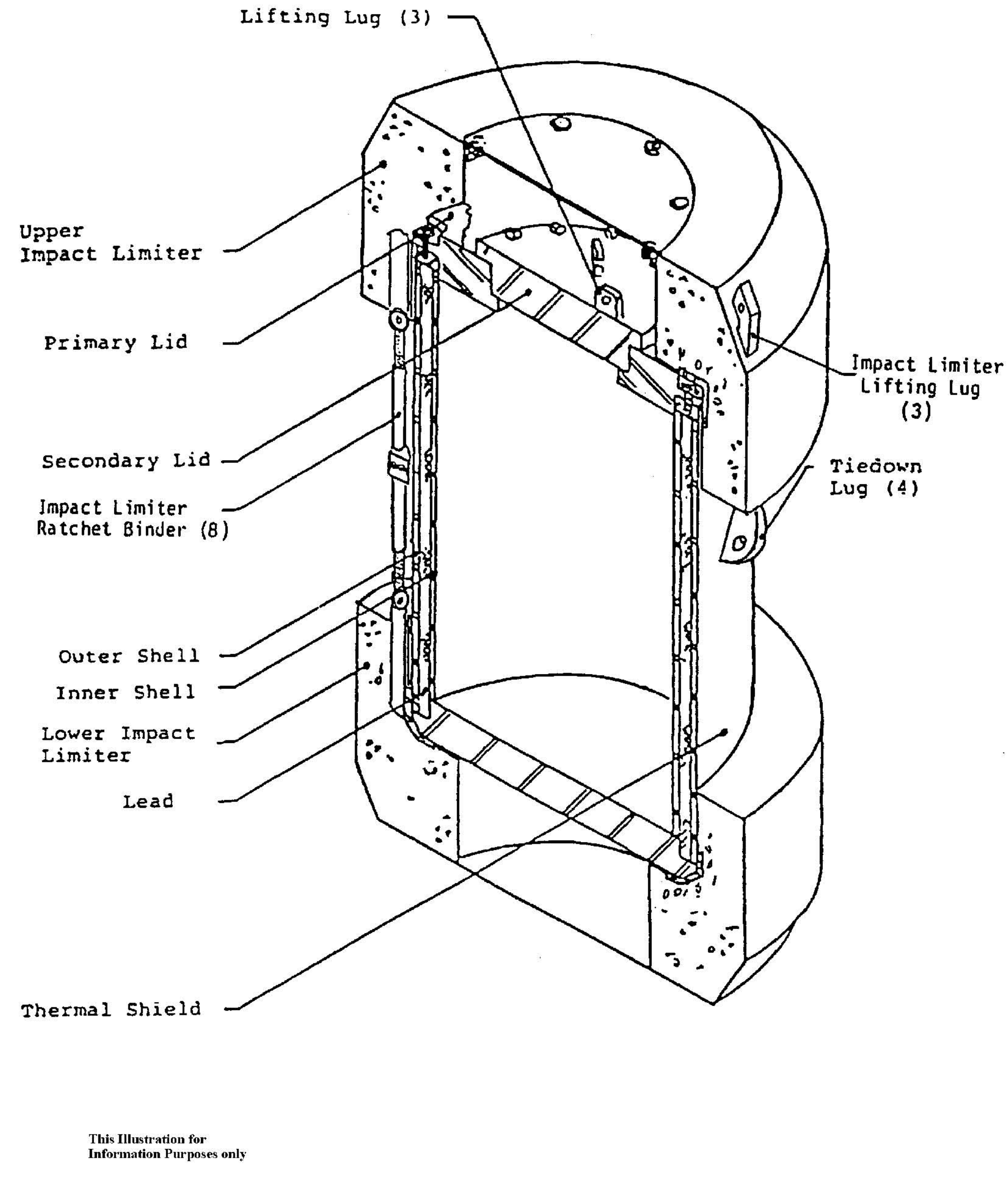

Figure 4.2-5 RH TRU 10-160B Road Cask

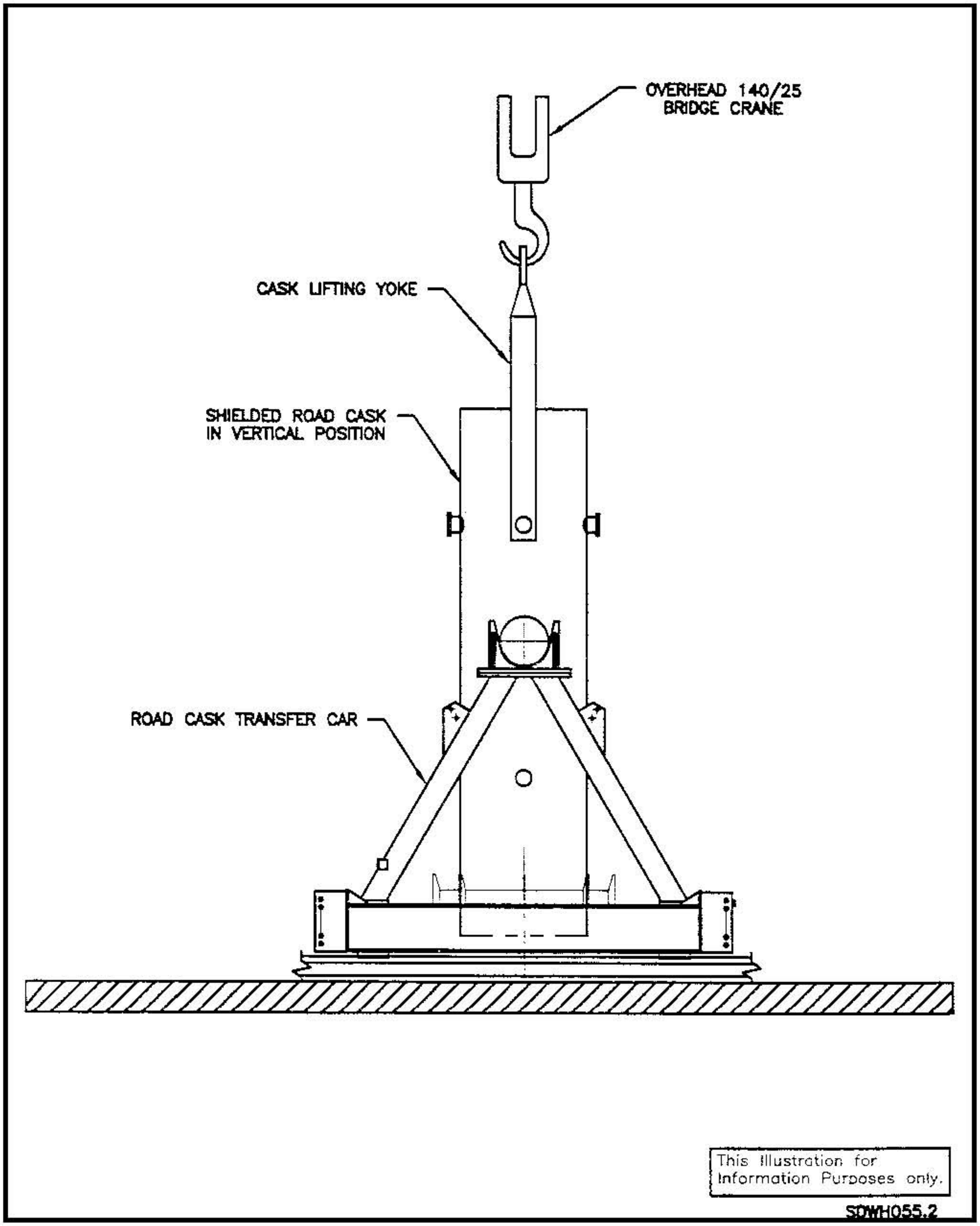

Figure 4.2-6 140-Ton Crane Cask Lifting Yoke In Use

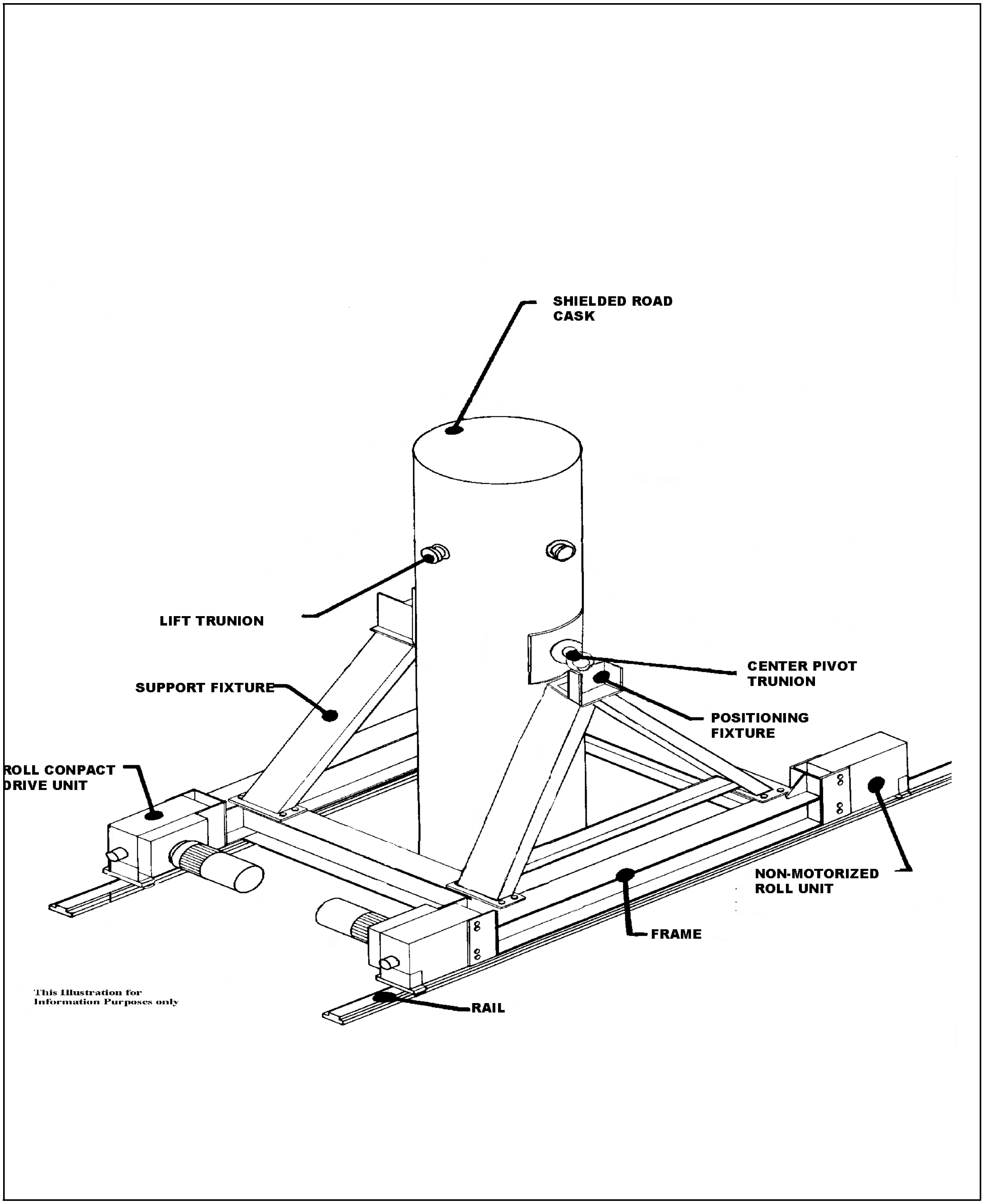

Figure 4.2-7 72B Road Cask on Transfer Car

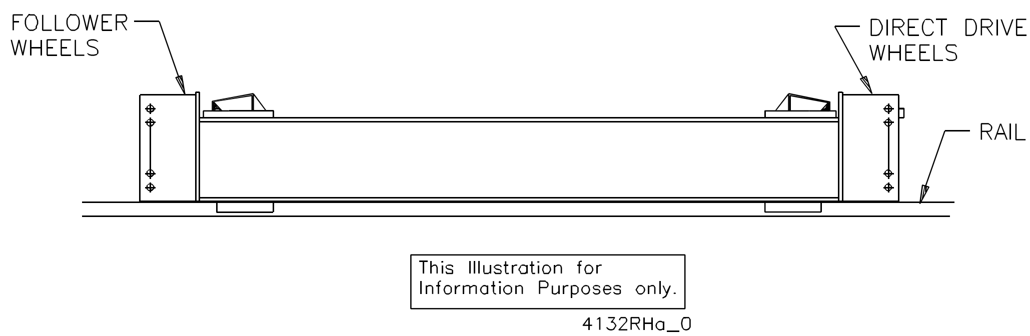

Figure 4.2-8 10-160B Transfer Car

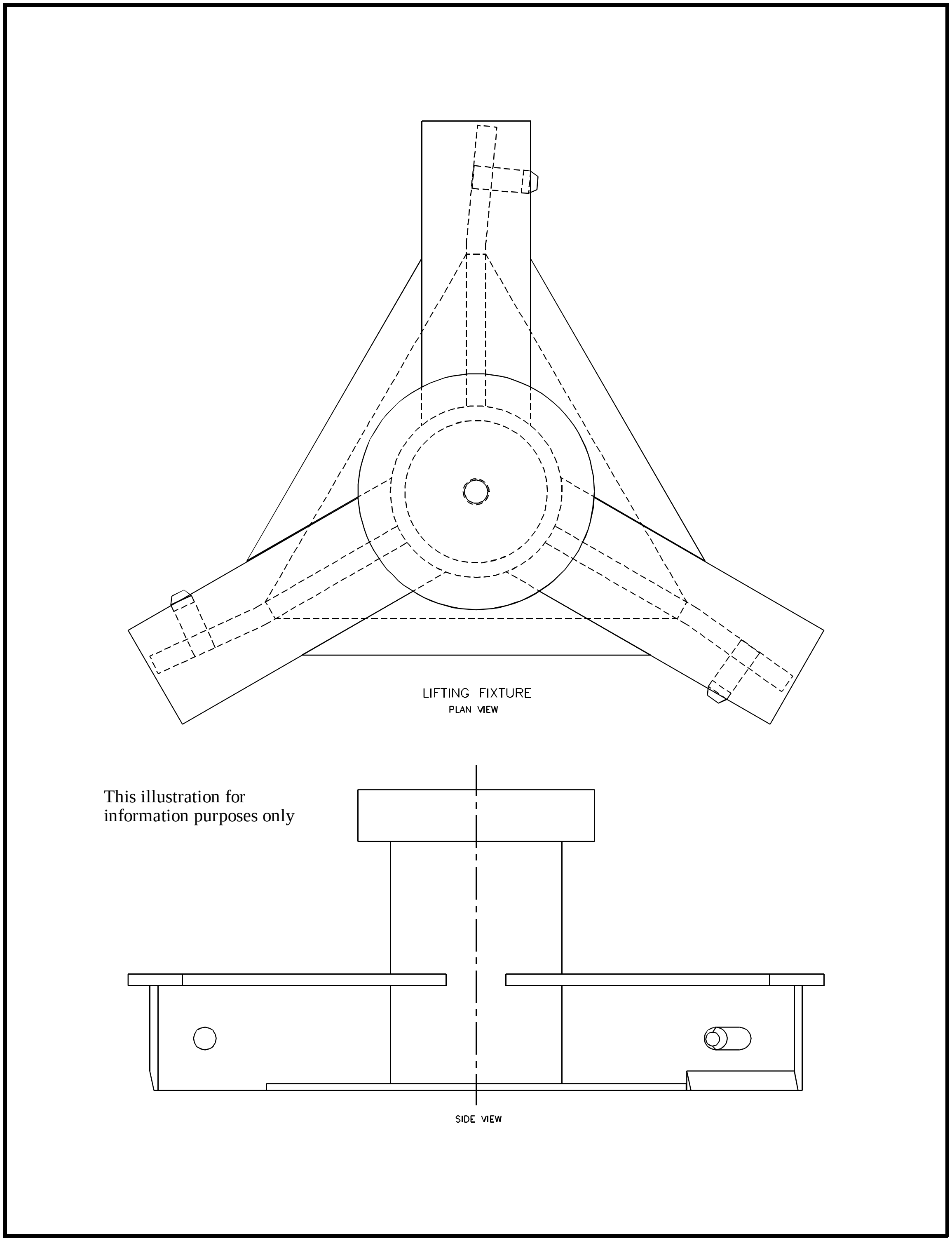

Figure 4.2-9 10-160B Cask Lid Lifting Fixture

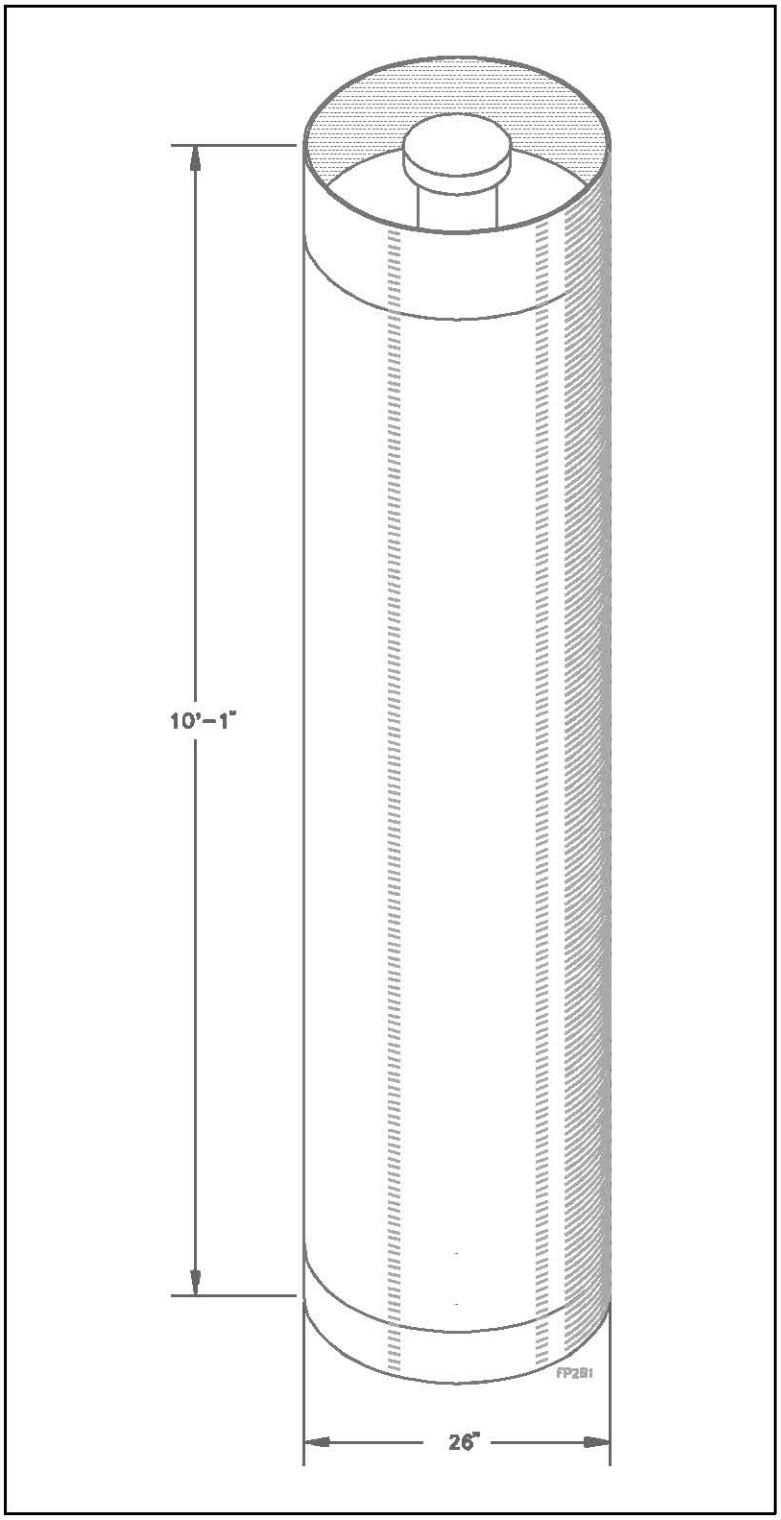

Figure 4.2-10 RH TRU Canister Assembly

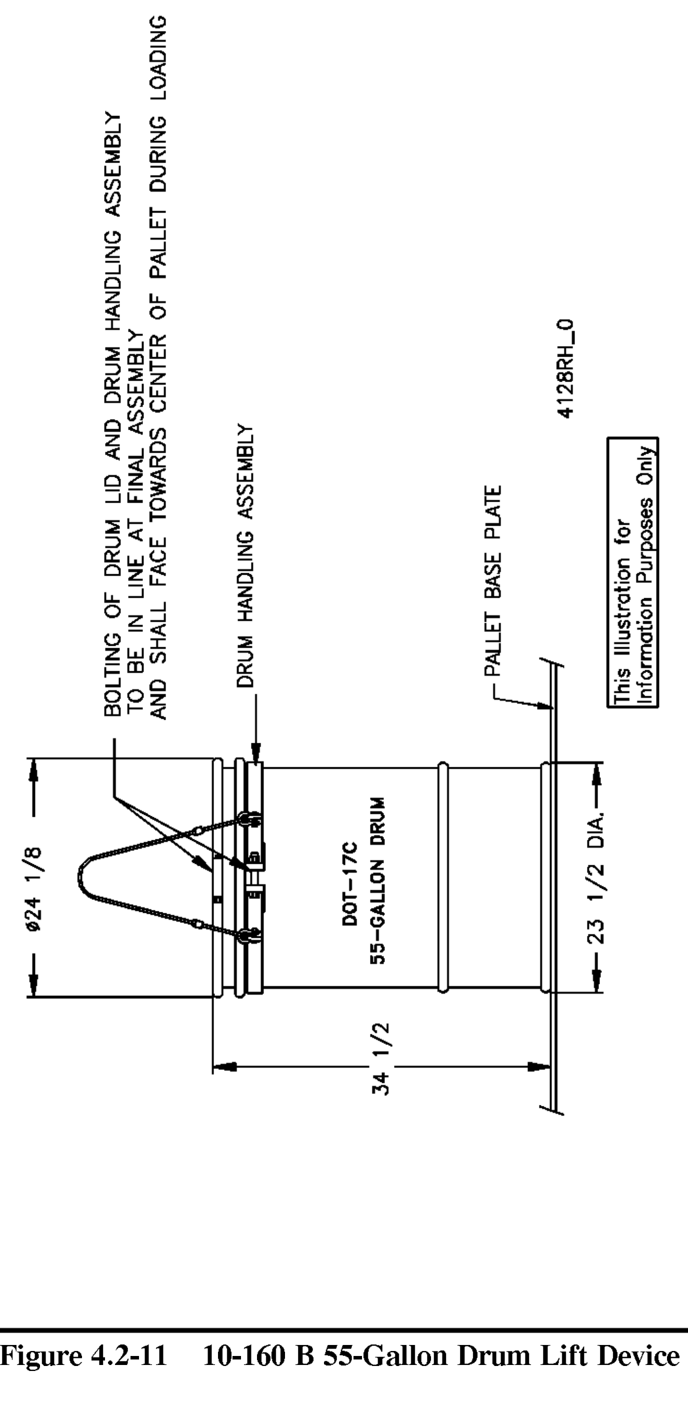

Figure 4.2-11 10-160 B 55-Gallon Drum Lift Device

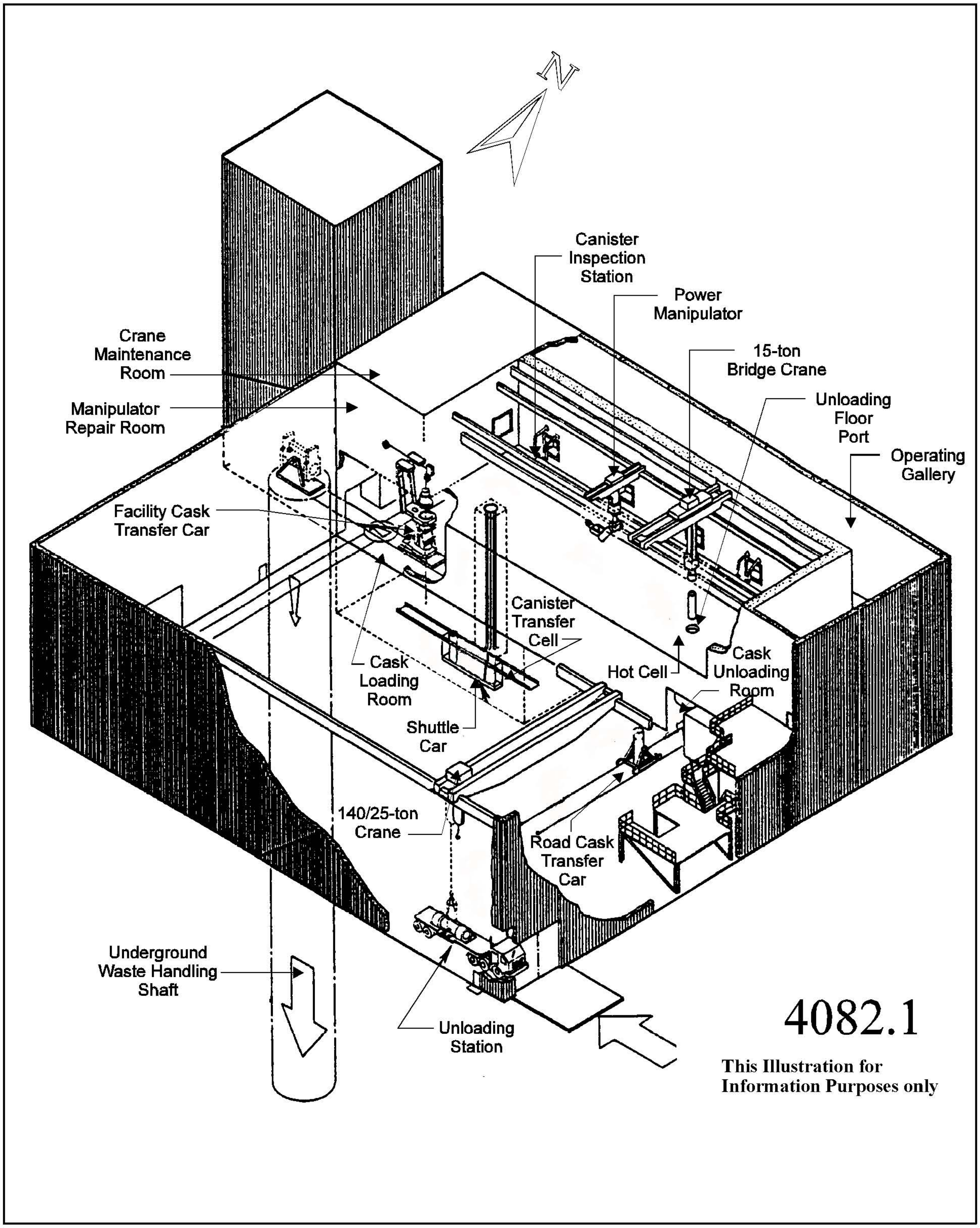

Figure 4.2-12 Pictorial View of the RH TRU Surface Facilities

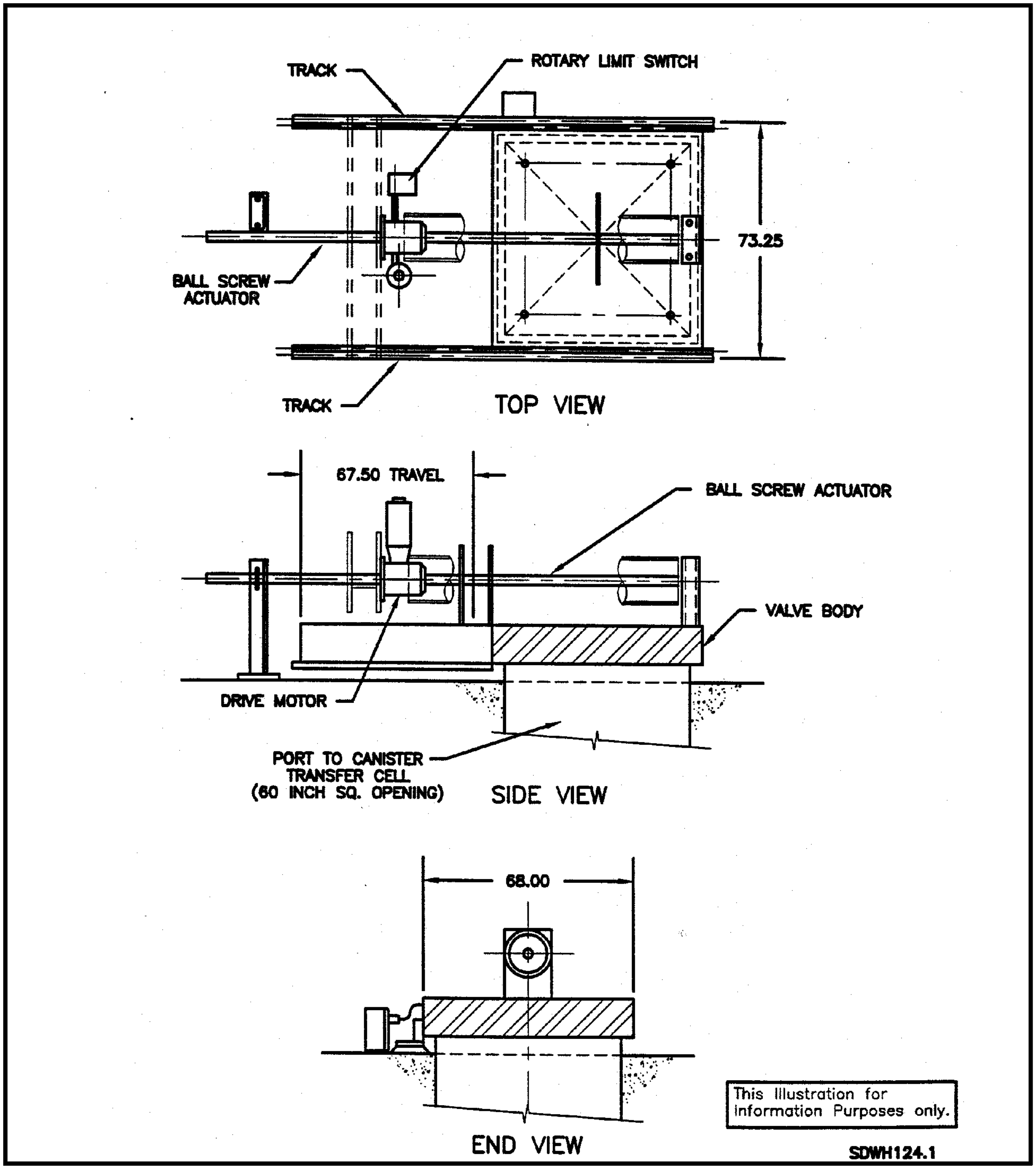

Figure 4.2-13 Shield Valve

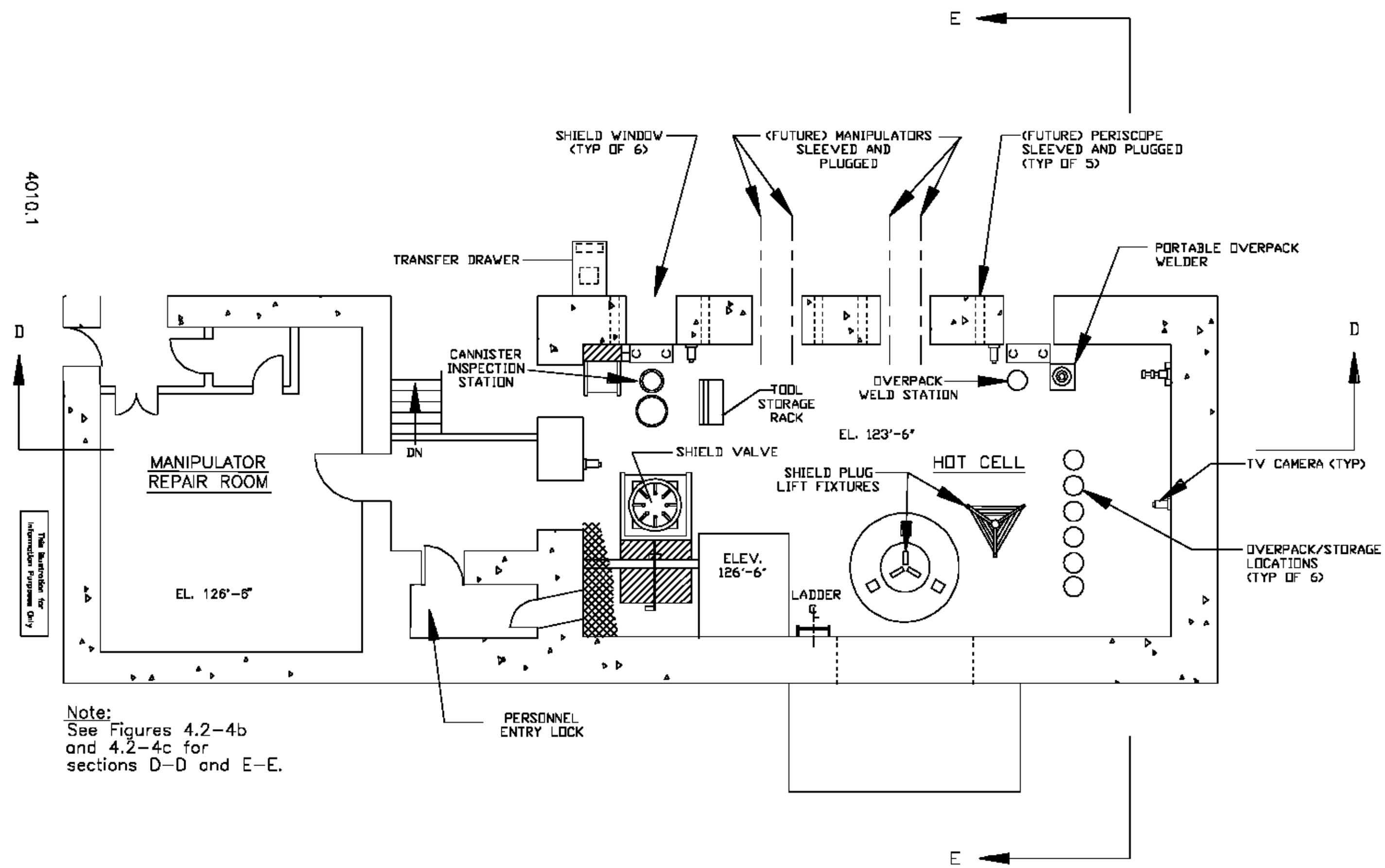

Figure 4.2-14a Details of Hot Cell

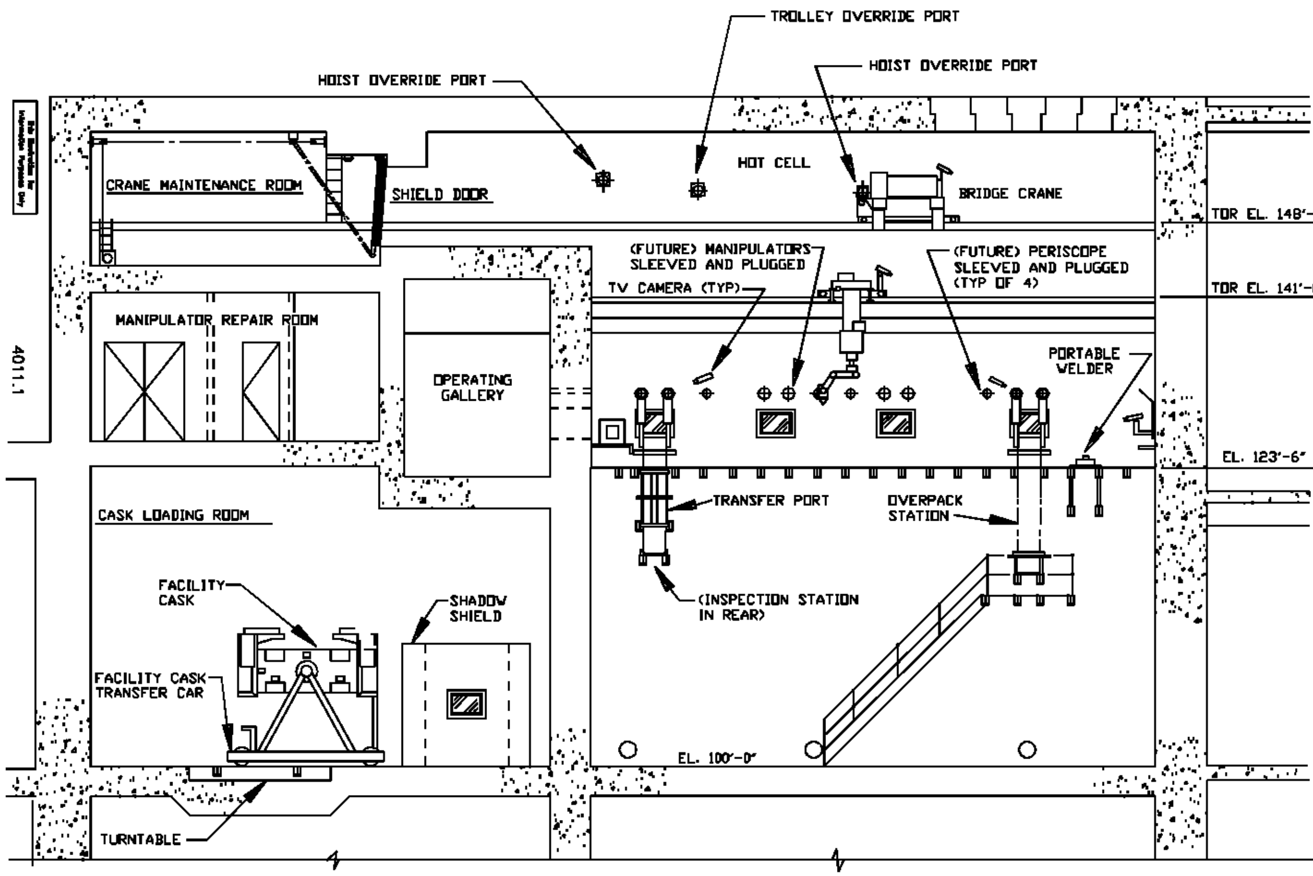

Figure 4.2-14b Details of Hot Cell Cross Section at D-D

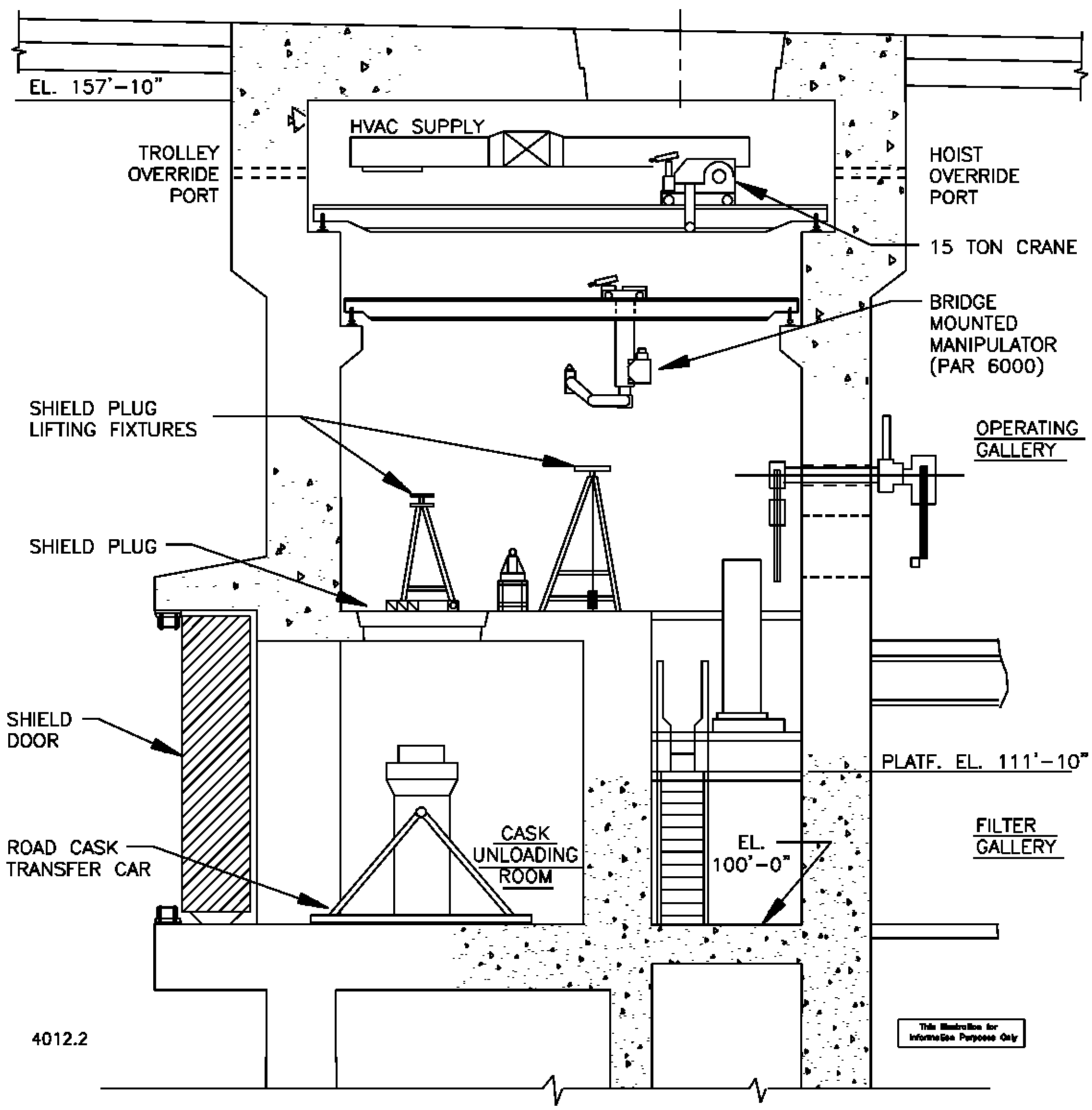

Figure 4.2-14c Details of Hot Cell at Cross Section E-E

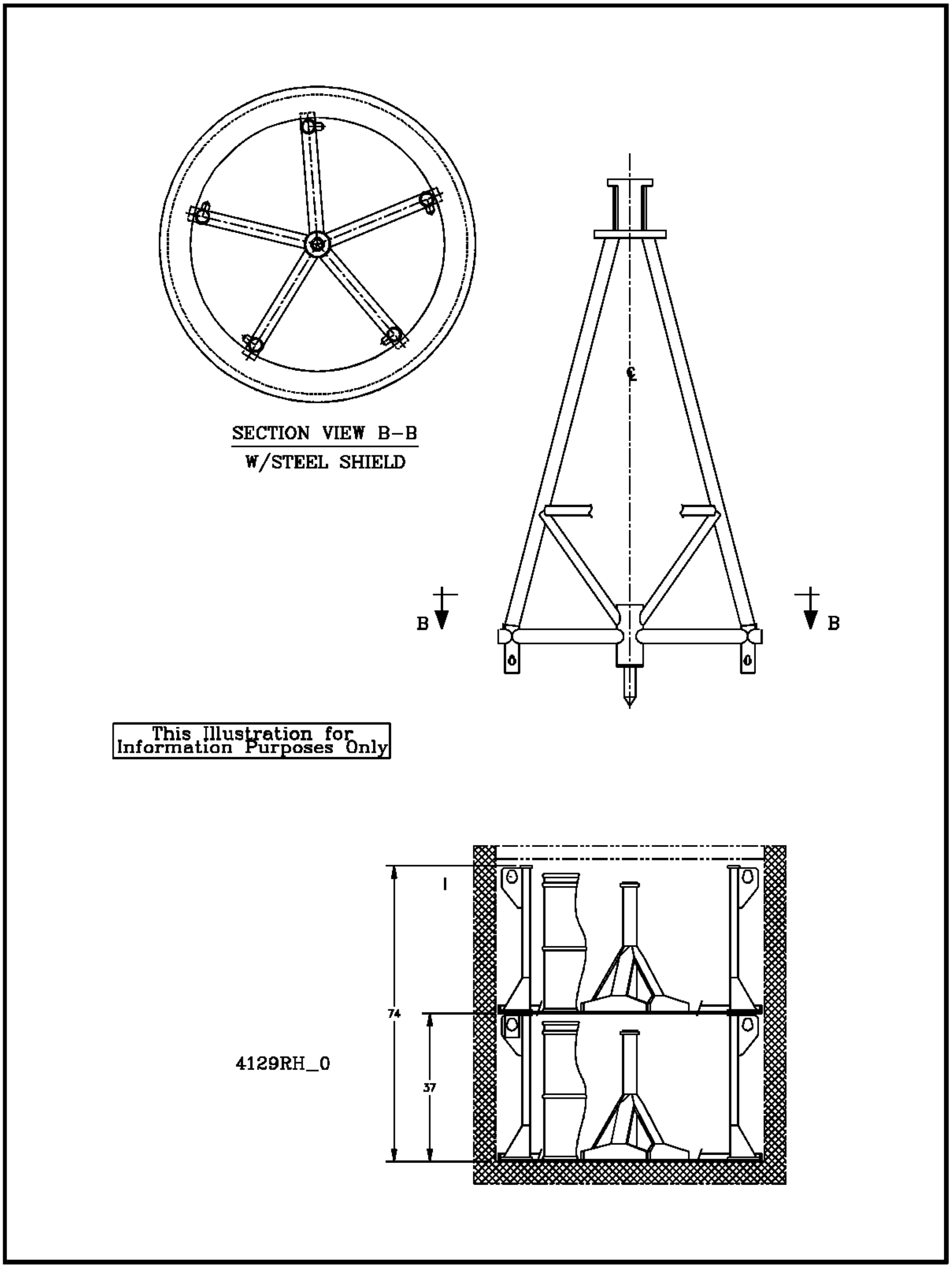

Figure 4.2-15a Drum Carriage Lift Fixture

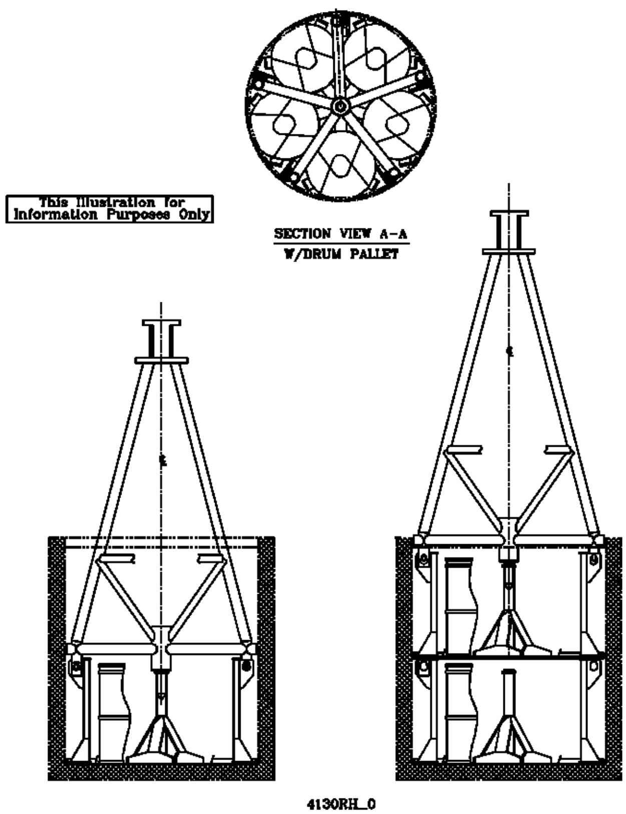

Figure 4.2-15b Drum Carriage Lift Fixture and Carriages

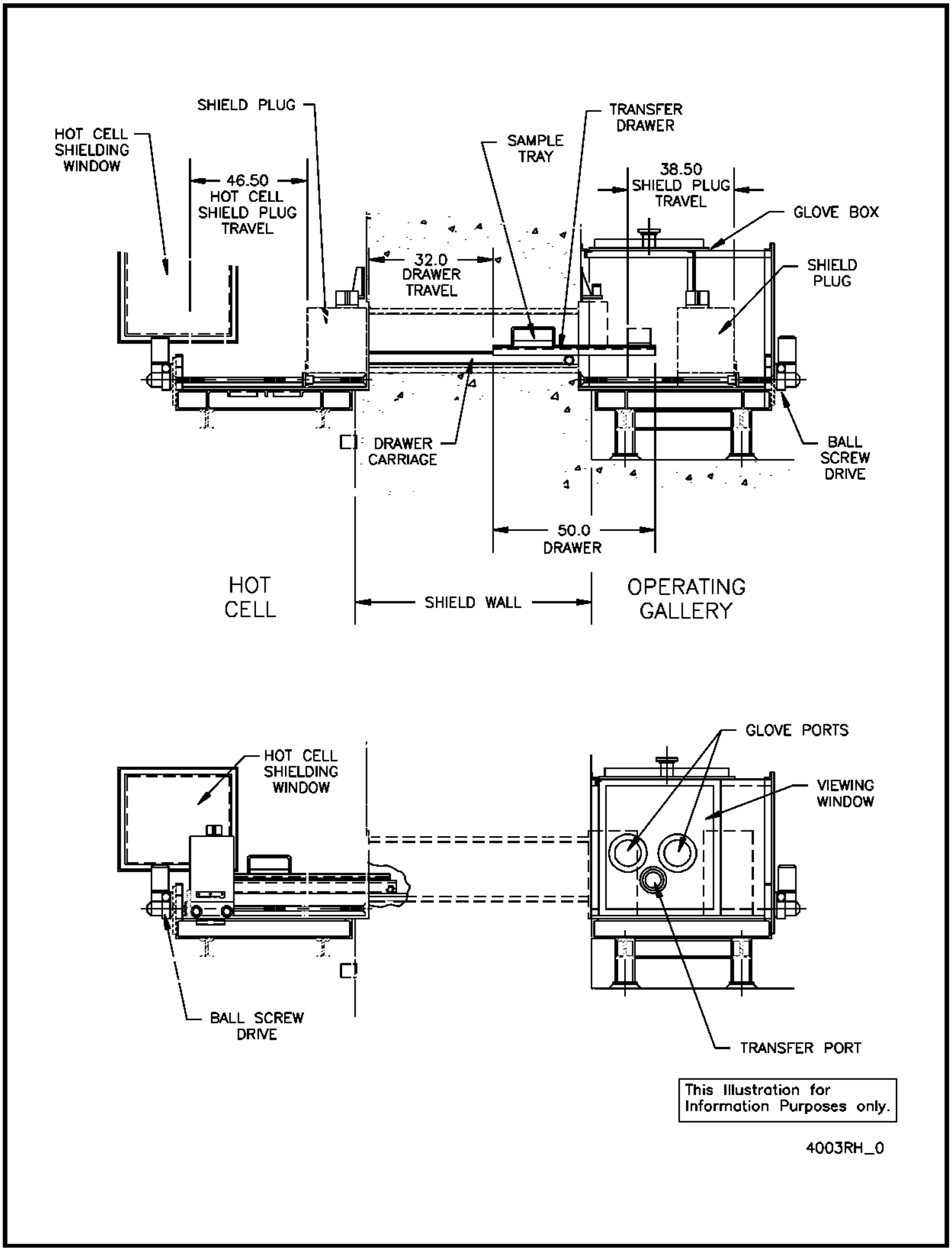

Figure 4.2-16 Shielded Transfer Drawer

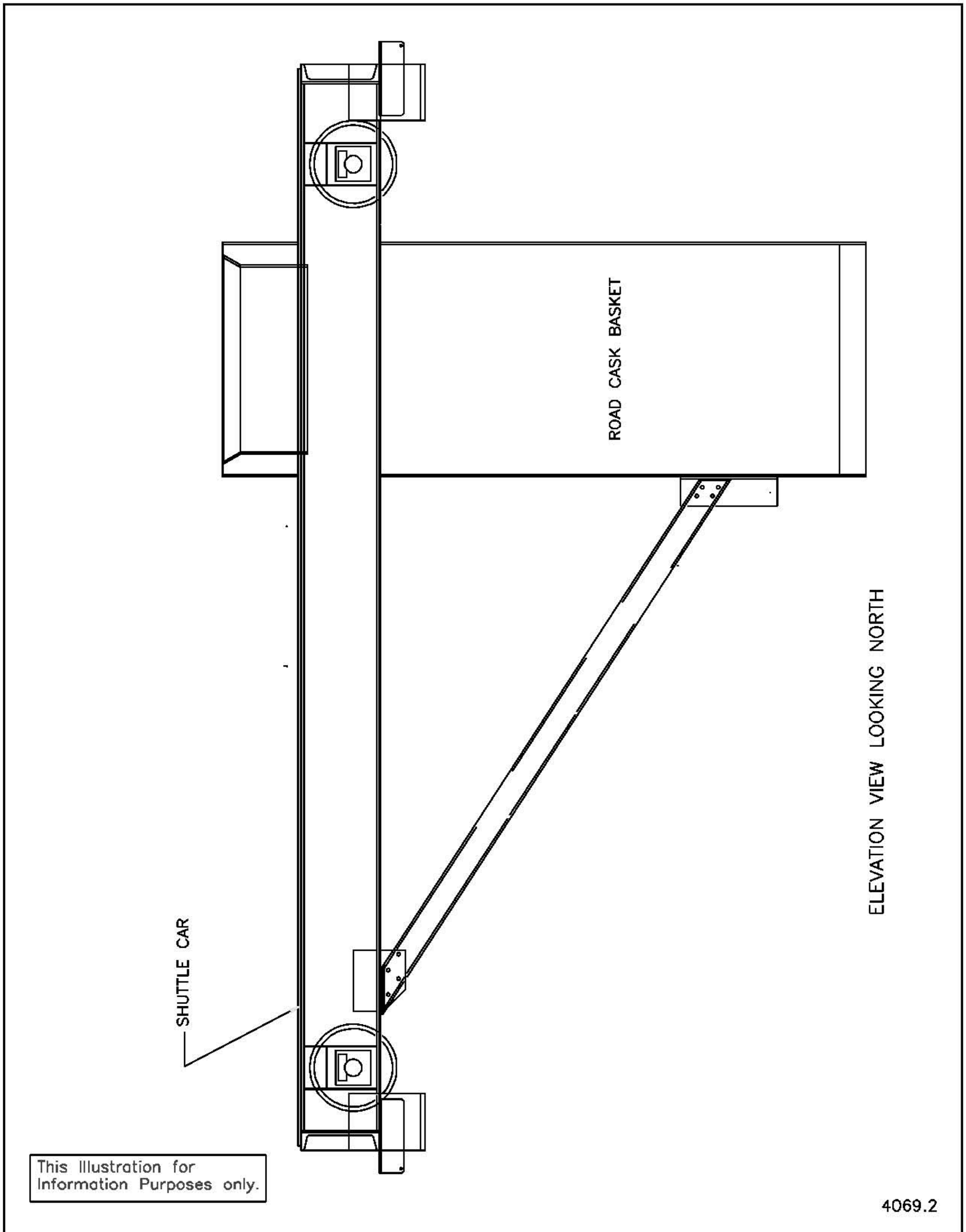

Figure 4.2-17 Transfer Cell Shuttle Car

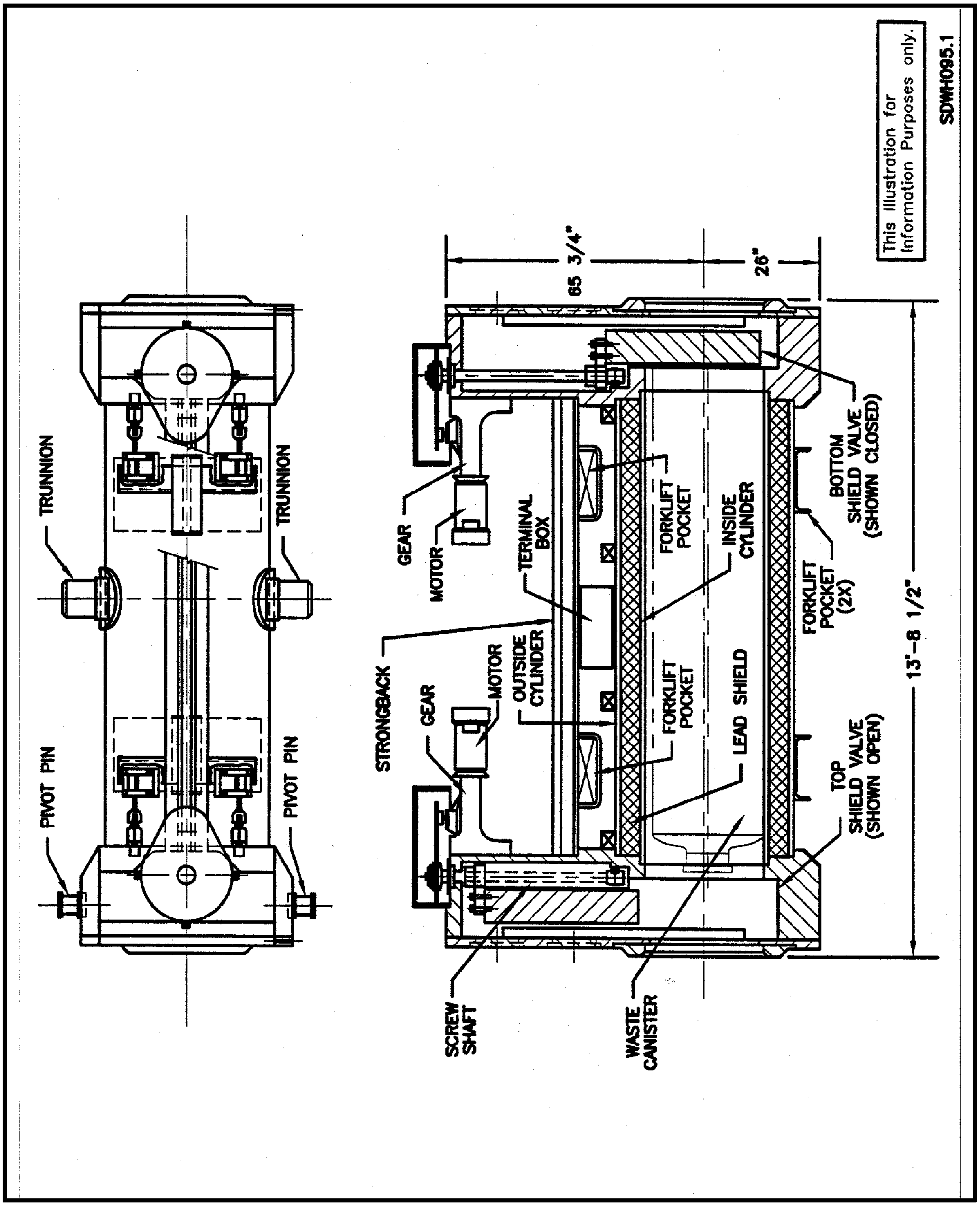

Figure 4.2-18 Facility Cask

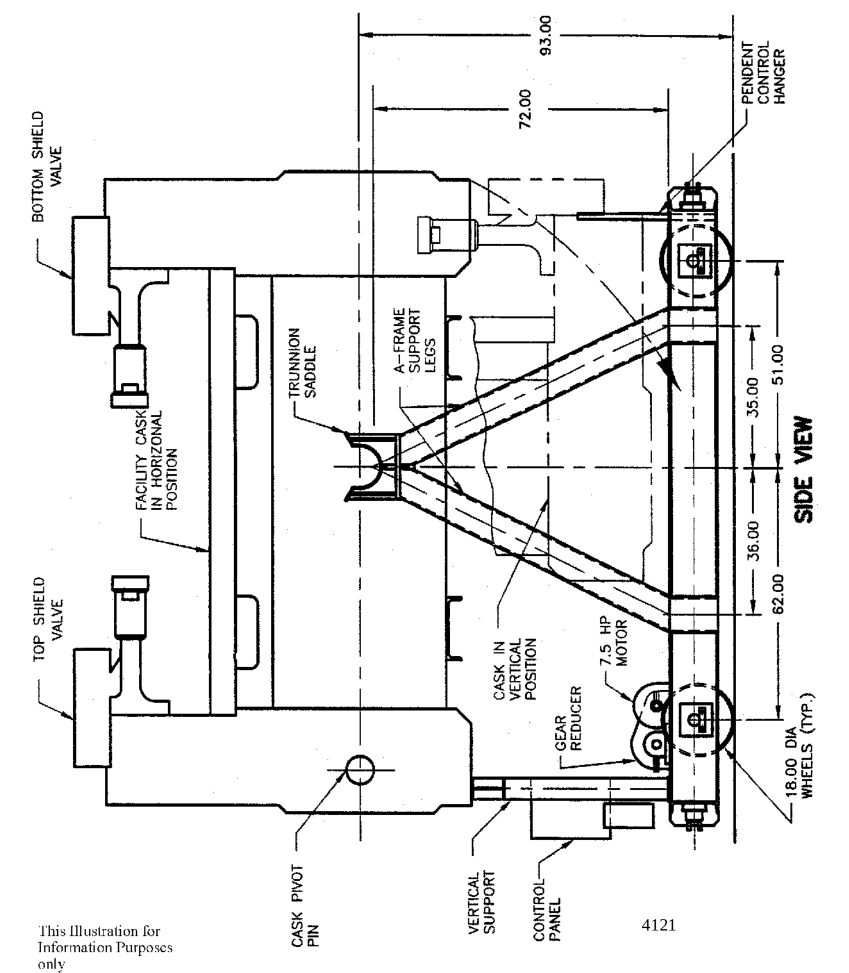

Figure 4.2-19 Facility Cask Transfer Car

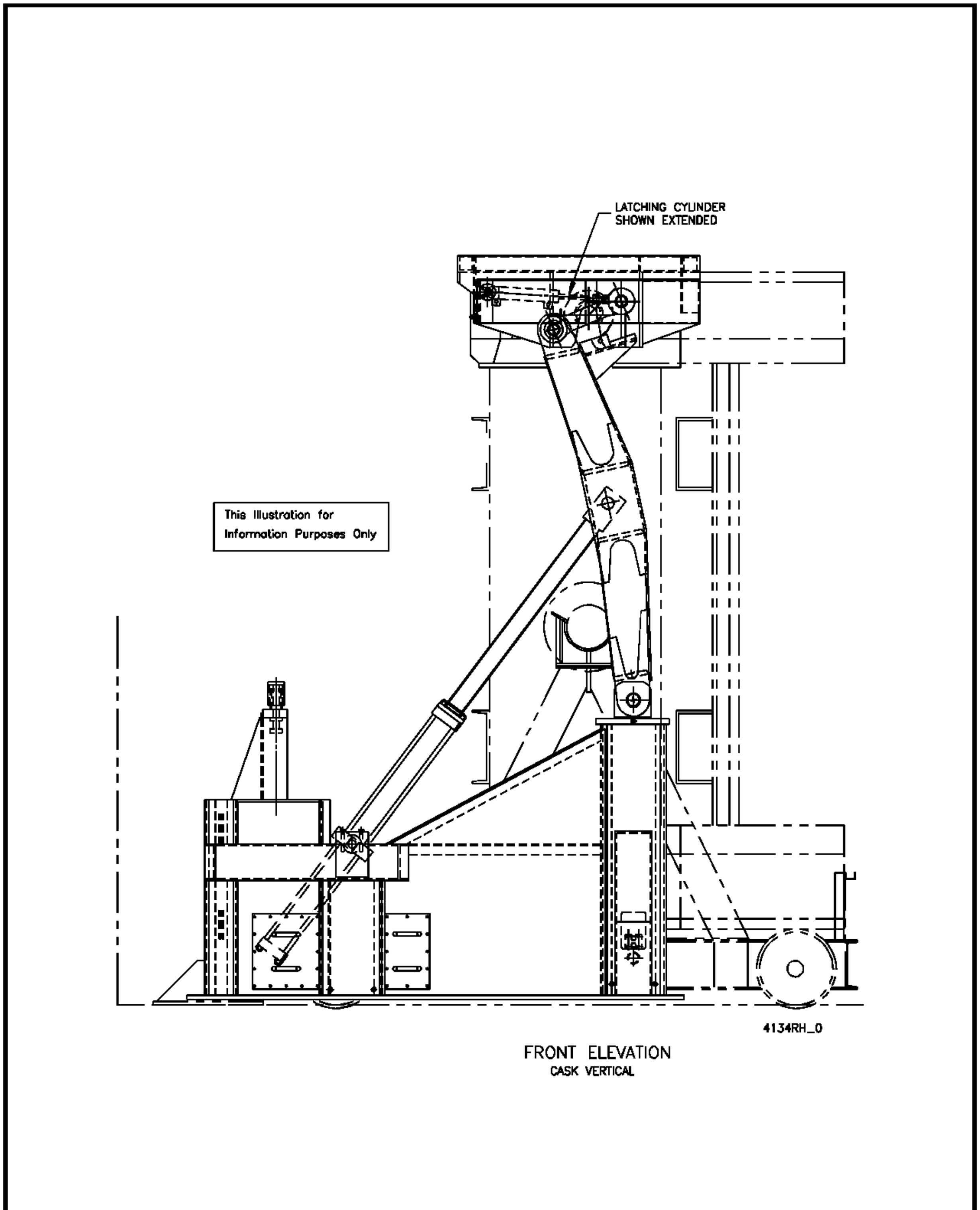

Figure 4.2-20 Facility Cask Rotating Device

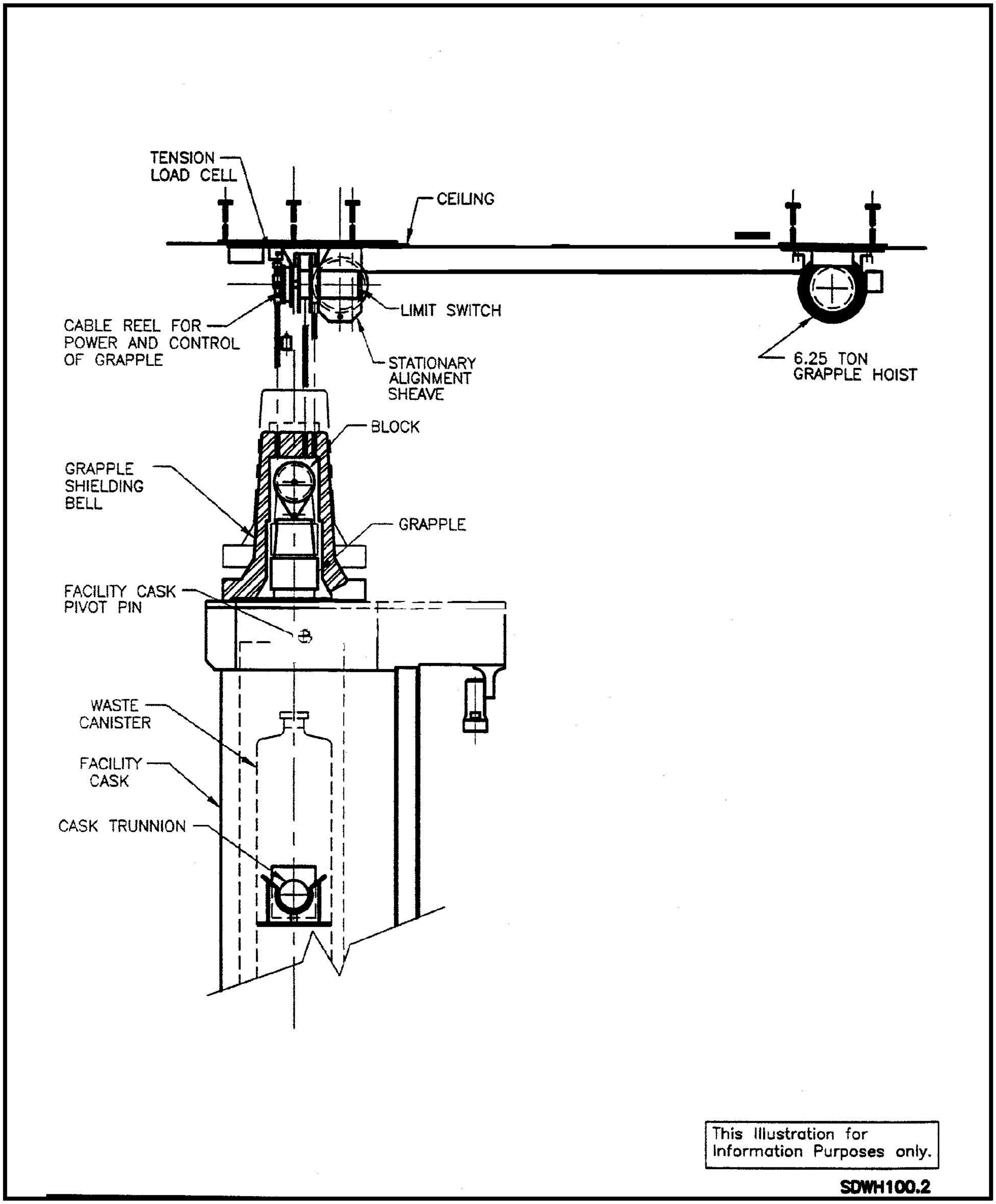

Figure 4.2-21 6.25-Ton Grapple Hoist

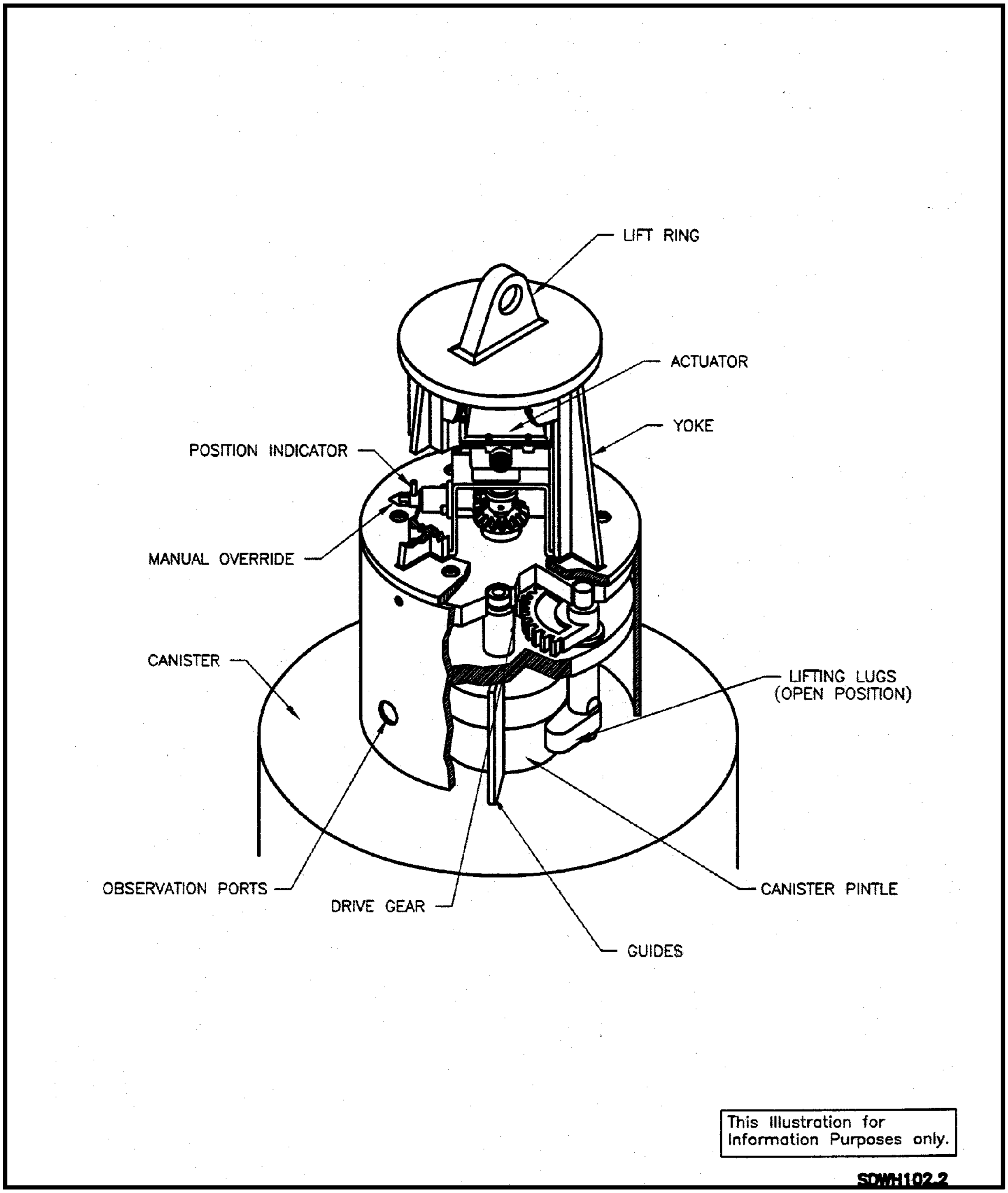

Figure 4.2-22 Facility Grapple

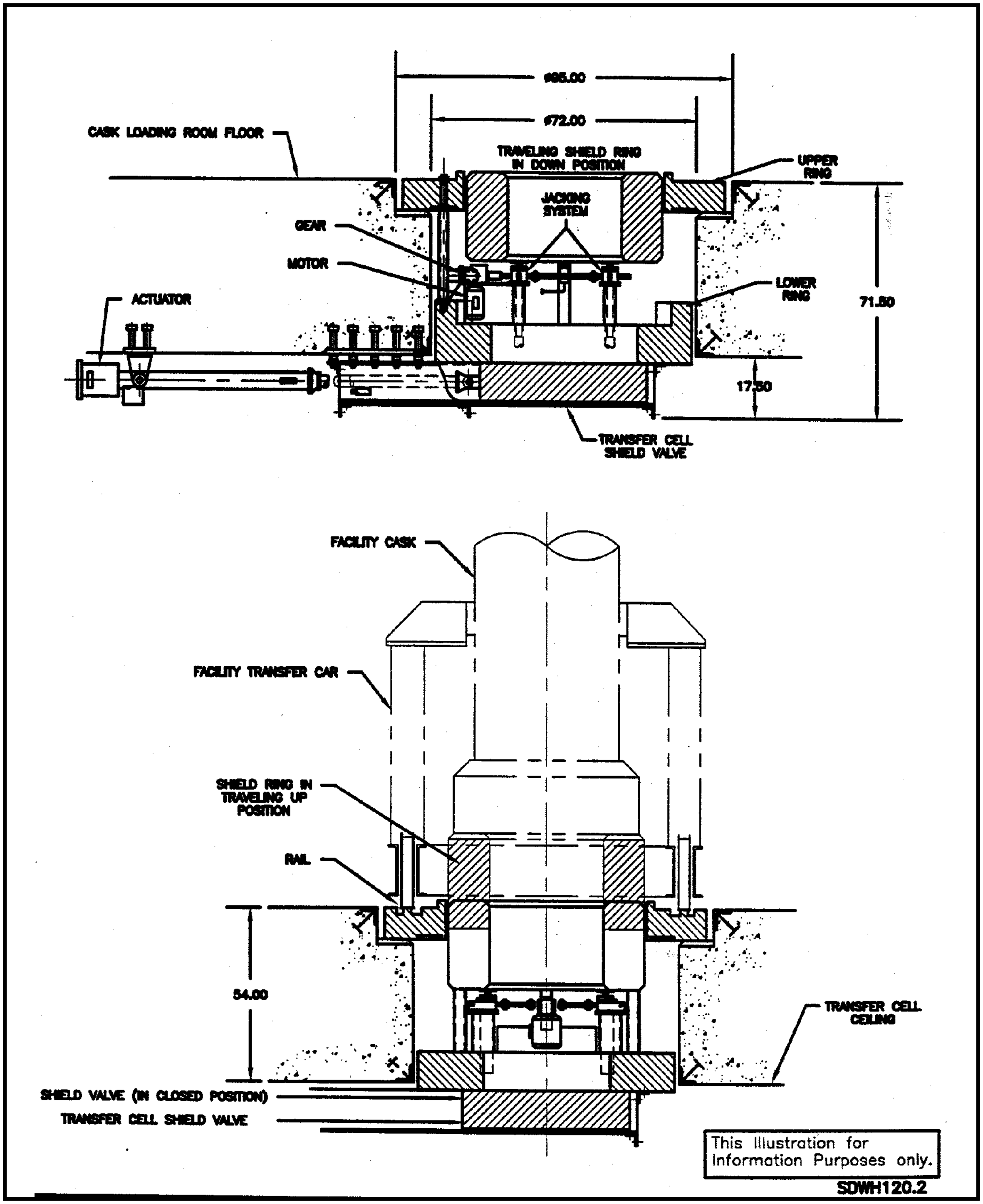

Figure 4.2-23 Telescoping Port Shield

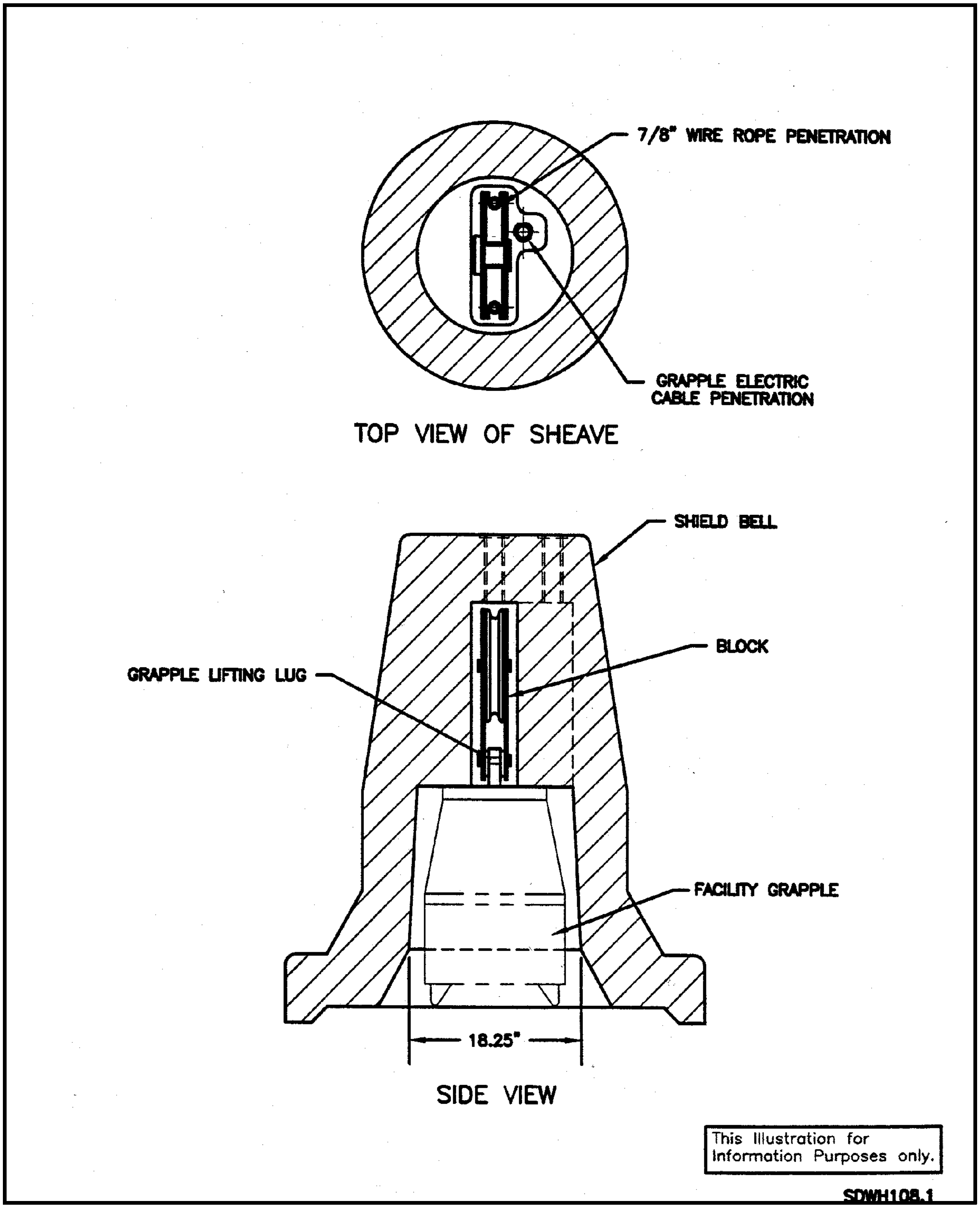

Figure 4.2-24 Bell Shield and Block

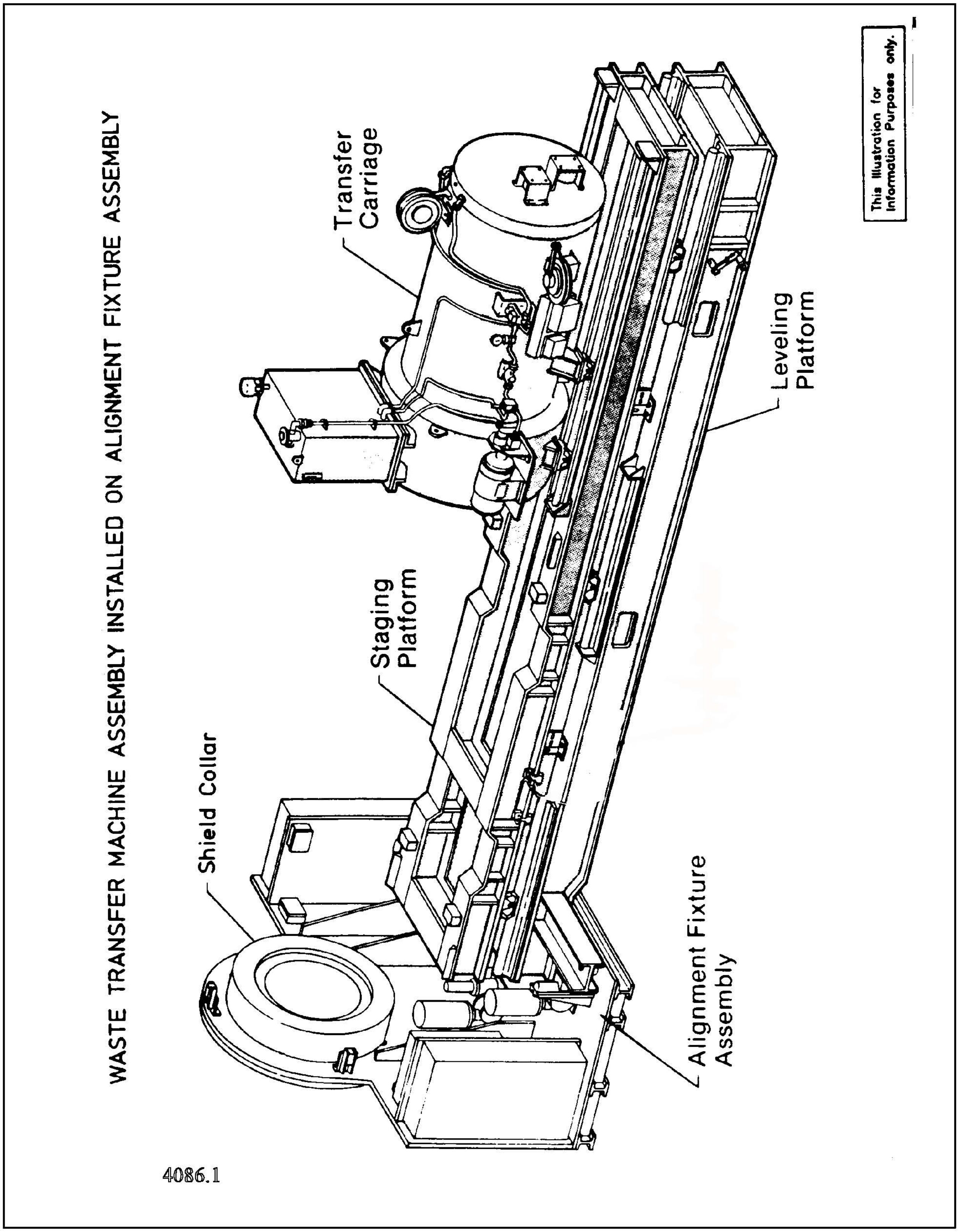

Figure 4.2-25 Waste Transfer Machine Assembly Installed on the Alignment Fixture

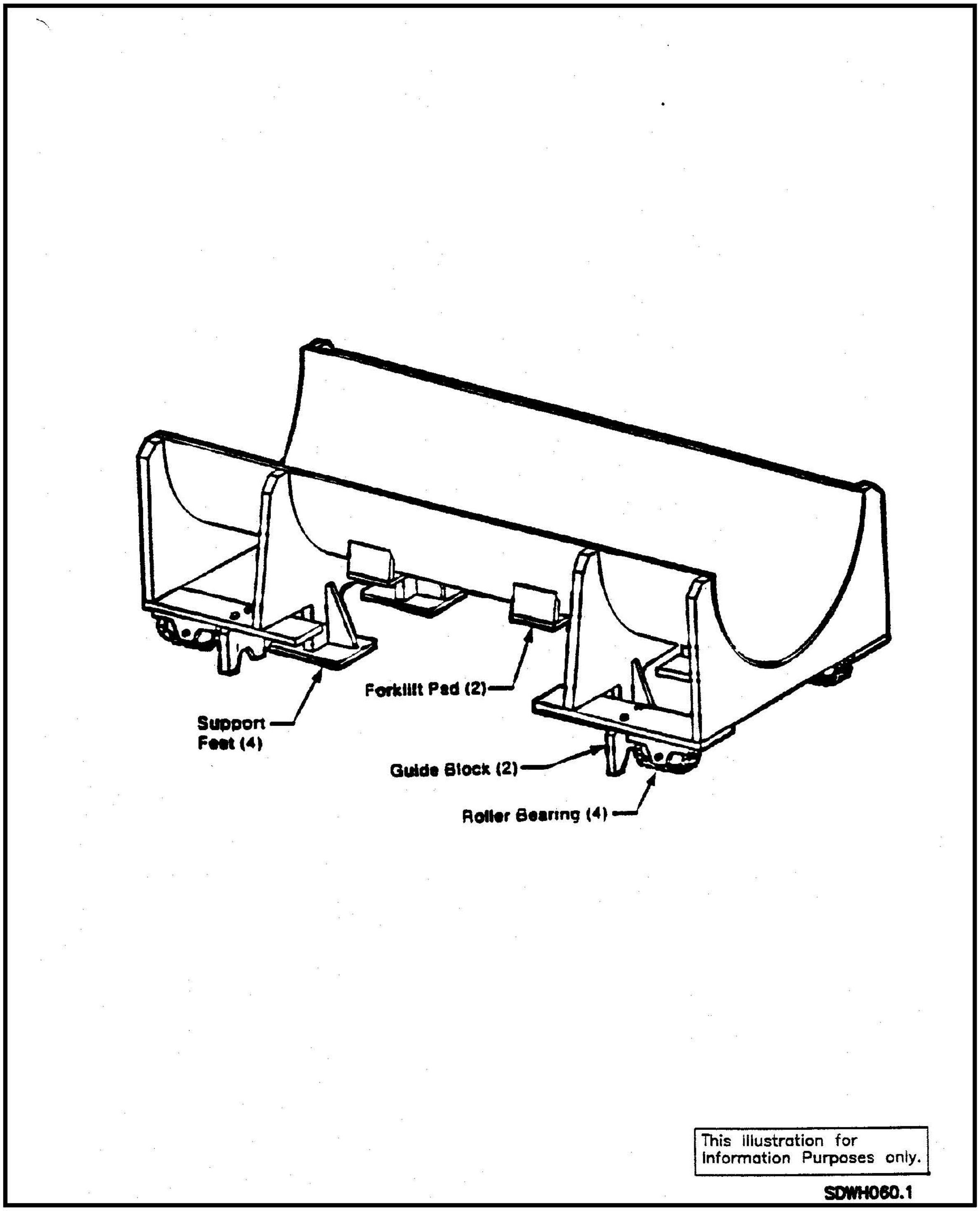

Figure 4.2-26 Shield Plug Carriage

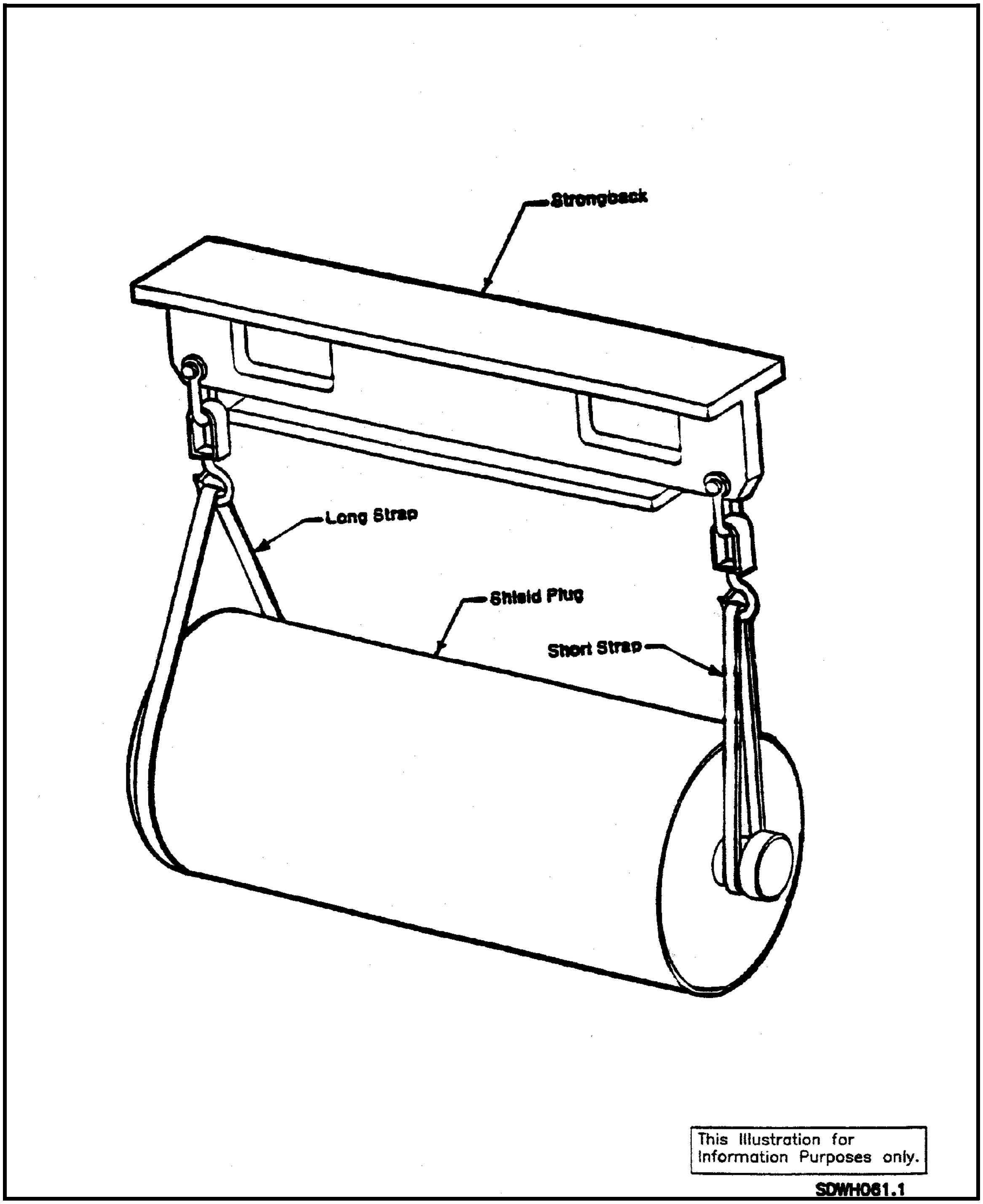

Figure 4.2-27 Strongback

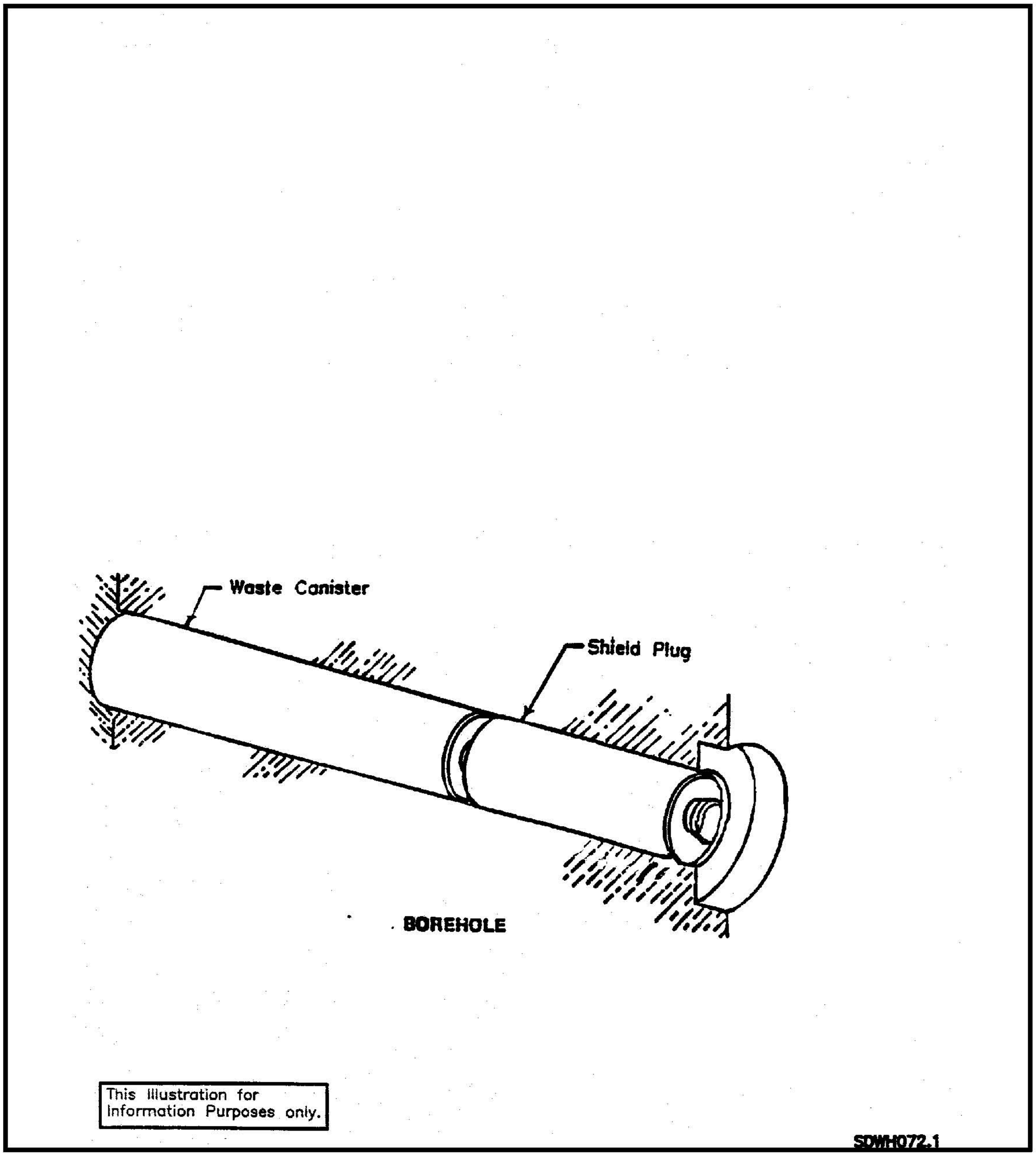

Figure 4.2-28 RH Emplacement Configuration

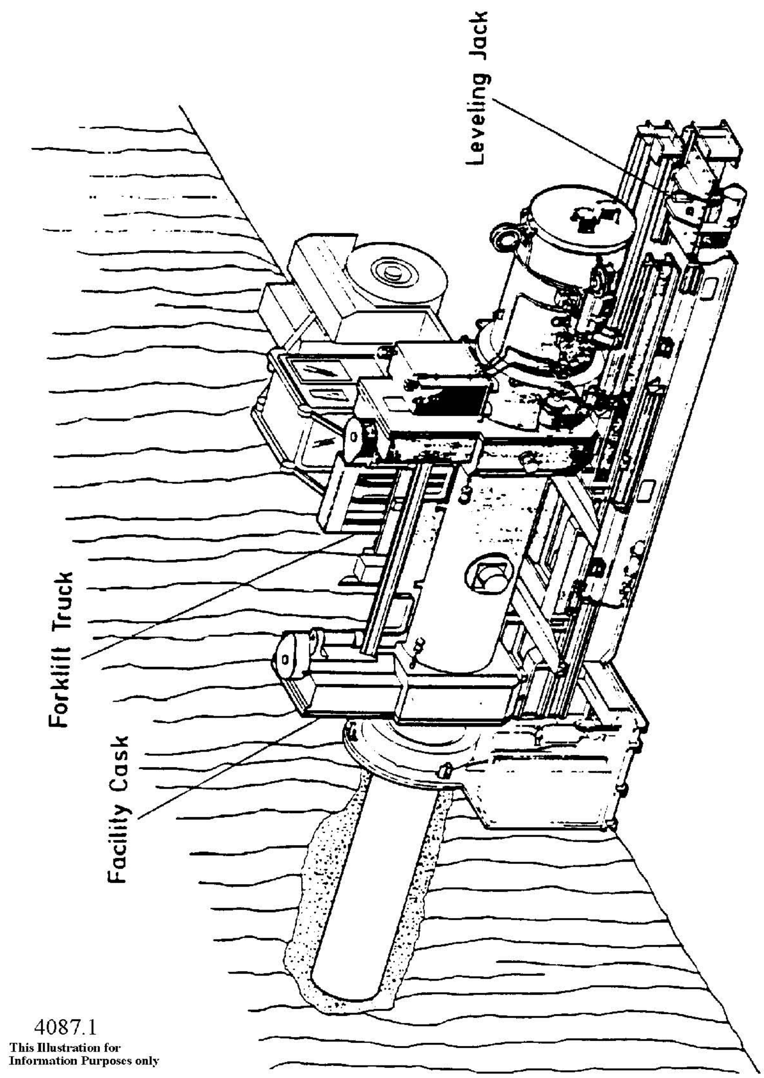

Figure 4.2-29 Facility Cask Installed on the Waste Transfer Machine Assembly

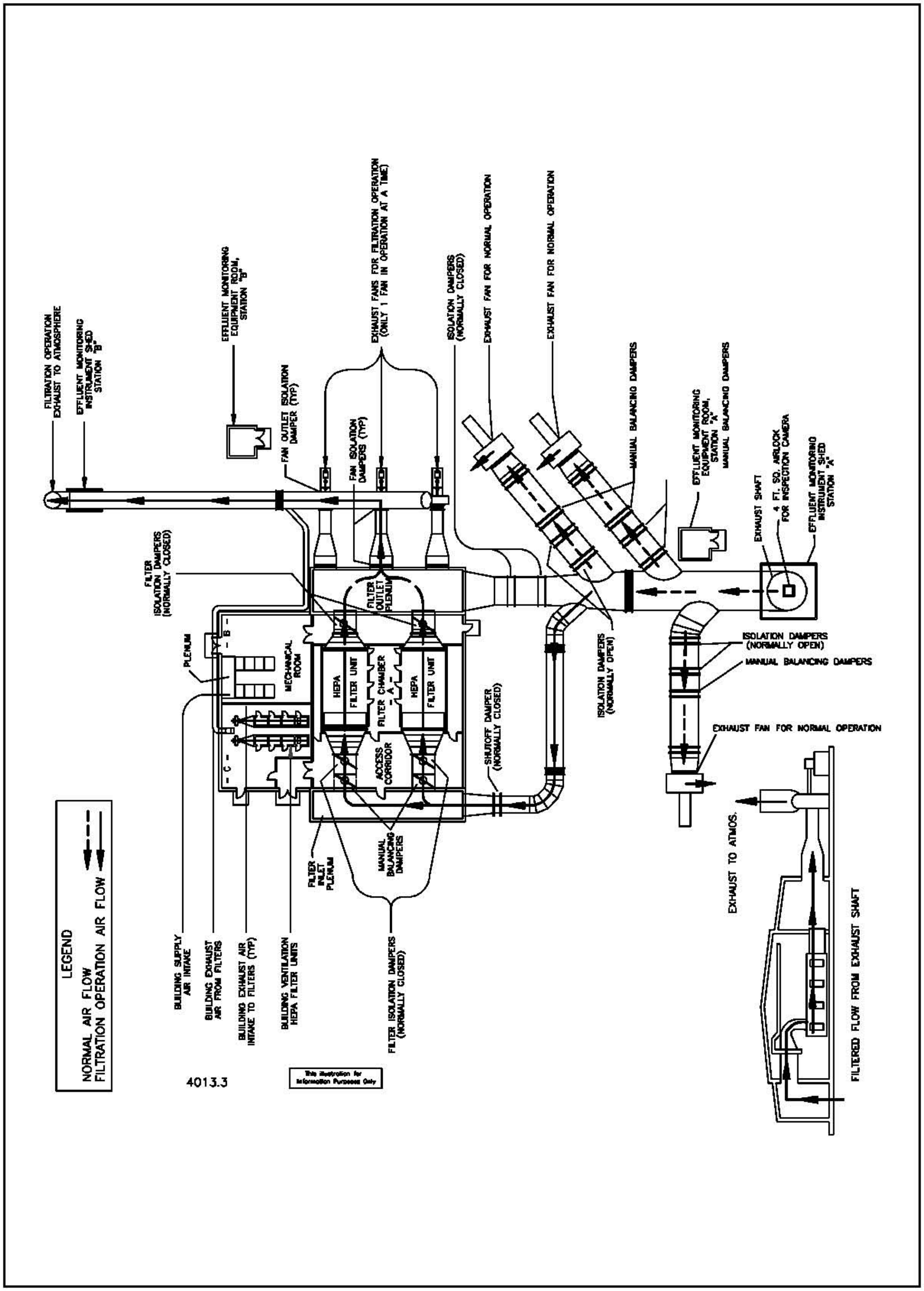

Figure 4.2-30 Exhaust Filter Building

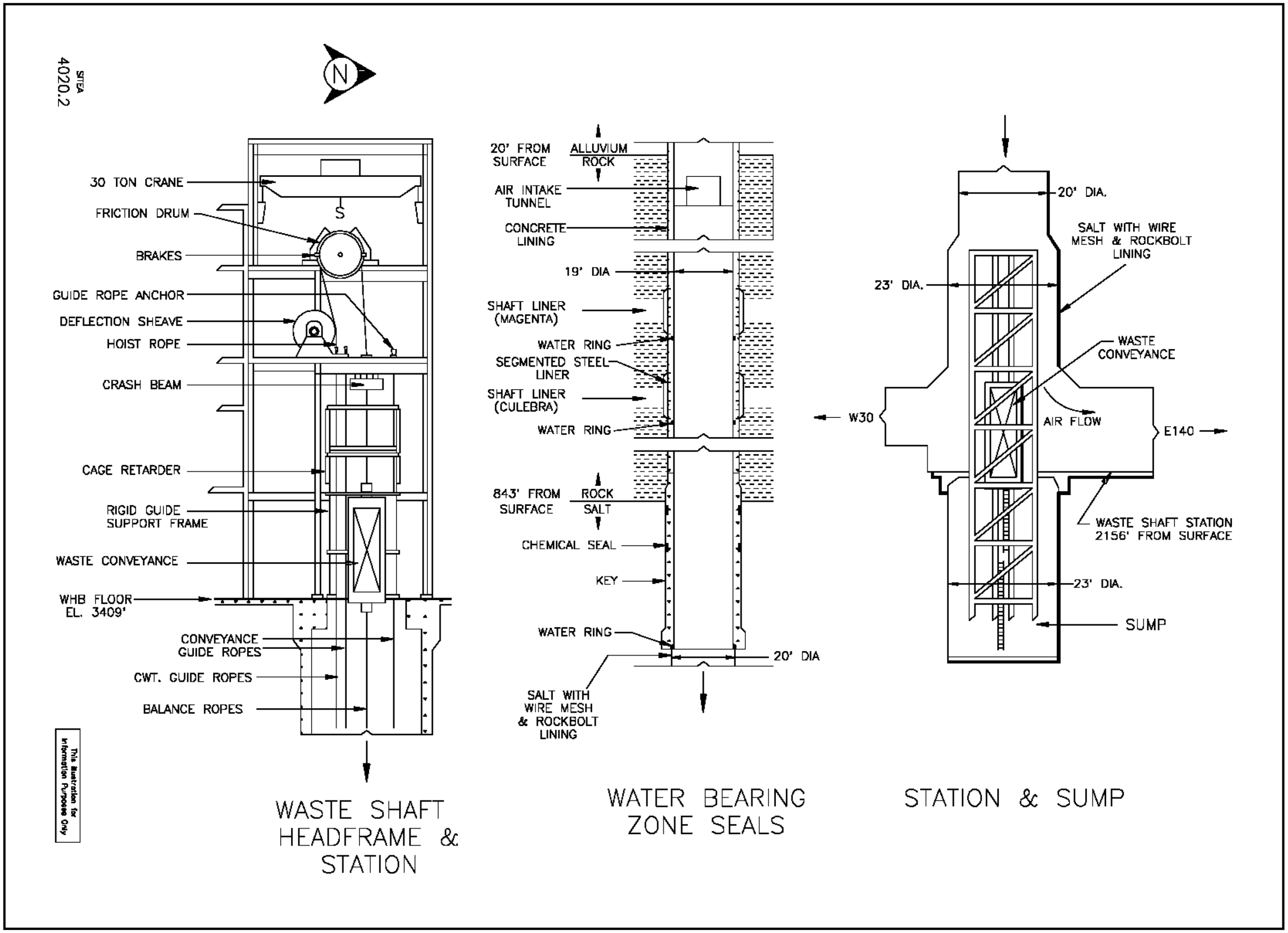

Figure 4.2-31 Waste Shaft and Hoist Arrangement

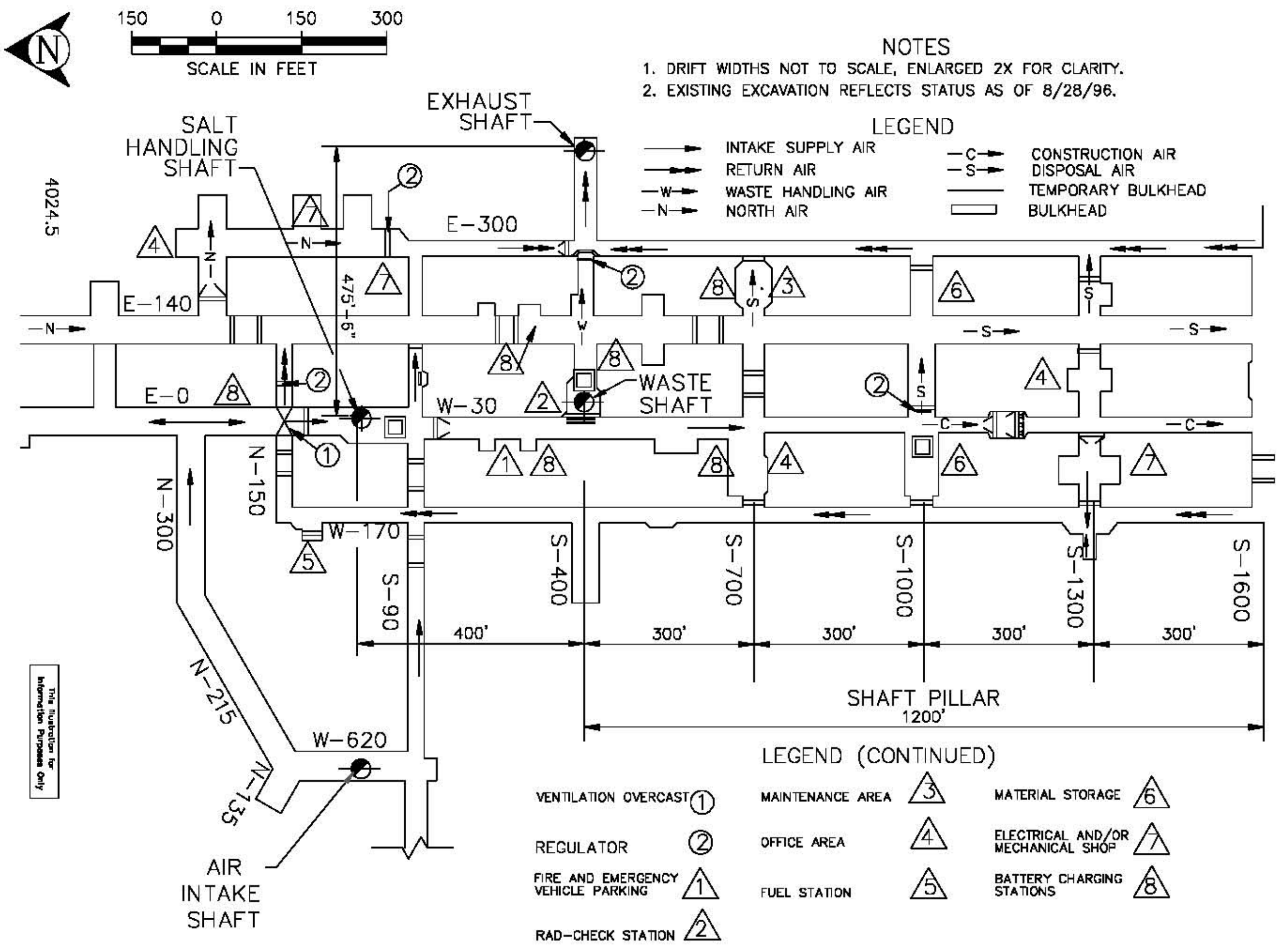

Figure 4.2-32 Shaft Pillar Area Layout and Ventilation Flows

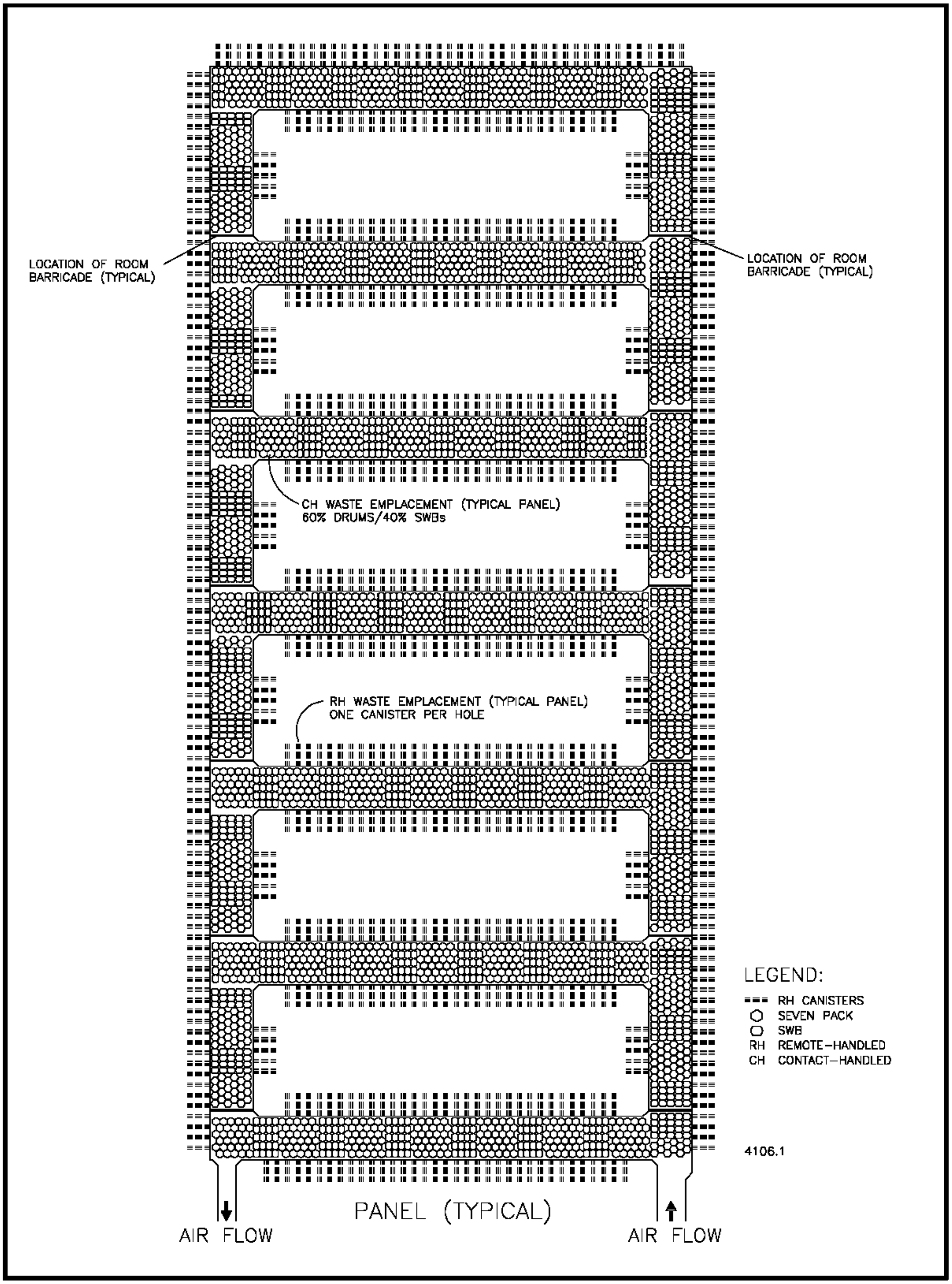

Figure 4.2-33 Typical RH and CH Transuranic Mixed Waste Disposal Configuration

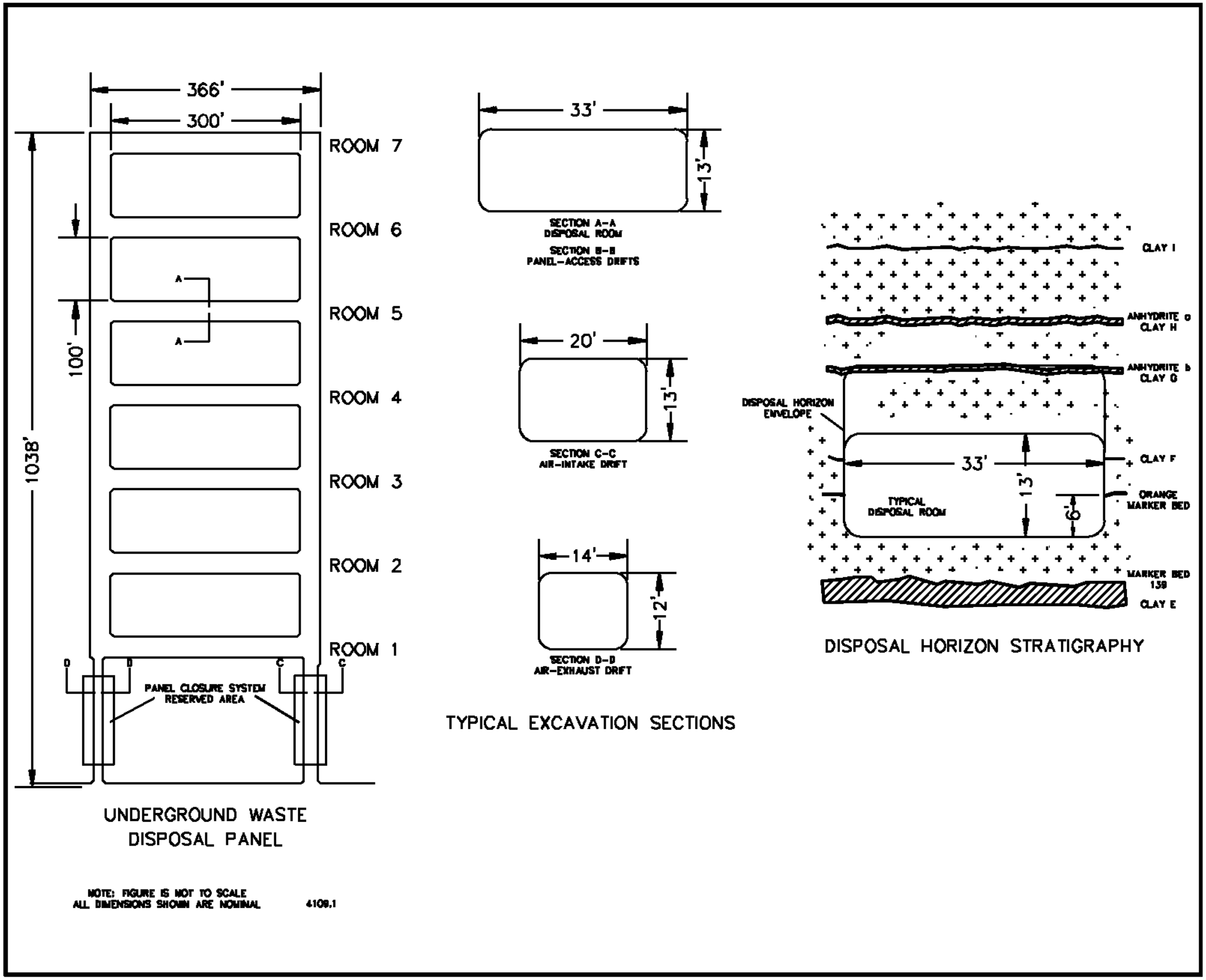

Figure 4.2-34 Typical Disposal Panel

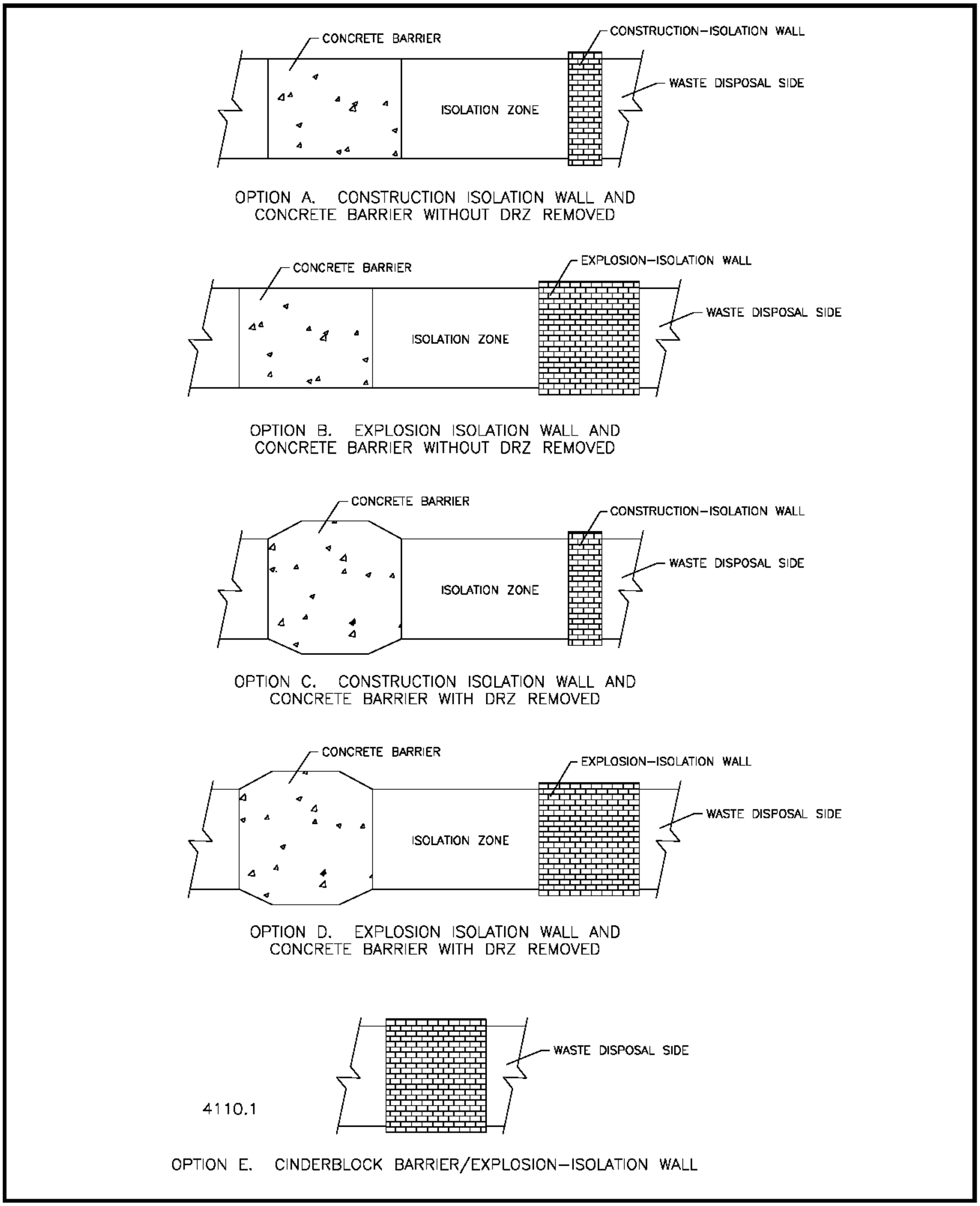

Figure 4.2-35 Design of a Panel Closure System

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4.3 Process Description

This section describes the RH TRU waste handling process at the WIPP facility. The process begins at the gate of the WIPP facility where RH TRU waste will arrive by truck. Rail shipments are not addressed at this time since they are not a current shipping mode. Description of the transportation system is beyond the scope of the RH PSAR.

This section addresses WIPP facility operation relative to design bases (e.g., 35-year operational life, design disposal capacity and throughput, etc). Process descriptions in this chapter are independent of the actual quantity of waste handled. The RH TRU waste handling system, including each function, the equipment used, and the operations performed, is discussed in this section. A pictorial view of the 72B RH TRU waste handling process is shown in Figure 4.3-1, while the 10-160B waste handling process is shown in Figure 4.3-2.

4.3.1 RH TRU Waste Receiving

Upon arrival, each incoming road cask shipment is inspected; which includes verifying the shipment documentation, performing a security check, and conducting an initial exterior radiological survey of the shipment. If any levels of radiation, contamination, or significant damage in excess of acceptance criteria are found, actions will be taken in accordance with approved procedures.

Following turnover of the shipping documentation, the driver transports and parks the trailer, unhooks the tractor in the parking lot adjacent to the RH waste entrance to the Waste Handling Building (WHB). The driver is subsequently released. The RH TRU waste outdoor storage area is designed to provide parking for RH TRU waste trailers. Only two loaded road casks are allowed in the RH bay at a time.

4.3.2 72B Cask Waste Handling Process

4.3.2.1 Cask Preparation

When space becomes available, a trailer with a loaded 72B road cask (Figure 4.3-3) is attached to a facility tractor and brought into the RH Bay by operations personnel. After the trailer is spotted inside the RH bay, Operators, using a motorized man lift as a work platform, remove the two impact limiters from the road cask while still on the trailer. The 140/25-ton overhead crane is used to lift the impact limiters and place on separate support stands. The cask lifting yoke is connected to the 140/25-ton overhead bridge crane. The lifting yoke engages the handling trunnions of the road cask. The road cask is lifted and rotated to the vertical position and placed on the road cask transfer car (Figure 4.2-7). The A-frame of the road cask transfer car supports the road cask at the transporter trunnions. The 72B road cask is then moved to the cask preparation station (elevated work platform) in the RH Bay. The work platform, which straddles the road cask transfer car rails, allows personnel to have access to the head area of the road cask for conducting radiological surveys, performing physical inspections or minor maintenance, and decontamination, if necessary.

The outer lid lift fixture is attached to the work platform 2.5-ton jib crane. After radiological surveys for surface contamination and radiation levels are performed, the space between the inner (IC) and outer (OC) lid is vented via the OC lid vent fixture. The operators then remove the OC lid bolts using the OC lid bolts detensioning device. The outer lid lift fixture is attached to the OC lid. The OC lid is lifted by the jib crane from the road cask and placed on its storage stand. The inner lid vent is opened to equalize the pressure between the road cask cavity and atmospheric, then the inner lid lift fixture (pintle) is attached to the inner lid.

4.3.2.2 Cask Unloading Room

The 72B road cask is moved from the cask preparation station into the CUR. The CUR 25-ton crane with a road cask lift fixture engages the two opposing lifting trunnions of the road cask. The 25-ton crane lifts the road cask from the road cask transfer car and positions it over the CUR shield valve. Interlocks require the 25-ton crane to be positioned over the floor shield valve, the shuttle car cask receiver (Figure 4.2-17) in the Transfer Cell to be positioned under the floor shield valve, the Transfer Cell ceiling shield valve to be closed, the Hot Cell shield valve to be closed, and the Hot Cell floor shield plugs installed before the CUR floor shield valve can be opened. When all interlocks are satisfied, the floor shield valve is opened. The process is reversed when a 72B road cask is removed from the Transfer Cell.

Differential air pressure flow from the CUR to the Transfer Cell is used to protect the workers and prevent the spread of contamination in the case of an off normal event.

4.3.2.3 Transfer Cell

The Transfer Cell is an exclusion area when a canister of RH TRU waste is present, and any reentry after RH TRU waste handling requires a radiological survey of the cell area.

The loaded 72B cask is lowered through the open CUR shield valve port into the Transfer Cell, then into the shuttle car road cask receiver. The height of the cask receiver and the size of the shuttle car prevents any road cask movement once it is inside the receiver. The road cask lift fixture is disengaged from the lifting trunnions (closed circuit TV cameras and load cells on the lift fixture are used to verify lift fixture disengagement). The 25-ton crane lift fixture is lifted back inside the CUR. When the open port of the floor shield valve is clear, the floor shield valve is closed.

The transfer cell shuttle car is designed to transfer one 72B cask from below the CUR floor shield valve to the various robotic work stations in the Transfer Cell. Remote controlled CCTV cameras are used to monitor waste handling operations in the Transfer Cell.

The shuttle car positions the72B cask next to the robotic inner lid bolts detensioning device. The detensioning device loosens the lid retaining bolts, which are spring loaded so that they remain in the lid. The shuttle car then positions the 72B cask directly below the Transfer Cell shield valve.

4.3.2.4 Facility Cask Loading Room

In the Facility Cask Loading Room, the facility cask, on the facility cask transfer car, has been positioned so that when it is rotated to the vertical position by the facility cask rotating device, it is in alignment with the opening of the Transfer Cell ceiling shield valve and the telescoping port shield. The Facility Cask Loading Room shield door is closed.

When the facility cask has been rotated to the vertical position, the telescoping port shield, mounted in the floor of the Facility Cask Loading Room, is raised to mate with the facility cask bottom shield valve body. The Facility Cask Loading Room 6.25-ton grapple hoist is lowered so that the shield bell is in contact with the facility cask top shield valve body. With the shield bell and the telescoping port shield in contact with the facility cask, a totally shielded volume is formed to allow the safe transfer of a RH TRU waste canister from the 72B cask into the facility cask.

The top facility cask shield valve is opened, the Transfer Cell ceiling shield valve is opened, then the bottom facility cask shield valve is opened and the facility grapple, attached to the 6.25-ton grapple hoist, is lowered through the facility cask into the Transfer Cell. (Note: the Transfer Cell ceiling shield valve and both facility cask shield valves are interlocked so that the facility cask bottom shield cannot be opened unless the Transfer Cell ceiling shield valve is opened and the Transfer Cell ceiling shield valve cannot be closed unless the facility cask bottom shield valve is closed) The facility grapple engages the inner lid pintle, installed at the cask preparation station, and lifts the inner lid clear of the 72B cask. When the lid is clear of the cask, radiological contamination swipes are taken by robotic means and are transferred from the Transfer Cell for analysis. The lid is lifted so that the Transfer Cell ceiling shield valve can be closed. The shuttle car is then repositioned so that the inner lid storage platform is aligned under the Transfer Cell ceiling shield valve. The Transfer Cell ceiling shield valve is opened and the facility grapple positions the inner lid on its storage platform and releases the pintle. The facility grapple is lifted so that the Transfer Cell ceiling shield valve can be closed. The shuttle car then positioned so that the 72B cask is in alignment with the Transfer Cell Shield valve and the shield valve is opened. The facility grapple is lowered until it engages the pintle of the waste canister.

As the waste canister is lifted from the 72B cask and before it passes through the Transfer Cell ceiling shield valve, radiological contamination swipes on the waste canister are taken by robotic means and are transferred from the Transfer Cell for analysis. Also the waste canister identification is observed by CCTV cameras and compared against the identity listed on the hazardous waste manifest and the WIPP Waste Information System (WWIS) to verify that the canister is suitable for emplacement. During the lift, the CCTV cameras provide a visual inspection to verify the mechanical integrity of the waste canister.

When the surveys have been satisfactorily completed and identification verified, the waste canister is lifted inside the facility cask. The bottom shield valve of the facility cask is closed, the Transfer Cell ceiling shield valve is closed, and the facility grapple lowers the waste canister so that it is resting on the gate of the bottom shield valve. the waste canister is held in position until the results of the contamination survey are completed. If the waste canister is cleared for disposal, the facility grapple disengages from the waste canister pintle and is lifted into the bell shield, then the facility cask top shield valve is closed. The bell shield is then lifted away from the facility cask and the telescoping port shield is lowered. The facility cask is rotated to the horizontal position. The Facility Cask Loading Room shield door is opened.

If any discrepancy in a waste canister's identity or surveys (radiological and integrity) is detected, the waste canister will be re-inserted inside the road cask and the inner lid placed on the road cask. The shuttle car will position the road cask under the Hot Cell transfer path opening in the ceiling of the Transfer Cell. Radiological surveys will be performed to determine if any streaming paths from the road cask inner lid exists. If determined to be radiologically safe, the inner lid bolts will be manually tensioned and the 72B road cask unloading process will be reversed.

4.3.3 10-160B Cask Waste Handling Process

4.3.3.1 Road Cask Preparation

A loaded 10-160B road cask is brought into the RH Bay. After the trailer is spotted inside the RH bay, Operators, using a motorized man lift as a work platform, remove the top impact limiter from the road cask while still on the trailer. The 140/25-ton overhead crane is used to lift the impact limiter and place at designated location. Operators install the lifting lugs on the sides of the road cask. The lid is left in place to provide shielding. The 140/25-ton bridge crane is used to lift the 10-160B cask from the trailer by engaging the lifting lugs and place it on the 10-160B road cask transfer car. Operators then vent the cask utilizing containment/filtration to contain any contamination which may have been released during transit. The venting rig/containment will be surveyed for surface contamination after the pressures have equalized. Operations then remove the road cask lid bolts.

After the 10-160B road cask has been placed on the transfer car, the lid lift fixture with an integral pintle is attached to the cask lid. The lid lift fixture is installed by using either the 140/25 ton crane or the cask preparation station jib crane.

4.3.3.2 Cask Unloading Room

The transfer car transports the 10-160B road cask to the CUR and positions it under the Hot Cell floor shield plugs. Waste Handling personnel leave the room and close the shield door. Interlocks require the CUR shield door and floor shield valve and the Hot Cell shield valve to be closed, before the Hot Cell shield plugs can be removed. When all interlocks are satisfied, the shield plugs are removed.

When a loaded facility canister is ready for processing out of the Hot Cell, a shielded insert (used to transport a facility canister in the Transfer Cell will be positioned inside the CUR using the 72B road cask transfer car. The 25-ton crane will be used to lower the shielded insert into the Transfer Cell shuttle car cask receiver.

4.3.3.3 Hot Cell

Re-packaging of the RH TRU waste drums shipped in the 10-160B cask occurs in the Hot Cell. The Hot Cell is an exclusion area when containers of RH TRU waste are present, and any reentry after RH TRU waste handling requires a radiological survey of the Hot Cell area. The Hot Cell equipment (15-ton bridge crane and its attachments, power manipulator and attachments, master-slave manipulators and CCTV system) are used for waste handling operations inside the Hot Cell.

Operators in the operating gallery use the Hot Cell 15-ton crane and the shield plug lift fixtures, while monitoring the CCTVs, to remove the Hot Cell floor shield plugs and set them aside in the Hot Cell. The crane with a facility grapple is lowered into the CUR and engages the lid lifting fixture pintle on the 10-160B cask lid. The cask lid is raised into the Hot Cell where radiological contamination surveys are performed on its inside surfaces before it is set aside. The facility grapple on the Hot Cell crane engages the pintle on the 10-160B drum carriage lift fixture and lowers it into the CUR where it engages the lifting elements of the upper drum carriage unit. The crane raises the drum carriage unit into the Hot Cell moves it to the inspection station. At the inspection station radiological contamination swipes on the drums and carriage are taken. The swipes are placed in the Hot Cell transfer drawer and transferred into the glove box in the operating gallery for radiological counting. While waiting for radiological counting results, the identification of each drum is verified and compared against the identity listed on the hazardous waste manifest and the WWIS. Once the ID of each of the five drums is verified and all are determined to be free of contamination, the carriage is placed at the designated storage location on the Hot Cell floor. The process is repeated for the second drum carriage unit. If any discrepancy in a waste drum's identity or radiological survey is detected, both loaded carriages will be re-inserted into the 10-160B road cask and 10-160B road cask unloading process will be reversed. If any empty drum carriage units are in the Hot Cell, a maximum of two will be placed into the empty 10-160B cask. The crane picks up the 10-160B cask lid and lowers it into the CUR and places it on the empty 10 –160B cask. The Hot Cell floor shield plugs are re-installed.

Facility canister(s) are pre-staged in the inspection station of the Hot Cell. A facility grapple installed on the 15-ton crane is used to remove the lid of one of the canisters in the inspection station. The bridge mounted power manipulator or the 15-ton Hot Cell crane is used to lift a drum from the carriage and place it into an empty facility canister. This process is repeated two more times until the maximum load of three drums are in a facility canister. This canister loading process is repeated until all drums have been removed from the two carriages. Any partially filled facility canisters can be maintained in the Hot Cell until another 10-160B is unloaded.

The power manipulator or the 15-ton Hot Cell crane is used to install and secure the lid(s) to the filled facility canister(s). Any partially loaded facility canister may be stored in the Hot Cell until it can be fully loaded. The 15-ton Hot Cell crane grapple engages the pintle on a loaded facility canister lid and lifts it from its stagged location. The facility canister is positioned directly over the closed Hot Cell shield valve.

4.3.3.4 Transfer Cell

The Transfer Cell is an exclusion area when a canister of RH TRU waste is present, and any reentry after RH TRU waste handling requires a radiological survey of the Transfer Cell area.

The transfer cell shuttle car is designed to transfer one facility canister in a shielded insert at a time from below the Hot Cell shield valve to below the Transfer Cell ceiling shield valve. Remote controlled CCTV cameras are used to monitor waste handling operations in the Transfer Cell. The shuttle car with a shielded insert, similar to but sightly larger than a 72B road cask, is positioned so that the shielded insert is directly below the Hot Cell shield valve. The Hot Cell shield valve, which is interlocked with the Transfer Cell ceiling shield valve, the CUR floor shield valve, and the Hot Cell shield plugs in such a manner that it can only be opened when the shield plugs are installed and the Transfer Cell and CUR shield valves are closed. The facility canister is lowered through the open Hot Cell shield valve port into the shielded insert. The 15-ton crane grapple is disengaged from the facility canister pintle (CCTV cameras and load cells on the crane are used to verify disengagement) and lifted back inside the Hot Cell. When the open port of the Hot Cell shield valve is clear, the shield valve is closed.

4.3.3.5 Facility Cask Loading Room

In the Facility Cask Loading Room, the facility cask, on the facility cask transfer car, has been positioned so that when it is rotated to the vertical position by the facility cask rotating device, it is in alignment with the opening of the Transfer Cell ceiling shield valve and the telescoping port shield. The Facility Cask Loading Room shield door is closed.

When the facility cask has been rotated to the vertical position, the telescoping port shield, mounted in the floor of the Facility Cask Loading Room, is raised to mate with the facility cask bottom shield valve body. The Facility Cask Loading Room 6.25-ton grapple hoist is lowered so that the shield bell is in contact with the facility cask top shield valve body. With the shield bell and the telescoping port shield in contact with the facility cask, a totally shielded volume is formed to allow the safe transfer of a facility canister from the shielded insert into the facility cask.

The top facility cask shield valve is opened, the Transfer Cell ceiling shield valve is opened, then the bottom facility cask shield valve is opened and the facility grapple, attached to the 6.25-ton grapple hoist, is lowered through the facility cask into the Transfer Cell. (Note: the Transfer Cell ceiling shield valve and both facility cask shield valves are interlocked so that the facility cask bottom shield cannot be opened unless the Transfer Cell ceiling shield valve is opened and the Transfer Cell ceiling shield valve cannot be closed unless the facility cask bottom shield valve is closed) The facility grapple engages the facility canister pintle and lifts the facility canister from the shielded insert. The facility canister is lifted inside the facility cask. The bottom shield valve of the facility cask is closed, the Transfer Cell ceiling shield valve is closed, and the facility grapple lowers the facility canister so that it is resting on the gate of the bottom shield valve. The facility grapple disengages from the facility canister pintle and is lifted into the bell shield, then the facility cask top shield valve is closed. The bell shield is then lifted away from the facility cask and the telescoping port shield is lowered. The facility cask is rotated to the horizontal position. The Facility Cask Loading Room shield door is opened.

4.3.4 Waste Shaft Entry Room

In the waste shaft entry room with the waste hoist cage properly positioned, the shaft gates are opened, the pivot rails are positioned, and the facility cask transfer car transports the facility cask onto the waste hoist conveyance. The Facility Cask Loading Room shield doors are closed. The waste hoist conveyance is lowered to the disposal horizon. The facility cask transfer car moves the facility cask from the hoist conveyance into the underground transfer area shown on Figure 4.3-2.

4.3.5 Underground Transfer Area

When the waste shaft conveyance has stopped at the disposal horizon, the shaft gates are opened, the pivot rails are positioned, power cable connected, and the facility cask transfer car moves from the conveyance (Figure 4.3-4) into the transfer area (E-140). The 41-ton forklift forks are inserted into the lower set of forklift pockets of the facility cask and lifts the facility cask from the facility cask transfer car. The forklift lowers the facility cask and transports it to the disposal location at a speed of approximately 3 to 4 mi (4.8 to 6.4 km) per hour.

4.3.6 RH TRU Waste Disposal

At the RH waste disposal location, the 41 ton forklift places the facility cask on the waste transfer machine, which will have been previously aligned with the horizontal borehole (Figure 4.2-26). The facility cask is moved forward to mate with the shield collar and the transfer carriage is advanced to mate with the rear facility cask shield valve. Both facility cask shield valves are opened and the transfer mechanism extends to push the canister into the hole (Figure 4.3-5). After retracting the transfer mechanism into the facility cask, the forward shield valve is closed, and the transfer mechanism is further retracted into its housing. A forklift using the strongback positions a shield plug (Figure 4.2-28) on the shield plug carriage. The transfer carriage is moved to the rear about 6.5 ft (2 m) and a 6-ton forklift places the shield plug carriage (Figure 4.2-25) on the staging platform. The transfer mechanism pushes the shield plug into the facility cask. The front shield valve is opened and the shield plug is pushed into the hole (Figure 4.3-6).

The transfer mechanism is retracted, the facility cask shield valves are closed, the transfer carriage retracted, and the facility cask removed from the emplacement machine. The emplacement machine is now available for transfer to another location.

4.3.7 Process Interruption Modes

Process interruption modes fall into two categories, routine and emergency/abnormal.

4.3.7.1 Routine Interruptions

Routine interruptions are plant process interruptions, including scheduled maintenance, unscheduled maintenance, and plant inspections during the life of the facility.

Actions taken during a routine interruption are conducted in accordance with established procedures, and monitoring of the plant parameters during the interruption is continued to ensure that no radiological problems are encountered. Any additional inspections that are necessary during the interruption are specified in the procedures.

4.3.7.2 Emergency/Abnormal Interruptions

Emergency interruptions are those process interruptions in the plant due to accident conditions, which include earthquakes, severe weather, and fires.

Earthquake - Normal plant operations may be suspended following an earthquake. If the earthquake is of sufficient magnitude (i.e., seismic event of 0.015 g or greater acceleration), inspection of structures and equipment will be required prior to resuming normal operations. The length of the interruption will depend upon the results of the inspection and all plant recovery corrective actions will be directed toward returning the plant to normal operation.

Severe Weather - Normal plant operations may be suspended during a tornado warning or a high wind condition. A tornado warning or high wind condition will exist based on information provided by the National Weather Service or a local observation. If a severe weather emergency condition occurs at the WIPP facility, inspections of structures and equipment may be required prior to resuming normal operations. The length of the interruption will depend on the results of the inspection, and all plant recovery corrective actions will be directed toward returning the plant to normal operation.

Fires - Fire accidents, although not expected, may result in a process interruption. The occurrence of a major fire requires the evacuation of personnel and response by appropriate emergency personnel. After extinguishing the fire, the area will be surveyed, controls will be established to mitigate any problems, and the area returned to normal operations.

Abnormal Interruptions are any unplanned and unexpected change in a process condition or variable adversely affecting safety, security, environment, or health protection performance sufficient to require termination (stopping or putting on hold) of an operating procedure related to the flow path of radioactive waste processing for greater than four hours.

Loss of Off-Site Power - The loss of off-site power affects all electrical equipment. The plant is designed with a manually started backup power supply, which picks up selected electrical loads such as the AIS hoist, lighting, and ventilation system. Certain equipment has uninterruptible (battery) backup for loss of power so that functions such as parts of the central monitoring system (CMS) continue without power interruption. The site backup power system can maintain the containment functions (e.g., negative pressure ventilation balance), and is discussed in Section 4.6.

4.3.8 WIPP Waste Information System

The RH WAC [1] requires specific information from the waste generators to meet the waste certification requirements. The WIPP waste information system (WWIS) provides an online source of data required by the RH WAC,[1] showing the waste form, type payload, weight, and radionuclide inventory.

The WIPP WWIS is a system of computerized tools in a multiuser relational database designed to facilitate the effective management and tracking of TRU waste from DOE waste generator sites to the WIPP. The WWIS will gather, store, and process information pertaining to TRU waste designated by the Secretary of Energy for disposal at the WIPP. The system will support those organizations who have responsibility for managing TRU waste by collecting information into one source and providing data in a uniform format that has been verified or certified as being accurate. The WWIS will be a reliable, secure, and accurate system to store all information pertaining to characterization, certification, and emplacement of waste at WIPP. Waste information for WWIS will be supplied by the generator sites of the TRU waste and the WIPP facility.

The WWIS includes features to automate the transfer of the data required by the RH WAC [1] from the waste generators to the WIPP and also includes the limiting criteria from the RH WAC[1]. Data input by the waste generators that does not meet these criteria is automatically flagged for review. In addition to providing RH WAC [1] related information for the repository, the WWIS provides operational information, and routine and special reports. See WP 08-WA.06 [2], Appendix A for an example of the WWIS Data Dictionary.

The WWIS provides the following functions:

- Entry and validation of waste characterization data for waste destined for the WIPP.
- Entry and validation of waste certification data for waste destined for the WIPP.
- Entry and validation of waste transportation data for waste destined for the WIPP.
- Entry and validation of waste emplacement location data for waste emplaced at the WIPP.

During the waste handling process, the waste container identity is entered into the WWIS to track the location of the waste, and to verify that the information contained in shipping documents was correct. Once the waste is emplaced, a final set of documents summarizing the contents and final disposition of the waste is generated by the WWIS and added to other pertinent documentation to create the required records. The records generated will be used to show WIPP's compliance with the applicable regulations relative to the type of wastes destined for disposal at WIPP.

4.3.8.1 72B RH TRU Waste Identification

The identification number of each 72B RH TRU waste canister is verified against the container data while the canister is in the Transfer Cell and just before it is loaded into the facility cask.

4.3.8.2 10-160B RH TRU Waste Identification

The identification number of each 10-160B RH TRU waste drum is verified against the container data while the drum is in the Hot Cell after it is unloaded from the road cask.

4.3.9 Underground Mining Operations

4.3.9.1 Mining Method

Mining is performed by continuous mining machines. Prior to mining in virgin areas, probe holes are drilled to relieve any pressure that may be present. After mining, vertical pressure relief holes are drilled up at the main intersections of drifts and crosscuts.

One type of continuous mining machine is a roadheader or boom type continuous miner operating a milling head. The milling head rotates in line with the axis of the cutter boom, mining the salt from the face. The mined salt is picked up from the floor by the loading apron. The muck (mined salt) is pulled through the miner on a chain conveyor, through a slewing conveyor, and then loaded in one of the haul vehicles.

Another type of continuous mining machine is a drum miner operating with a head that rotates perpendicular to the axis of the cutter boom, and cuts the salt away from the working face. The muck is pulled through the miner on a chain conveyor and then loaded in one of the haul vehicles.

During and immediately after mining, a sounding survey of the roofs of drifts is made to identify areas of drummy or slabby rock, which might represent safety or stability problems. A comprehensive underground safety and maintenance program has been established and can be found in procedure WP 04-AU1007, Underground Openings Inspections.[3]

Remedial work, including hand scaling of thin drummy areas, removal of larger drummy areas up to 18 in thick with the continuous miners, or rock bolting, is accomplished immediately after soundings in any areas identified as potentially unstable. Additional scaling is performed, as required, using a mechanical scaler, improving the safety of this operation.

Rock bolts are used extensively throughout the underground openings for remedial work and for safety. In addition, roofs in the first waste disposal panel and high traffic areas are pattern bolted for extra safety. Both resin and mechanical bolts are used in most ground control activities. Only certified bolts are used at the WIPP; the specifications in WP 04-AU1007 [3] and 30 CFR 57, Safety and Health Standards - Underground Metal and Nonmetal Mines [4] are used in defining bolting requirements for the underground.

The WIPP engineering staff is responsible for ensuring that ground control systems comply with all rules and regulations.

4.3.9.2 Interface Between Mining and Waste Disposal Activities

Separate mining ventilation and disposal ventilation circuits are maintained by means of temporary and permanent bulkheads. Air pressure in the mining side is maintained higher than in the disposal side to ensure that any leakage results in airflow to the disposal side. The underground ventilation system is discussed in Section 4.4.3. Rooms being mined are within the mining ventilation circuit, and rooms under disposal are within the disposal ventilation circuit.

4.3.9.3 Mined Material

The salt removed during underground mining is brought to the surface by the salt handling system. From the surge pocket, salt is loaded into the 8-ton salt handling skip with a skip measuring and loading hopper, the skip is raised to the surface, and dumped through a chute to surface haulage equipment which transports the salt to an on-site storage pile.

4.3.9.4 Ground Control Program

The WIPP facility ground control program ensures underground safety from any potential unplanned roof or rib falls. Care is taken from the moment a drift is mined and throughout the life of the opening to remove or restrain any loose or potentially unsafe pieces of ground. As the opening ages, areas of the roof, ribs, and floor may require some ground control. To ensure this is achieved in a timely and efficient manner, a very comprehensive ground control monitoring program has been established.

Ground Control Planning

An internal ground control operating plan is used to guide both short and long-term planning. For the purpose of ground control activities, the underground facility at the WIPP site is divided into over 100 zones. These zones facilitate detailed evaluation and documentation of the status and conditions of the underground. A database has been developed which documents the current status of each ground control zone. The current status refers to the physical state of an underground excavation (zone) with respect to geometry, excavation age, ground support, and operational use. The data collected for the plan and the evaluation of those data are most useful when used or considered immediately after collection. Detailed work packages are developed specifically for each ground control activity. The plan also serves as a foundation document for the development of the Long-Term Ground Control Plan.[5]

The Long-Term Ground Control Plan[5] provides a strategy for development and selection of the most applicable and efficient means of maintaining and monitoring the ground conditions of the WIPP in order to assure safe and operational conditions from the present time to closure of the facility. The plans for the most current years covered by the plan are explained in more detail than the later years, since it is easier to predict the immediate future than the distant future. The Long-Term Ground Control Plan[5] addresses technical aspects of the underground facility which are concerned with the design, construction, and performance of the subsurface structures and support systems. In particular, this plan addresses the requirement for maintaining the ground conditions in the underground facility in a safe and operational state for its anticipated lifetime.

Topics associated with the stability of the roof of the underground facility are the primary focus of the Long-Term Ground Control Plan.[5] During the period of time that the underground has been active, a variety of ground control issues have been encountered ranging from minor spalling to roof falls. Minor spalling is small pieces of the back flaking off or falling. The ground control program consists of many aspects which include continuous visual inspections of the underground openings, extensive geotechnical monitoring, numerical modeling, analysis of rockbolt failures, implementation of ground control procedures, and comprehensive in situ and laboratory testing and evaluation of ground control components and systems.

Each year the Long-Term Ground Control Plan[5] is rolled forward one year. This revision takes into account developments in both WIPP and industrial support practices and materials, and any changes in WIPP life and operational requirements. WIPP ground control plans are living documents that keep ground control practice at WIPP both current and responsive.

Ground Control Practice

A comprehensive ground control program for the entire underground facility is followed at WIPP to ensure safe conditions, operational efficiency, reliability and confidence, and regulatory compliance for personnel and equipment.

Qualified and experienced personnel in Geotechnical Engineering, Mine Engineering, and Underground Operations are responsible for and committed to the success of this program. The elements of the program are monitoring; initial and on-going evaluation; engineering design and specification; data collection and analysis; implementation; and maintenance as necessary. These elements include the following main activities.

- Monitoring: The geotechnical performance of the underground facility is regularly evaluated by the Geotechnical Engineering section. This evaluation is focused on providing early detection of conditions that could affect safety and operations, and to permit further engineering analysis of the performance of WIPP excavations in salt. At present there are over 1,000 instruments installed underground, and additional instruments are installed as conditions warrant. Daily and weekly visual examinations are performed by Mine Operations staff.

- Evaluation: Geotechnical and mining engineers perform a variety of rock mechanics analyses to ensure that rock mass behavior is correctly understood and proper ground control measures are instituted from the beginning.

- Engineering Design and Specification: The ground support system is designed and specified to ensure the safety of staff and to facilitate operations. Maintenance activities are specified in performance standards and procedures so that ground conditions presenting a potential hazard are safely rectified. Ground control problems are addressed on an individual basis so that the most appropriate method of remediation is implemented. Geotechnical Engineering is constantly improving ground support systems in order to provide the most effective and safe methods and materials possible for the underground facility.

- Data Collection and Analysis: Field activities are established for data collection from geotechnical instrumentation, fracture and excavation effect surveys, and general observations. Ground conditions are examined on a regular basis (at the beginning of each shift, weekly, monthly, and annually according to regulatory requirements and operating plans). Monitoring results are analyzed in comparison with established design criteria, and are utilized in a variety of computer models. The results of these studies are published in a variety of formats ranging from specific reports through frequent regular assessments (e.g., bi-monthly summaries) to comprehensive annual reports (e.g. Geotechnical Analysis Report), which are available to the public in reading rooms. All data and related documentation are maintained in databases which are regularly subjected to quality assurance audits. These data are available to those who make independent assessments.

The fundamentals on which the ground control program at the WIPP facility are based are as follows:

- Ground stability is maintained as long as access is possible.
- Ground control maintenance efforts increase with the age of the openings.
- Ground control plans are specific but flexible.
- Regular ground control maintenance is required.

The ground control program at the WIPP facility uses observational experience and analysis of salt behavior underground to enable various projections regarding future ground support requirements. This approach recognizes that salt moves or creeps. Because of its plastic nature, salt will flow into an excavated opening. To provide long-term ground support, the ground control system must:

- Accommodate the continuous creep of salt
- Retain broken fractured rock in the back or rib

Two major categories for support systems are rock bolts and supplementary systems. The rock bolt systems are mechanically-anchored bolts and resin-anchored threaded rods. The supplementary systems include cables with mesh, trusses, and the Room 1, Panel 1 design.

Initial Roof Support System (Rock-Bolt System)

Prior to waste emplacement in any specific area (room), the plans (for Panels 2-8) are to spot bolt with short, mechanically anchored bolts only as necessary, if spalls or loose ground are encountered during and after the mining process. Mesh may be used in conjunction with these bolts to secure any loose ground encountered during normal inspection processes. These bolts would not penetrate through to the next clay/anhydrite interface, and would be anchored within the beam formed by the mine roof and the clay/anhydrite interface above. This is the primary or initial support which will be used in Panels 2-8.

However, based on experience with the Site and Preliminary Design Validation (SPDV) rooms and the rooms in Panel 1, pattern bolting is not expected to be required until 2-5 years after excavation. Disposal rooms may be pattern bolted prior to waste emplacement. The expert panel convened to study Panel 1 in 1991 concluded that the then current support technology of 10 ft (3.05 m) long mechanical bolts used in Panel 1 should be adequate to ensure stability for 7 to 11 years from the time of excavation. These bolts were installed beginning approximately two years after initial excavation on a pattern described as a 5 ft by 5 ft (1.5 m by 1.5 m) offset pattern (one bolt per 25 ft^2 [2.3^2 m]). Experience in Panel 1 confirms the conclusion of the expert panel. Plans call for bolt systems installed in future bolt patterns to be equal to or exceed the bearing characteristics of the mechanically anchored bolts used in the primary pattern in Panel 1.

The justification for choosing these systems includes their demonstrated ability to support the expected loads. In the case of yielding systems, they will be chosen based on their support capabilities and the ability to accommodate expected rock deformation.

Primary support will consist of Grade 75 steel mechanically-anchored bolts of at least 5/8 in (1.6 cm) diameter. Depending on the need, the bolts may be as short as 24 in (61 cm) and as long as 72 in (183 cm). Mesh may be chain-link, welded wire, or polymer.

Pattern bolting will be designed using the best support technology available at the time. Because yielding systems are still under evaluation, current plans call for use of Grade 60 threaded bars of at least 7/8 in (2.2 cm) diameter installed on a maximum 5 ft by 5 ft (1.5 m by 1.5 m) pattern in the center half of the room. The bars would be resin-anchored above the first clay/anhydrite interface. Four or 6 ft (1.2 or 1.8 m) long mechanical bolts would be used near the ribs.

Materials procured for installation as primary support, spot bolting, and pattern support will meet the requirements of 30 CFR 57, Subpart B.[4] This requirement will be verified as part of the quality assurance program. Primary support installation requires quality control by the installation crews. Proper installation is confirmed as part of the audit function of the underground safety and Quality Assurance groups. Quality control and assurance is more rigorous during a pattern bolting sequence. Work instructions for the sequence will require Quality Assurance to perform at least one random inspection to verify that material requirements and hole construction specifications are met.

Operations (construction) supervisors will also be responsible for monitoring the construction. Finally, before turnover or completion of the installation, Quality Assurance will review the work, and certify their approval. Independently, MSHA inspectors also perform a Quality Assurance function during their frequent inspection visits to the WIPP, making certain that support construction is performed in accordance with 30 CFR 57, Subpart B.[4]

Supplementary Support Systems

Similar to the plan for pattern bolting, any supplementary system will be designed using the best support technology available at the time. Should a supplementary support system be required, it is anticipated that, if not already in place, mesh will be installed over the primary and pattern support. The mesh will be augmented either by cables (wire ropes) anchored near the ribs and suspended across the rooms or by steel mats. The cables or mats and, therefore, the mesh will be further pinned to the roof by bolting. The use of either the cables or mats in conjunction with meshing and re-bolting should be adequate in supporting even a highly fractured roof beam.

Support System Performance

Several distinct ground-support systems are installed in Panel 1. They can be generally grouped as rigid, non-yielding systems and yielding systems. Rigid, non-yielding systems are not designed to accommodate salt creep. However, they do respond to creep and continue to provide support during ductile behavior. Based on experience with Panel 1, if Panels 2-8 are excavated and each are filled within five to seven years, these non-yielding systems should provide the necessary support. If pattern bolting is performed just prior to waste emplacement in each room or area, experience at the WIPP has shown that these rigid systems can certainly accommodate the salt creep that will occur during the one to two years of emplacement.

The ground support system installed in Room 1, Panel 1 is a yielding system only as long as access can be maintained. This is because of the necessity to manually reduce the tension of the bolts. If the detensioning process is stopped, the system becomes a rigid, non-yielding system and will undergo the same ductile behavior as other rigid systems.

Other yielding systems are installed in the WIPP underground and each is being evaluated. Each of these systems is designed to yield at predetermined loads. All are designed to work over their prescribed yield interval without maintenance. Some of the systems are designed to respond to the loading by salt creep and provide over one ft of yield without system degradation. A detailed evaluation of the adequacy of these systems is not possible at this time.

The initial roof support system, consisting of mechanical anchor bolts, was installed in 1988. The ground control design was developed based on information obtained from the SPDV rooms. Panel 1 rooms were pattern bolted with 10 ft (3.05 m) long, 3/4 in (19 mm) diameter, mechanical anchor bolts on a 3.0 ft (0.9 m) by 3.9 ft (1.2 m) center spacing through the middle third of each room. The outer third along each rib uses the same roof bolt but on a 3.9 ft (1.2 m) by 6 ft (1.8 m) center spacing pattern.

The original design for the waste disposal rooms at the WIPP provides a limited period of time during which to mine the openings and to emplace wastes. Each panel, consisting of seven disposal rooms, is scheduled to be mined and filled in less than five years, at which time it would be closed. Field studies, part of the SPDV Program, showed that unsupported openings of a typical disposal room configuration would remain stable, and that creep closure would not impact equipment clearances during at least a five year period following excavation. The information from these studies verified that the design of openings for the permanent disposal of wastes under routine operations was acceptable.

Panel 1 was developed to receive waste for a demonstration phase that was scheduled to start in October 1988. The original plan consisted of the storage of drums of CH TRU waste in panel rooms for a period of 5 years. During this time and immediately following it, the rooms were to be inaccessible, but the option to reenter was to be maintained so that waste could be removed, if required. The demonstration phase was later deferred, and an experimental program was added in Room 1, Panel 1. This led to more stringent requirements for roof stability.

To ensure the roof stability for the revised tests and durations, a supplemental roof support system was designed. The Supplemental Roof Support System is designed to contain and support the weight of a detaching salt wedge of the immediate roof, if one begins to form, while allowing it to be deformed by creep behavior. The system is not designed to prevent the creep of salt into the room. The Supplemental Roof Support System consists of 26 steel channel support sets, installed laterally across the room on approximately 10 ft (3.05 m) centers. Each channel support set is carried by 11 resin anchored roof bolts. The bolts are anchored over the interval between 8.5 and 11.5 ft (2.6 and 3.5 m) into the roof, which is above the expected failure surface. The roof area between the channel sets is covered by a network of steel wire lacing cables, which hold a mat of steel wire mesh and expanded metal against the rock salt surface.

The design of this system was subjected to exhaustive scrutiny by two formal Design Review Panels. The first review was conducted by qualified project personnel from the Westinghouse Waste Isolation Division (WID) Engineering, Operations, Quality Assurance, and Safety groups with the participation of SNL. A second formal review was conducted by a panel of rock mechanics experts not associated with the WIPP project. This Expert Review Panel consisted of representatives from the mining industry, U.S. Bureau of Mines, Mine Safety and Health Administration (MSHA), academia, and independent consultants. These Design Review Panels approved the design based on evaluation of design documents, on-site observations at the WIPP underground facility, and detailed discussions with members of the design team.

The support system is adjusted (Room 1, Panel 1 only) to ensure that the loads on the anchors do not exceed the working loads specified by the design. Support system monitoring results are used to determine when load adjustments (or other maintenance) are required. When the load on the bolt approaches 20,000 lbs (9070 kg), the bolts are adjusted to about 5000 lbs (2268 kg). Modifications were made to the support system to improve the reading accuracy of the monitoring system. This provided a better interaction between the rock and the support system.

A monitoring program for Room 1, Panel 1 has been in place since initial excavation of the room. Room stability has been assessed from monitoring of room closure, rock deformations in and around the room, and fracture development and separation. The deformation data collected by the monitoring system is then compared against previously acquired data to identify deviations from expected performance. This program has provided a great deal of information on support system performance, room and rock mass behavior, and ground control techniques and materials.

4.3.9.5 Geotechnical Monitoring

Geotechnical data on the performance of the repository shafts and excavated areas are collected as part of the geotechnical field-monitoring program. The results of the geotechnical investigations are reported annually. The report describes monitoring programs and geotechnical data collected during the previous year.

Instrumentation, Monitoring, and Evaluation

The WIPP geotechnical programs are conducted in accordance with written procedures, and provide in-situ data to support continuing assessments of the designs for the shafts and underground facilities. The safety of the underground excavations is, and will continue to be evaluated on the basis of criteria established from actual measurements of room behavior. These criteria are regularly evaluated and modified as more field data are collected, and additional experience is gained with the performance of the WIPP underground excavations.

Geotechnical monitoring programs provide measurement of rock mass performance for design validation, routine evaluation of the safety and stability of the excavations, and the short-term and long-term behavior of underground openings. The minimum instrumentation for Panels 2 through 8 is one borehole extensometer installed in the roof at the center of each disposal room. The roof extensometers will monitor the dilation of the immediate salt roof beam and possible bed separations along clay seams. Additional instrumentation may be installed as conditions warrant.

Geotechnical Engineering evaluates the performance of the excavation. These evaluations will provide an assessment of the effectiveness of the roof support system and an estimate of the stand-up time of the excavation. If the trend is toward adverse (unstable) conditions, the results of these assessments are reported to the Operations Manager to determine if it is necessary to terminate waste disposal activities in the open panel.

Data collection, analyses, and evaluation criteria ensure that geotechnical monitoring results provide timely indications of changes in measured room closure rates over time, and when those measured room closure rates exceed projected values. Closure rates are compared to projected values based on statistical evaluations of closure data that are updated annually. Areas with observed rates which significantly vary from projected values are monitored more closely to determine the cause of the variance. If the cause cannot be related to operational considerations, such as mining activity, then additional field investigation is undertaken to characterize the conditions. Should the field data indicate that ground conditions are deteriorating, corrective actions are taken as required.

Geologic investigations provide ongoing data collection on the geotechnical performance of the underground facility, and include geologic and fracture mapping, seismic monitoring, and special activities performed as-needed. Further assessments of the geotechnical performance of the excavations are made using borehole inspections to detect displacements, fractures, and separations occurring within the strata immediately surrounding the excavations. The results of geologic investigations provide continued confidence in the performance and geology of the site with respect to site characterization.

All data obtained are maintained for data reduction, tabulation, analysis, and archiving. The annual Geotechnical Analysis Report provides the principal documentation of data, describes the techniques used for data acquisition, and summarizes the performance history of the instruments. The report also details the geotechnical performance of the various underground facilities including shafts, and provides an evaluation of the geotechnical aspects of performance in the context of the relevant design criteria developed during the SPDV phase. The Geotechnical Analysis Report is reviewed by the DOE and its contractors for technical accuracy. These reports have been regularly prepared, audited for quality assurance, and made publicly available since 1983.

The assessment and evaluation of the condition of WIPP excavations is an interactive, continuous process using the data from the monitoring programs. Criteria for corrective actions are continually reevaluated and reassessed based on total performance to date. Actions taken are based on these analyses and planned utilization of the excavation. Because WIPP excavations are in a natural geologic medium, there is inherent variability from point to point. The principle adopted is to anticipate potential ground control requirements and implement them in a timely manner rather than to wait until a need arises.

References for Section 4.3

1. DOE/WIPP-Draft 7-3123, Remote-Handled Waste Acceptance Criteria for the Waste Isolation Pilot Plant.

2. WP 08-WA.06, WIPP Waste Information System Software Requirements Specification

3. WP 04-AU1007, Underground Openings Inspections.

4. 30 CFR 57, Safety and Health Standards - Underground Metal and Nonmetal Mines, 8th edition, 1994.

5. WIPP/WID 96-2180, Long-Term Ground Control Plan for the Waste Isolation Pilot Plant.

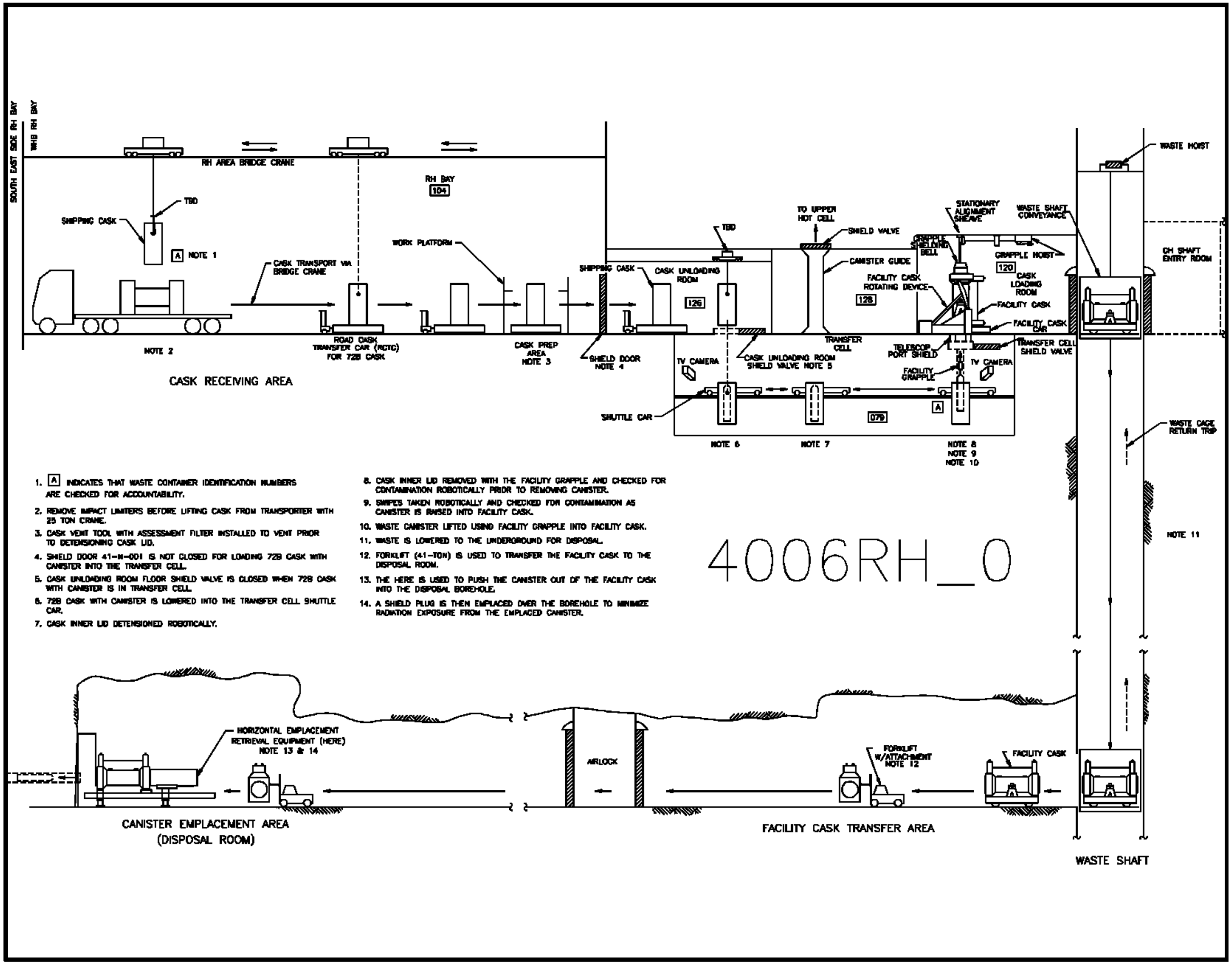

Figure 4.3-1 72B RH TRU Process

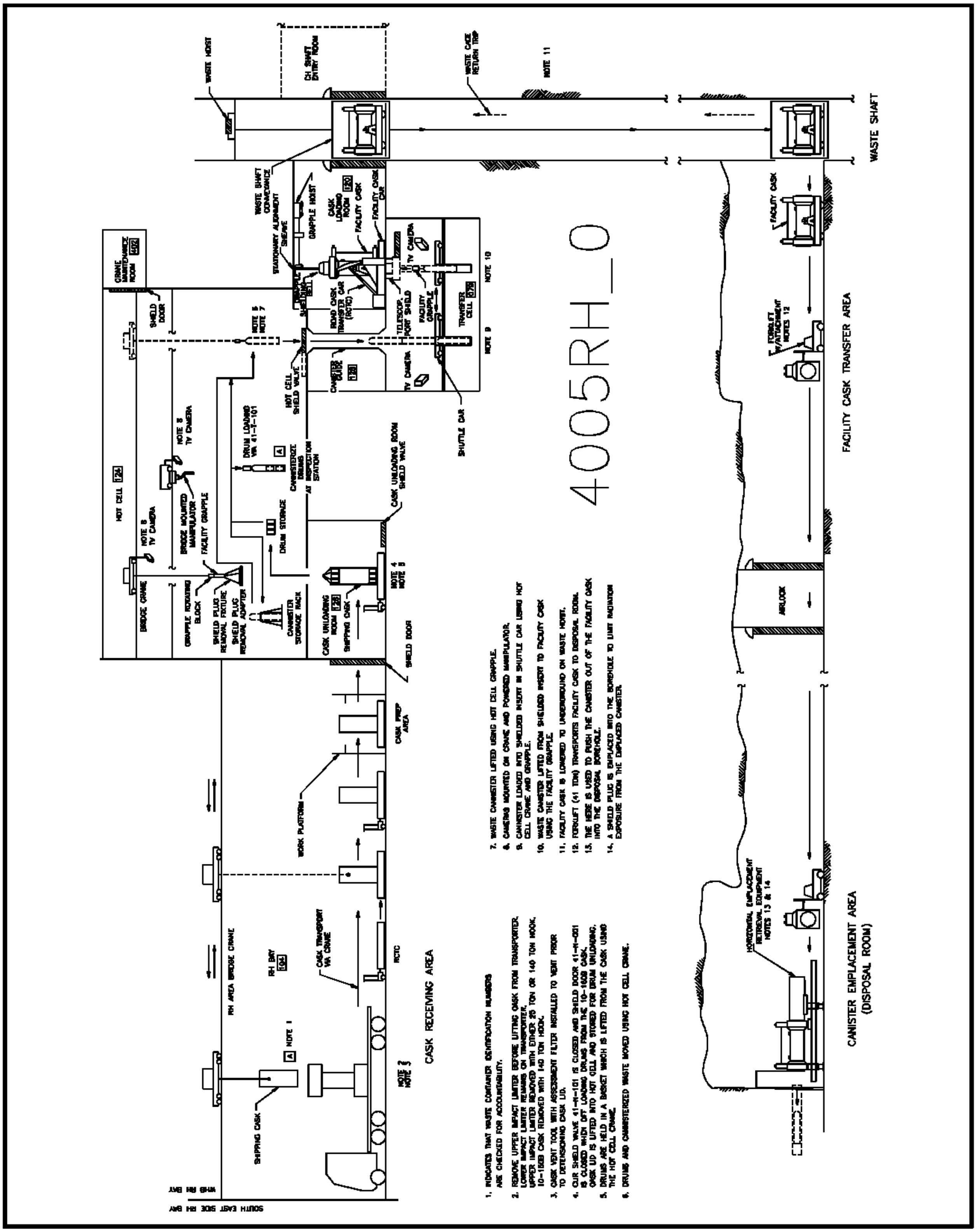

Figure 4.3-2 10-160B RH TRU Process

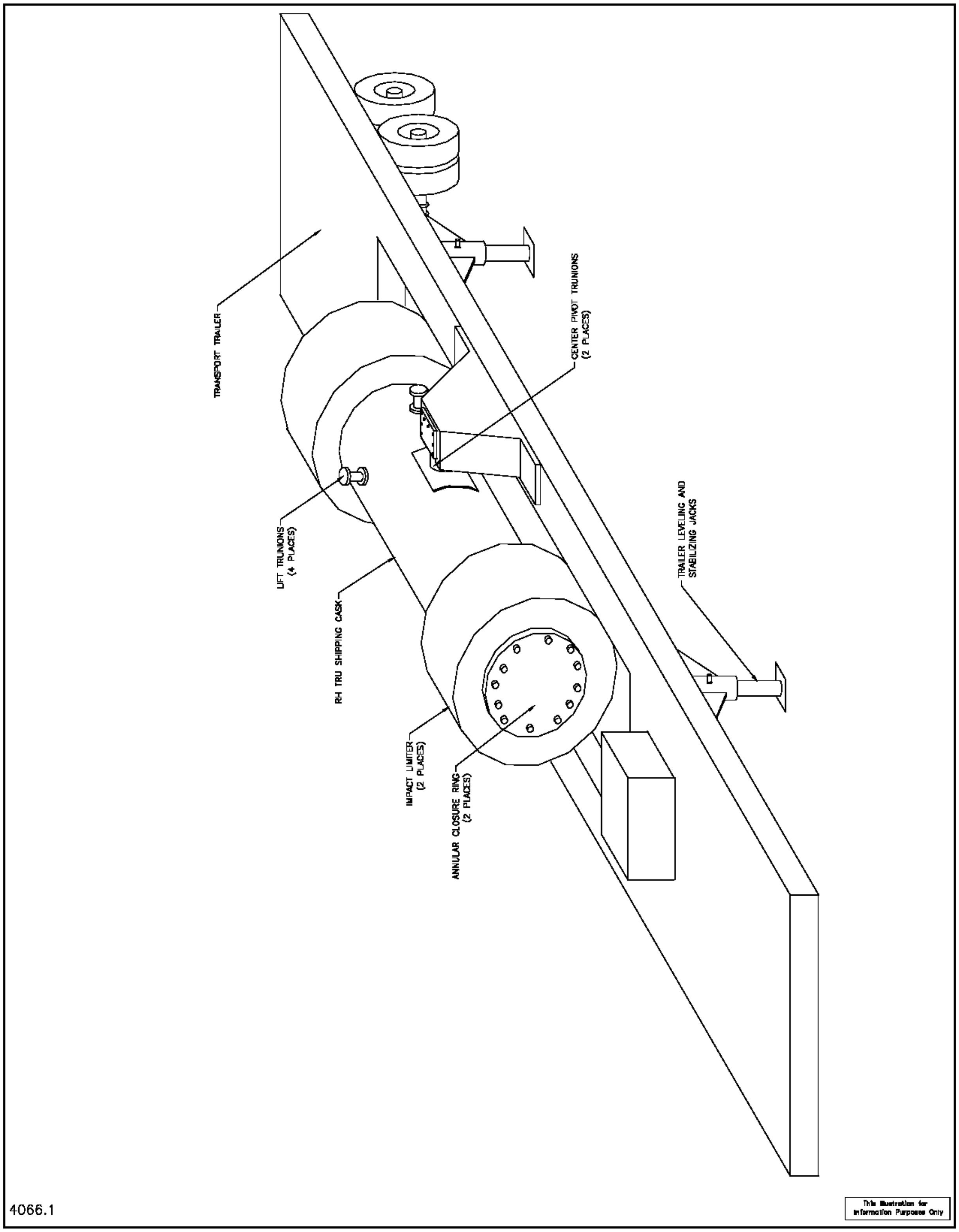

Figure 4.3-3 72B RH TRU Road Cask on Trailer

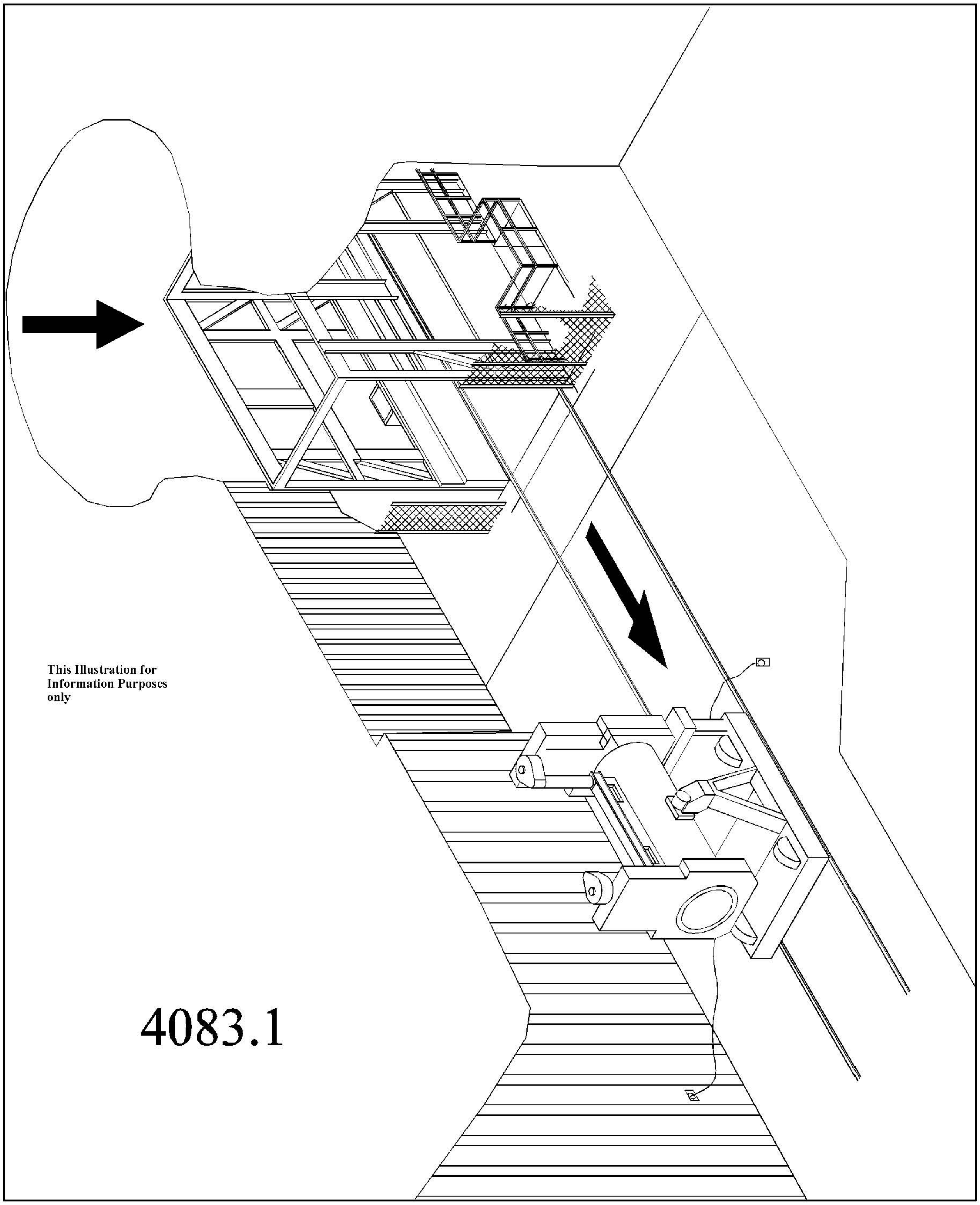

Figure 4.3-4 RH TRU Waste Handling Facility Cask Unloading from Cage

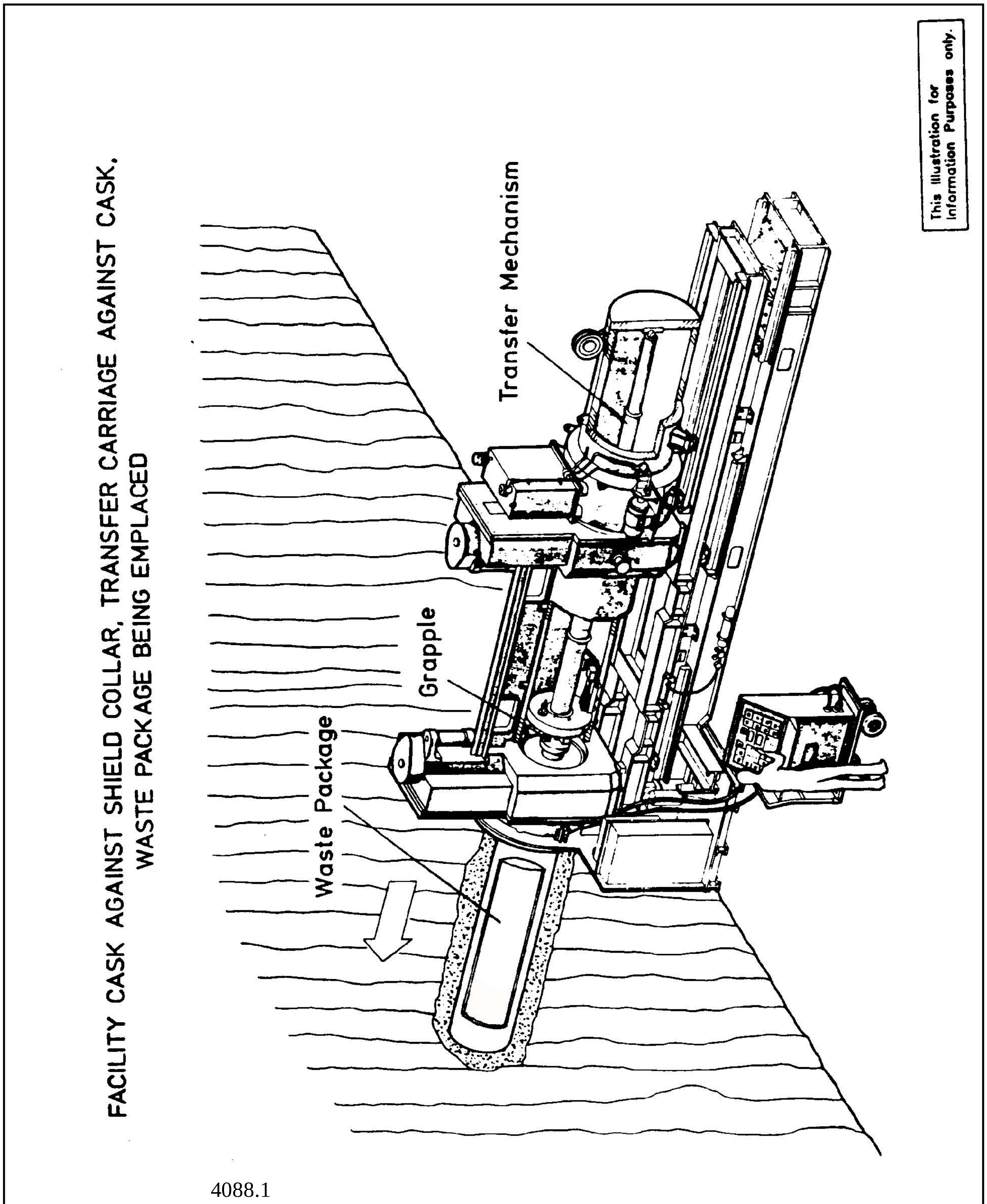

Figure 4.3-5 Waste Emplacement Equipment

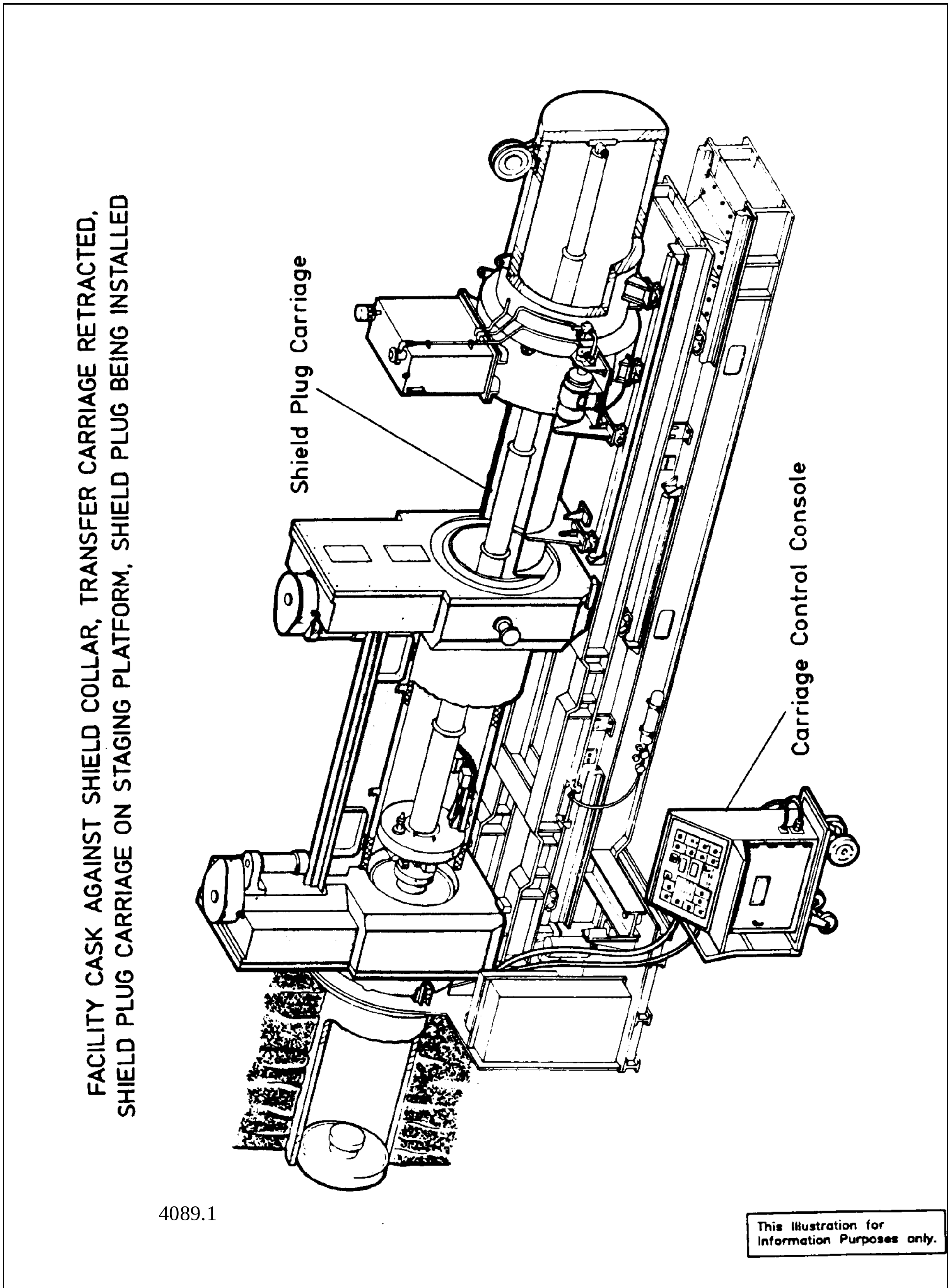

Figure 4.3-6 Installing Shield Plug

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4.4 Confinement Systems

The WIPP facility confinement system consists of static and dynamic barriers designed to meet the following requirements of DOE Order 6430.1A,[1] Section 1300-7:

- Minimize the spread of radioactive and other hazardous materials within the unoccupied process areas.

- Prevent, if possible, or minimize the spread of radioactive and other hazardous materials to occupied areas.

- Minimize the release of radioactive and other hazardous materials in facility effluents during normal operation and anticipated operational occurrences.

- Limit the release of radioactive and other hazardous materials resulting from Design Basis Accidents (DBAs) including severe natural phenomena and man-made events in compliance with the guidelines contained in DOE Order 6430.1A,[1] Section 1300-1.4.2, Accidental Releases.

In addition to the above requirements, the WIPP is designed to meet the specific confinement requirements of DOE Order 6430.1A,[1] Section 1324-6 and Section 1300-1.4.

Static barriers are structures that confine contamination by their physical presence, while dynamic barriers control the flow of contamination in the air. For the WIPP, static barriers consist of waste containers, building structures, geological strata, and HEPA filtration systems; dynamic barriers consist of the surface and subsurface ventilation systems that maintain pressure differentials ensuring airflow is from areas of lower to higher contamination potential.

For the WIPP, the primary confinement is the static barrier consisting of the waste containers, and the secondary confinement consists of those SSCs designed to remain functional (following DBAs) to the extent that the guidelines in DOE Order 6430.1A,[1] Section 1300-1.4.2, Accidental Releases, are met.

Consistent with DOE Order 6430.1A,[1] Section 1324-6, tertiary confinement is not required for the WIPP during disposal operations.

Confinement system design within DOE Order 6430.1A,[1] requirements meets the requirements of DOE O 420.1, Facility Safety.[2]

4.4.1 Waste Handling Building

Static and dynamic barriers are incorporated into the design of the WHB confinement system, and the primary confinement is the canister holding the waste.

The secondary confinement consists of the SSCs that house the primary confinement, including the shielded road cask, the shipping canister when loaded with 55-gallon drums, the rooms, the building walls, and the ventilation system, which maintains a static pressure differential between the primary confinement barriers and the environment. To assist the ventilation system, "air locks" are provided between separate areas where pressure differentials are necessary. The WHB HEPA filtration system connects with the ventilation systems and provides the final barrier for airborne particulates.

4.4.2 Underground

The primary confinement system for the underground is the canister being disposed in the underground. The secondary confinement consists of the natural barrier formed by the salt in the underground disposal areas and the underground bulkheads, which separate the disposal and mining areas. The underground ventilation system has provisions for exhausting to the exhaust filtration system, when in use, to mitigate any accidental releases of contaminated airborne particulates.

4.4.3 Ventilation Systems

The WIPP facility air handling systems are designed to provide a suitable environment for personnel and equipment during plant operations, and to provide contamination control for operational occurrences and postulated waste handling accidents. Certain components of the air handling systems are also used for functions related to space cooling and removal of heat. The WIPP facility air handling systems serve three major plant areas: the surface facilities, the surface support facilities, and the subsurface facilities. The air handling systems are designed to meet the emissions limitations in DOE Order 5400.5[3] using the following general guidelines:

- Transfer and leakage air flow is from areas of lower to areas of higher potential for contamination.
- In building areas that have a potential for contamination, a negative pressure is maintained to minimize the spread of contaminants.
- Consideration is given to the temporary disruption of normal air flow patterns due to scheduled and unscheduled maintenance operations by providing dual trains of supply and exhaust equipment. Air handling systems are provided with features to reestablish designed airflow patterns in the event of a temporary disruption. Generally, ducts that carry potentially contaminated air are routed away from occupied areas. In addition, potentially contaminated ducts are welded to the maximum extent practical to reduce system leakage.

The filtration system consists of pre-filters and HEPA filters sized in accordance with design air flows utilizing the manufacturer's rating standards for maximum efficiency.

HVAC components are sized so that some components can be taken out of service for maintenance, allowing the system to continue operation. The schematic flow diagrams of the ventilation systems are shown in Figures 4.4-1a through 4.4-5.

4.4.3.1 Surface Ventilation Systems in Controlled Areas

There are independent ventilation systems for each of the following areas:

- Waste shaft hoist maintenance room
- CH waste handling area
- Hot Cell
- RH waste handling area
- WHB mechanical equipment room
- Waste handling shaft hoist tower

- EFB

The waste shaft hoist maintenance room is outside the CA and the ventilation system that serves this area is not expected to contain radioactivity. The ventilation systems for the WHB and EFB are "once through" systems designed to provide confinement barriers with the capability to limit the extent of releases of airborne radioactive contaminants. The ventilation systems are also designed to provide the necessary heating, ventilating, and air conditioning for personnel comfort and to remove heat.

The WHB ventilation system continuously filters the exhaust air from waste handling areas to reduce the potential for release of radioactive effluents to the environment. Some of air from the waste handling areas can flow down the waste shaft.

The design provides for differentials to be maintained between building interior zones and the outside environment, maintaining control of potentially contaminated air. The pressure differentials between different interior potential for contamination areas are based on the design contamination zone designations with respect to function and permitted occupancy. ERDA 76-21[4] is used as a guide in establishing zone differential pressures.

The ventilation systems supply 100 percent outside air conditioned to provide a suitable environment for equipment and personnel. Design air quantities limit the spread of airborne radioactive contaminants and maintain design temperatures.

The design provides for "air locks" in the following circumstances:

- At entrances to potentially contaminated areas to maintain a static barrier
- Between areas of large pressure differences to provide a pressure transition and to eliminate high air velocity, dust entrainment, and eddy currents
- Between areas where pressure differentials must be maintained
- To minimize air movement from the WHB to the waste shaft

The ventilation systems are designed to provide adequate instrumentation monitoring the operating parameters. The following parameters are monitored:

- Pressure drop across each prefilter and HEPA filter bank
- Air flow rates at selected points, e.g. downstream of the HEPA filters (Station C)
- Pressure differentials surrounding areas of high potential for contamination levels

Fresh air supply intakes are located away from the exhaust vent to minimize the potential for the intake and re-circulation of exhaust.

The operation of the supply and exhaust fans is controlled by electrical motor interlocks to maintain the designed air flow patterns and sufficient air leakage into the building. The exhaust fans and controls are capable of being supplied by backup power in the event that normal power is interrupted.

4.4.3.1.1 RH TRU Waste Handling Area

The CH and RH TRU waste handling areas are served by separate, independent ventilation systems, shown on schematic flow diagrams, Figures 4.4-1a through 4.4-3. Both supply systems are Design Class IIIB, and the exhaust systems are Design Class IIIA, with the exception of HEPA filter units and associated isolation dampers, which are Design Class II.

Fan operating status, filter bank pressure drops, and static pressure differentials are monitored in the Central Monitoring Room (CMR). Excessive HEPA filter pressure drops alarm in the CMR.

The Station C radiation fixed air sampling system has provisions for monitoring the effluent air discharged from the exhaust vent.

In the RH TRU waste handling area, particular design consideration is given to inhibit the potential for spreading airborne radioactive particles from the Transfer Cell and the Hot Cell. The main air supply to the CUR, Transfer Cell and Facility Cask Loading Room is from the RH Bay. Additional ventilation air enters the Transfer Cell when the CUR or the Facility Cask Loading Room shield valves are open. Sufficient exhaust capacity is provided to maintain the design pressure differential between the Transfer Cell and the adjoining rooms or to maintain at least 125 linear ft/min (0.635 m/s) inward flow through the maximum credible breach, minimizing the potential for contaminants to escape. The exhaust air from the Transfer Cell joins the RH Bay exhaust. The supply air to the Hot Cell is drawn by the Hot Cell exhaust fan from the RH Bay into the Hot Cell. The duct that carries the air to the Hot Cell has a damper arrangement that allows air to flow directly from the RH Bay or through an air handling unit (AHU) with a chilled water cooling coil. The AHU fan is necessary to overcome the additional air pressure drop caused by the cooling coil. The AHU fan, chilled water coil, and damper realignment are controlled by a temperature sensor located in the Hot Cell exhaust Duct. The static pressure in the Hot Cell is maintained by control of the Hot Cell exhaust fans. Air flow from the Hot Cell is by either of two exhaust fans drawing air through two of three HEPA filter units. Additionally, when the Hot Cell shield valve is open, air will enter the Hot Cell from the Transfer Cell.

The waste shaft is separated from the RH waste handling area by a door that opens into the Facility Cask Loading Room. The door, which is normally closed, minimizes the air movement between the RH waste handling areas and the shaft.

Major Components and Operating Characteristics - The ventilation supply and exhaust systems for each building subsystem supply air to the rooms of the areas served. Each supply air handling unit consists of filters, cooling coils, heating elements, fans with associated duct work, and controls to condition the supply air maintaining the designed temperature during winter and summer. Exhaust air is filtered and monitored by the radiation monitoring system.

In the event of a tornado, tornado dampers will **automatically** close to prevent the outward rush of air caused by a rapid drop in atmospheric pressure. Damper closure mitigates the destruction of HEPA filters and ducts by preventing a high-pressure differential from affecting the filters.

Safety Considerations and Controls - The exhaust system remains functional to the extent that confinement and differential pressures are maintained, exhaust air is filtered, and during a tornado excessive flow that could cause duct damage is prevented by automatic tornado dampers.

In case of an off-site power failure, the capability exists to selectively switch one exhaust fan to the backup power system in order to continue to exhaust air in the designed flow pattern. Backup power is applied to exhaust fans in accordance with the WIPP procedure WP 04-ED1342, Surface Backup Power Distribution [5].

The supply and exhaust fans are designed and interlocked to maintain the RH Waste Handling Area, except the RH Bay, at sub-atmospheric pressure and maintain the design airflow requirements. During normal operation, if an operating exhaust fan fails, the corresponding supply fan is stopped in order to prevent positive building pressure. If a corresponding supply fan fails, the exhaust fan also stops but may be operated in manual mode to insure sub-atmospheric pressure conditions within the RH waste handling path. Both trains of RH supply and exhaust fans must operate in order to maintain room differential pressure set points in the RH portion of the WHB.

Sufficient remote instrumentation is provided enabling the operator to monitor equipment from the CMR. The monitored parameters include fan operating status, filter bank pressure drop, and static pressure differential in areas of the Transfer Cell, the Hot Cell and the cask preparation station. The CMR also receives alarm signals for main exhaust fan failure, main exhaust fan low flow and from the CAMs monitoring RH exhaust. The CAMs have alarms for excessive radiation levels (Hi and Hi-Hi Alpha and Beta/Gamma alarms) and low flow.

Filter differential pressure is displayed in the CMR. An alarm for a pressure drop indicating filter replacement is needed actuates at a predetermined level across the HEPA filters.

Instruments and system components are accessible for, and will be subject to, periodic testing and inspection during normal plant operation.

For those HEPA filters which are on-line continuously in the WHB, the CMS monitors prefilter pressure differential (D/P) and HEPA D/P ensuring satisfactory system operation. The EFB HEPA filters are normally off-line, and not subject to dust buildup during normal operation. All nuclear grade HEPA filters are tested for conformance with ANSI N510,[6] and have a combined 99.95 percent removal efficiency per stage.

4.4.3.1.2 Mechanical Equipment Room

The mechanical equipment room is maintained at a pressure slightly below atmospheric to minimize leakage of room air, which may contain airborne radioactive contaminants. Negative pressure is maintained by the same exhaust fan systems that exhaust air from the CH TRU and RH TRU waste handling areas. This equipment room is maintained within design temperature limits for equipment and personnel.

4.4.3.1.3 Waste Handling Shaft Hoist Tower

The ventilation system provides filtration of supply air, unit heaters to prevent equipment from freezing, and a unit cooler to provide supplementary cooling of equipment in summer. Exhaust airflow is down through the tower and into the waste shaft, where it combines with incoming air from the waste shaft auxiliary air intake tunnel (Figure 4.4-3).

A pressurization system serves the air lock to the crane maintenance room at 142 ft-1 in (43.3 m) elevation and pressurizes the air lock preventing the release of potentially contaminated air from the crane maintenance room to the 142 ft-1 in (43.3 m) elevation access corridor.

4.4.3.1.4 Exhaust Filter Building

A schematic flow diagram of the EFB ventilation system is shown in Figure 4.4-4. This building supports the operation of the underground ventilation system and contains the underground ventilation system pre-filters and HEPA filters.

The function of the ventilation system in the EFB, major components, operating characteristics, safety considerations, and controls, are similar to the TRU waste handling areas in the WHB.

Each supply air handling unit in the EFB consists of prefilters, an electric heating coil, and a fan to condition the air, as required to maintain the design temperature.

The EFB ventilation system exhausts air from all potentially contaminated areas of the building through two filter housings, each containing a bank of prefilters and two stages of HEPA filters, and two exhaust fans before discharging to the atmosphere. The building's exhaust air is discharged to the underground exhaust duct so that it can be monitored for airborne radioactive contaminants.

4.4.3.2 Surface Support Structures Ventilation System

The following surface support facilities are served by separate heating, ventilation, and air-conditioning systems:

- The Support Building
- Main Warehouse/Shops Building
- Water Pump House
- Guard and Security Building
- Maintenance Shop
- Compressor Building (exhaust fans only)
- Safety and Emergency Services Building
- Engineering Building
- Training Building

The design of the surface support facilities HVAC systems provides for:

- Regulating temperature for the comfort of personnel and satisfactory operation of equipment
- Filtering the air supply for personnel
- Maintaining building spaces at slightly positive pressures with respect to the outside, except radioactive materials areas, where negative pressures shall be maintained relative to the outside and to adjacent accessible non-radioactive building spaces
- Confining ventilation air to designed airflow paths for discharge to the atmosphere

- Minimizing the possibility of exhaust air re-circulation by an adequate distance between fresh air supply intakes and exhaust air outlets

The design of the ventilation system for the CMR requires functions to be performed with respect to environmental control for personnel and equipment following a postulated accident, such as a fire or radioactivity release. The CMR system is manually switched to the backup power supply to ensure operation monitoring, and control of the HVAC systems if the normal power supply is lost.

In addition, the independent CMR HVAC system provides for:

- 100 percent equipment redundancy (except duct work)

- Make-up air being processed through HEPA filters in the event of a airborne high radioactivity signal

- Static pressure controls to regulate the amount of outside air that may be drawn into the system through the HEPA filters before it is supplied to the CMR permitting occupancy.

Safety Considerations and Controls - The HVAC systems for these surface support facilities, with the exception of the CMR, are not required to perform functions that are essential to safety. Fan motor interlocks, dampers, temperature indicators, filter pressure differential alarms, and other required instrumentation and controls are provided.

CMR

The Support Building CMR area HVAC system serves the computer room, CMR and associated vestibule, vault, office, and storage room. Equipment redundancy is provided for the following: supply air handler, air cooled condensing unit, and exhaust fan.

The HVAC system provides a suitable environment for continual personnel occupancy, and equipment integrity under normal and emergency conditions and maintain a slightly positive pressure in the CMR. Air passes through at least a two-stage filtration system before it enters the above listed areas.

Major Components and Operating Characteristics - Major components of this HVAC system consist of supply air handling units (containing fans, direct expansion cooling coils, and filters), air cooled condensing units, duct heaters, exhaust-return fans, booster fans, HEPA filter units, dampers, instrumentation, and controls.

The schematic airflow diagram for the CMR area HVAC system is shown in Figure 4.4-5. The CMR area is served by two 100 percent capacity air-conditioning units. One in service and one in standby status. The standby unit will automatically start in the event the operating unit fails.

Under normal operating conditions (re-circulation mode), outside makeup air and return air are filtered by a two-stage air filter system. The first stage of filtration consists of nominal 2 in (5 cm) thick low efficiency filters and the second stage consists of high efficiency filters rated at 85 percent efficiency (atmospheric dust) by ASHRAE Standard 52-76.[7] After the second stage of filtration, the air supply temperatures are thermostatically controlled, as necessary to maintain designed temperatures. The filtered and conditioned air supply is distributed to the various rooms within the CMR area by means of duct work and air outlets.

Safety Considerations and Controls - The main function of the HVAC system is to provide a suitable environment enabling the CMR area to be occupied under normal and emergency operating conditions including the prevention of airborne radioactive contaminants entering the supply systems.

A backup air conditioning system (air handler, air cooled condensing unit, and exhaust fan) is available to automatically start in the event an operating component fails. The supply and exhaust air handling systems are capable of being manually connected to the backup power system for operation during a loss of off-site power.

Locally-mounted instruments are provided for monitoring the HVAC system and filter, pressure drop is monitored and alarmed, locally and in the CMR.

The supply and return exhaust fans are electrically interlocked, to maintain the designed airflow pattern, and the entire HVAC system is interlocked with the fire protection system.

4.4.3.3 Subsurface Facilities Ventilation System

The subsurface ventilation system serves all underground facilities and provides confinement of radioactivity, acceptable working conditions, and a life-sustaining environment during normal operational occurrences and postulated waste handling accidents. Operation of diesel equipment in the underground repository is limited to the available airflow in the area.

Subsurface ventilation is divided into four independent flow paths on the disposal horizon supporting the waste disposal area, the mining area, north area, and the waste shaft and waste shaft station area. The waste disposal, and mining and underground shop areas receive their air supply from common sources (see Figure 4.4-6) (the AIS and the SH shaft) and are independent of each other after the initial distribution/split is made. The waste shaft station receives its air supply from the waste shaft and is kept completely isolated from the other three. All four air circuits combine near the exhaust shaft, which acts as the common discharge from the system.

All bulkheads and ventilation controllers used to maintain the integrity of the underground ventilation circuits are made of fire resistant material, and can support the maximum pressure differential that could occur under normal operating conditions. These structures are designed, installed, and maintained in such a manner that they can accommodate the ground deformation (salt creep) occurring in the underground.

One of three filtration surface exhaust fans is capable of being connected to the backup power supply (one at a time) in the event that normal power is lost. Changeover to backup power is manual. The ventilation system is instrumented to provide for verification of proper system function.

The design and operation of the underground ventilation system meets or exceeds the criteria specified by 30 CFR 57 [8] and the New Mexico Mine Safety Code for All Mines.[9] The underground mine ventilation is designed to supply sufficient quantities of air to all areas of the repository. During normal operating mode (simultaneous mining and waste emplacement operations), approximately 140,000 ft^3 (3,962 m^3) per min can be supplied to the panel area. This quantity of air is required to support the numbers and types of diesel equipment that are expected to be in operation in the area, to support the underground personnel working in that area, and to exceed a minimum air velocity of 60 ft (18 m) per min, as specified in the WIPP Ventilation Plan.

Approximately 35,000 ft^3 (990 m^3) per minute will be required in each of three active rooms during operations. This quantity of air is required to support the numbers and types of diesel equipment that are expected to be in operation in the area, to support the underground personnel working in that area, and to exceed a minimum air velocity of 60 ft (18 m) per minute, as specified in the WIPP Ventilation Plan. The remaining rooms in a panel will either be completely filled with waste; be idle, awaiting waste handling operations; or being prepared for waste receipt. The remainder of the air is needed in order to account for air leakage through inactive rooms and support facilities.

Air will be routed into a panel from the intake side. Air is routed through the individual rooms within a panel using underground bulkheads and air regulators. Bulkheads are constructed by erecting framing of rectangular steel tubing and screwing galvanized sheet metal to the framing. Figure 4.4-8 shows a typical bulkhead with an airflow regulator installed. In order to accommodate salt creep, bulkheads use telescoping extensions that are attached to the roof. Bulkheads use either a sheet metal or rubber flashing attached to the salt to provide an effective seal. Flow is also controlled using brattice cloth barricades. These consist of chainlink or other suitable materials fence that is bolted to the salt and covered with brattice cloth; and are used in instances where the only flow control requirement is to block the air temporarily. Ventilation will be maintained only in active rooms within a panel. After all rooms within a panel are filled, the panel will be closed using a closure system described in Section 4.2.3.4.

Once a disposal room is filled and is no longer needed for emplacement activities, it will be barricaded against entry and isolated from the mine ventilation system by constructing chain link/brattice cloth barricades at each end. A brattice cloth air barricade is shown in Figure 4.4-9. There is no requirement for air for these rooms since personnel and/or equipment will not be in these areas.

The ventilation path for the waste disposal side is separated from the mining side by means of air locks, bulkheads, and salt pillars. A pressure differential is maintained between the mining side and the waste disposal side to ensure that any leakage is towards the disposal side. The pressure differential is produced by the surface fans in conjunction with the underground air regulators. Pressure differentials across these bulkheads between the mining and disposal sides (located nearer to the disposal panel) are monitored from the CMR.

The exhaust air is discharged through the exhaust shaft, by the exhaust system, under the following modes of operation:

Normal Mode During normal operation, four different levels of Normal Mode ventilation can be established to provide four different air flow quantities as follows

- Normal Ventilation: Two main exhaust fans operating to provide 425,000 scfm (224 m^3/s) unfiltered.
- Reduced Ventilation: Two filtration fans operating as ventilation fans to provide 60,000 scfm (28.3 m^3/s) each unfiltered.
- Minimum Ventilation: One filtration fan operating as a ventilation fan to provide 60,000 scfm (28.3 m^3/s) unfiltered.
- Maintenance Ventilation: Simultaneous operation of one or two main ventilation fans with one or two of the filtration fans in support of flow calibration and maintenance activities.

<u>Filtration Mode</u> - This mode mitigates the consequences of a waste handling accident by providing a HEPA filtered air exhaust path from the waste disposal areas and also reducing the air flow. Manual activation is required if the CMR is notified of an underground occurrence involving the waste packages. This mode may also be activated automatically by the Radiation Monitoring System active waste disposal room exit alpha CAM.

The ventilation system is designed as an exhausting system that maintains the working environment below atmospheric pressure. Schematic diagrams of the underground ventilation system are presented in Figures 4.4-6 and 4.4-7. All underground flows join at the bottom of the Exhaust Shaft before discharge to the atmosphere.

Outside air will be supplied to the mining areas, and the waste disposal areas and the North U/G Shop area through the Air Intake Shaft, the Salt Handling Shaft, and access entries. A relatively small quantity of outside air will flow down the Waste Shaft to ventilate the Waste Shaft station. The ventilation system is designed to operate with the Air Intake Shaft as the primary source of fresh air. In Normal Ventilation Mode, sufficient air will be available to simultaneously conduct all underground operations (e.g., waste handling, mining, and support).

If the nominal flow of 425,000 scfm (224 m^3/s) is not available, underground operations may proceed, but the number of activities that can be performed in parallel may be limited depending on the quantity of air available. Ventilation may also be achieved by operating one main fan (Alternate Ventilation Mode), or either one or two of the filtration fans (Minimum and Reduced modes respectively). To accomplish this, the isolation dampers will be opened, which will permit air to flow from the main exhaust duct to the filter outlet plenum. The filtration fans may also be operated to bypass the HEPA plenum. The isolation dampers of the filtration exhaust fan(s) to be employed will be opened, and the selected fan(s) will be switched on. ln this mode, underground operations will be limited.

Shift from normal flow to Filtration mode has been tested and it was demonstrated that a reverse pressure pulse was generated upon closure of the main exhaust fan inlet dampers. This reverse pressure pulse results in reverse flow temporarily in select portions of the underground system. Testing has further demonstrated that the reverse pressure/flow phenomena is greatly lessened if main fan coast down is allowed for a period of time prior to isolation. Modifications have been made that cause the main fan isolation dampers to close slowly, when the main exhaust fans are shut down, to minimize any pressure pulse back through the system.

In the filtration mode, the exhaust air will pass through two identical filter assemblies, with only one of the three EFB filtration fans operating (all other fans are stopped). This system provides a means for removing the airborne particulates that may contain radioactive and hazardous waste contaminants in the reduced exhaust flow before the air is discharged through the exhaust stack to the atmosphere. The filtration mode is activated either manually or automatically if the radiation monitoring system detects abnormally high concentrations of airborne radioactive particulates. Shifting of the exhaust system to the filtration mode can be accomplished manually, either locally at the Exhaust Filtration Building, or by the CMR operator. A Hi-Hi alarm condition from a Radiation Monitoring System active waste disposal room CAM will cause an automatic shift of the mine exhaust air from unfiltered to filtered mode, System Design Description SDD-RM00.[10] The reduced exhaust flow is diverted to the HEPA filters by isolation and diversion dampers on the exhaust fans and duct work preventing unfiltered flow escaping to the atmosphere. The filtration mode is not initiated by the release of gases such as VOCs.

Provisions are included for detecting airborne radioactive contaminants in the waste disposal areas, in the waste shaft and station, and in the discharge to the surface exhaust vent.

Major Components and Operating Characteristics - The ventilation system consists of six centrifugal exhaust fans (three in the normal flow path and three in the filtration flow path), two identical HEPA filter assemblies arranged in parallel, isolation and back draft dampers, filter bypass arrangement, and associated duct work. Operation of the underground ventilation system is detailed in the WIPP procedure WP 04-VU1608.[11]

The six fans are divided into two groups. One group consists of three fans, which are used during normal operation to provide an underground flow of 425,000 scfm (224 m^3/s), and are located near the exhaust shaft. One main fan can be operated to provide 260,000 scfm (123 m^3/s). The remaining three fans, rated at 60,000 scfm (28.3 m^3/s) each, are located at the EFB and are capable of being used during the filtered mode of operation. This mode of operation requires the use of only one of the three fans at any given time with all other fans stopped and isolated. Two of the three filter mode fans can also be operated (with the HEPA system bypassed) to provide other underground ventilation requirements, when needed.

Each filter assembly consists of two banks of prefilters and two banks of HEPA filters arranged in series; and, each assembly will handle 50 percent of the filtered mode airflow (30,000 cfm each [849.5 m^3/m]).

Any one of the three EFB fans is capable of delivering 100 percent of the design 60,000 scfm flow rate with all filters at their maximum pressure drop. Fan failure is monitored by a flow sensing device on the fan’s discharge side, and alarms in the CMR.

Safety Considerations and Controls - The operating status of the exhaust fans and the airborne contamination level of the effluent discharged are displayed in the CMR. Provides a means to switch to filtration.

An alarm for excessive pressure drop across the filters is actuated at a predetermined level. Filter differential pressure is displayed locally and in the CMR.

Instruments and system components are accessible for periodic testing and inspection during normal plant operation. Under normal operating conditions, the ventilation system functions continuously.

4.4.3.3.1 Natural Ventilation Pressure

The air flow in the underground is normally driven by the negative pressure induced by the exhaust fans. There can be a second pressure resulting from the difference in density between the air entering and leaving the repository which can influence airflow. This phenomenon is called the natural ventilation pressure (NVP). It is experienced on days when outside temperatures are either very hot or very cold.

4.4.3.3.2 Hot Weather NVP

During hot weather, the air going down to the underground is warmer and less dense (lighter) than the air returning from the underground. This lighter air has a natural tendency to resist being drawn down into the repository (hot air rises). Hence in hot weather there is a (negative) NVP which opposes the fan pressure. This reduces the flow down the AIS and SH shaft. It also reduces the differential pressures between the waste shaft station, waste disposal area, and the other areas. The air in the waste shaft will be cooler than that in the AIS and SH shaft, which further reduces the waste shaft station to W30 differential pressure. (See Figure 4.1-3 for U/G locations).

Under ordinary operating conditions, the pressure in W30 is higher (less negative) than that in the waste shaft station (S400). On very hot days (exceeding 100° F [37.8° C]) the reduction of this differential pressure caused by the negative NVP can result in the pressure in S400 being higher than in W30. Without corrective actions, this would allow airflow from the CA area into a non-CA area.

4.4.3.3.3 Cold Weather NVP

During cold weather, the air going down to the underground is colder and denser (heavier) than the air returning from the underground. This denser air has a natural tendency to sink down the AIS and SH shaft (cold air sinks). In cold weather there is a positive NVP which augments the fan pressure. This increases the airflow down the intake shafts, reduces the fan suction pressure (constant flow control) and increases the differential pressure between the waste shaft station, waste disposal area, and the other areas.

The WIPP mine ventilation system is designed for intake air to downcast in the AIS, SH shaft, and waste shaft. The system pressure required to induce those down drafts is supplied by the surface fans. On extreme cold weather days, a portion of the air entering the repository through the AIS and SH shaft may be the result of a positive NVP. This air is entering the repository without the aid of the mechanical fans. The fans in turn reduce their operating pressure because they are receiving a sufficient and constant volume of air. Upcasting of the air in the waste shaft can occur if the situation is not corrected.

The air feeding the waste shaft comes primarily from the auxiliary air intake tunnel, partly from leakage into the waste hoist tower, and partly from the WHB. The result is that the air feeding the waste shaft tends to be warmer than the surface air feeding the AIS. The reduction in fan pressure, coupled with the warmer air in the waste shaft is only under alternate, reduced, and minimum ventilation modes.

Administrative action is required to adjust the underground ventilation configuration to avoid reverse flow in the waste shaft. There are several alternatives which can be performed concurrently to prevent or correct this problem should it occur. They include:

- Start second main exhaust fan (normal ventilation).
- Open the regulator to the waste shaft station.
- Cover the AIS and/or the SH shaft on the surface.
- Close the regulators to the mining, waste disposal and experimental areas.

A pressure chamber has been constructed on the west side of the waste shaft station to ensure that leakage from the CA side into the non-CA area does not occur. The pressure chamber is manually activated whenever waste handling is occurring in the waste shaft and/or waste shaft station, and differential pressure between S400 and W30 is low. The chamber is pressurized by six high pressure fans. The fans are operated in various combinations to provide the airflow necessary to maintain the pressure buffer. As a secondary backup system, pressure will be supplied by an actuated valve on a plant air pressurized line. The valve will be controlled by a Foxboro controller to regulate the flow of air into the chamber and maintain pressure differentials. The pressure inside the chamber is monitored to ensure that it is sufficient to prevent airflow reversal even if the differential pressure from S400 to W30 (which is also monitored) is in the wrong direction or positive NVP is sufficient to cause waste shaft reversal.

References for Section 4.4

1. DOE Order 6430.1A, General Design Criteria, April 1989 (For reference only, superceded by DOE O 420.1 and DOE O430.1A).

2. DOE O 420.1, Facility Safety (superceded 6430.1A).

3. DOE Order 5400.5, Radiation Protection of the Public and the Environment, June 1990. (Latest is Change 2, January 1993).

4. Energy Research and Development Administration, 76-21.

5. WP 04-ED1341, Surface Backup Power Distribution.

6. ANSI N510, American National Standards Institute, Standard for Testing of Nuclear Air Cleaning Systems.

7. ASHRAE, Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter, 52-76.

8. 30 CFR 57, Safety and Health Standards - Underground Metal and Nonmetal Mines, 8th edition, 1994.

9. New Mexico Mine Safety Code for All Mines, 1990.

10. SDD-RM00, Radiation Monitoring System.

11. WP 04-VU1608, Underground Ventilation and Filtration System Operation

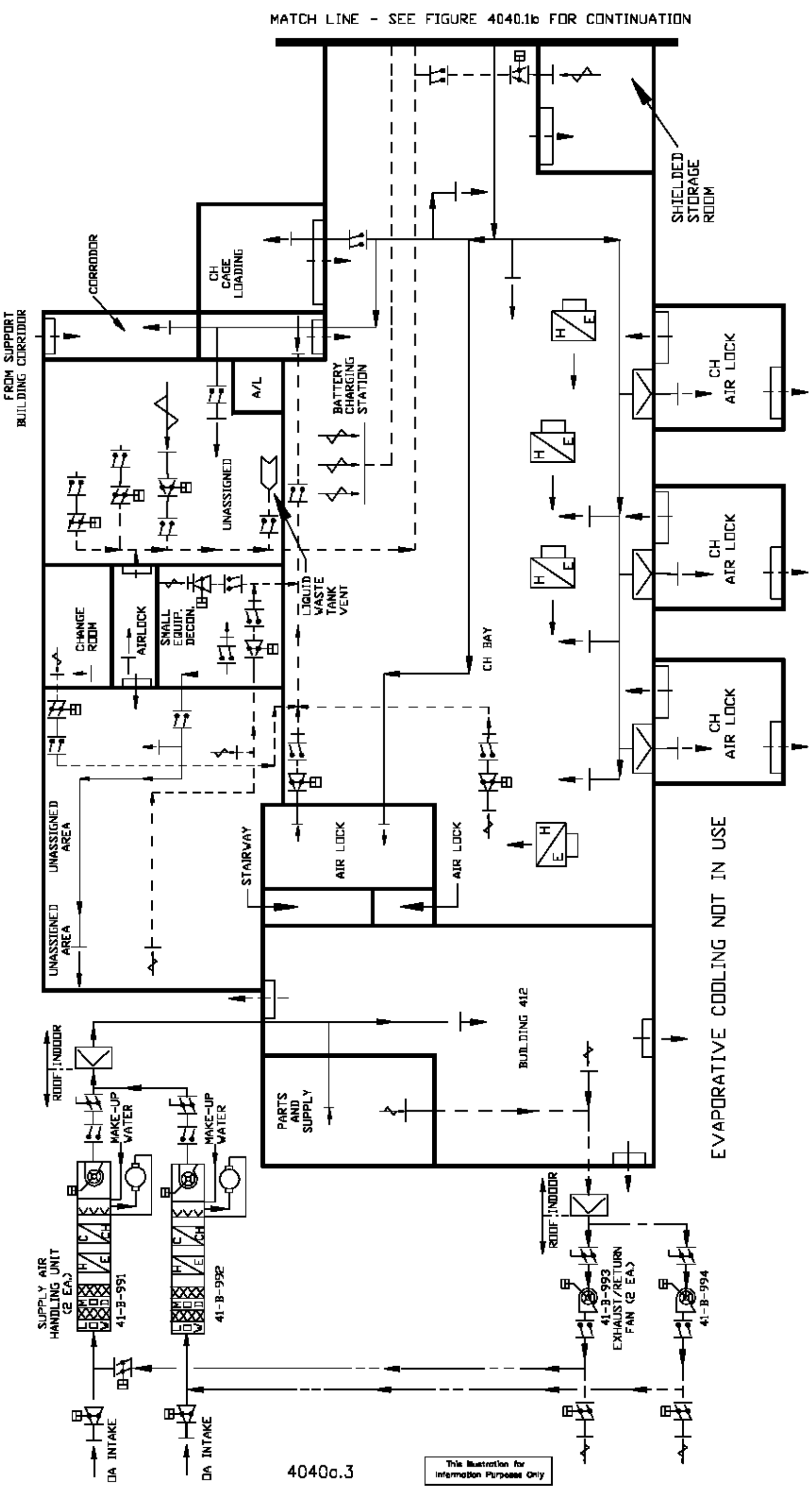

Figure 4.4-1a WHB and TRUPACT Maintenance Facility

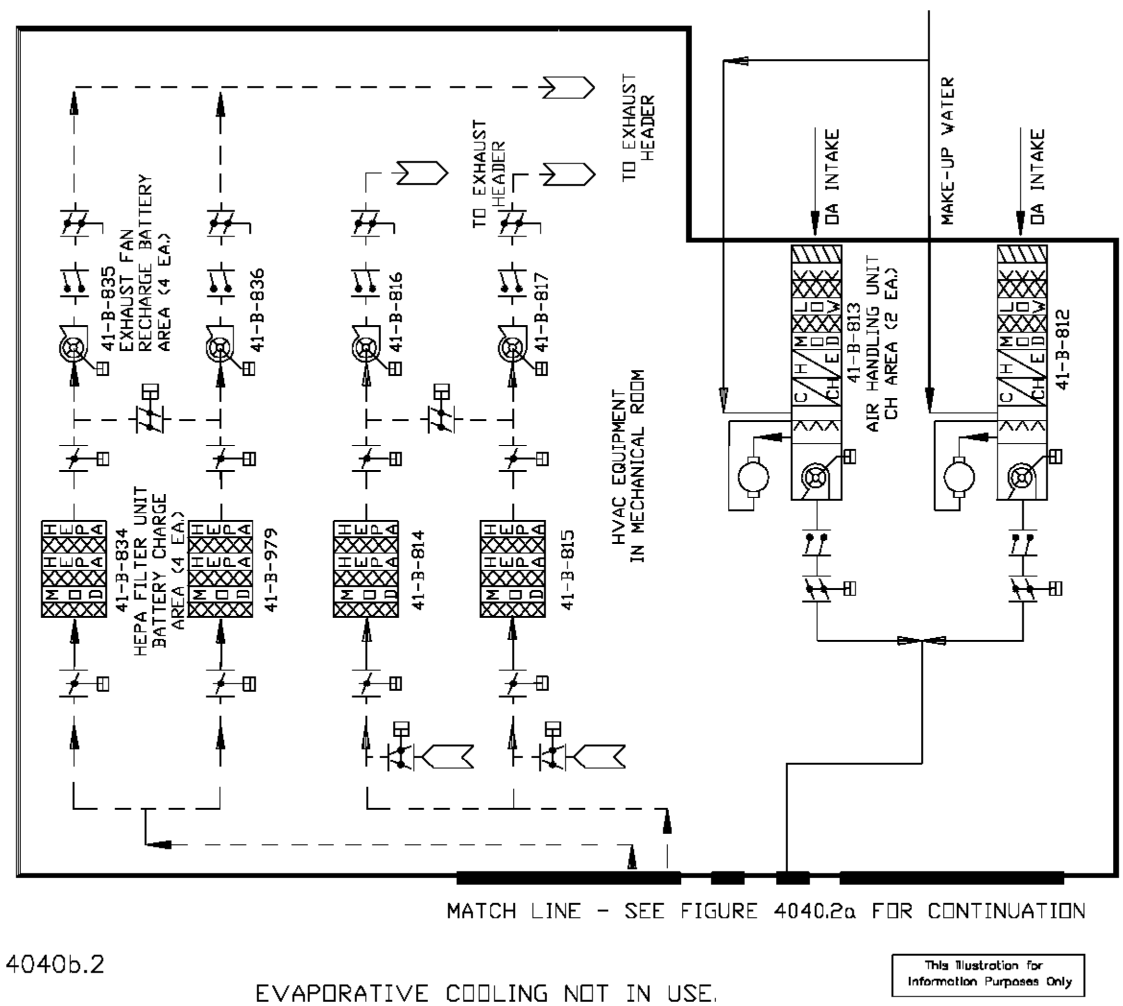

Figure 4.4-1b Waste Handling Building

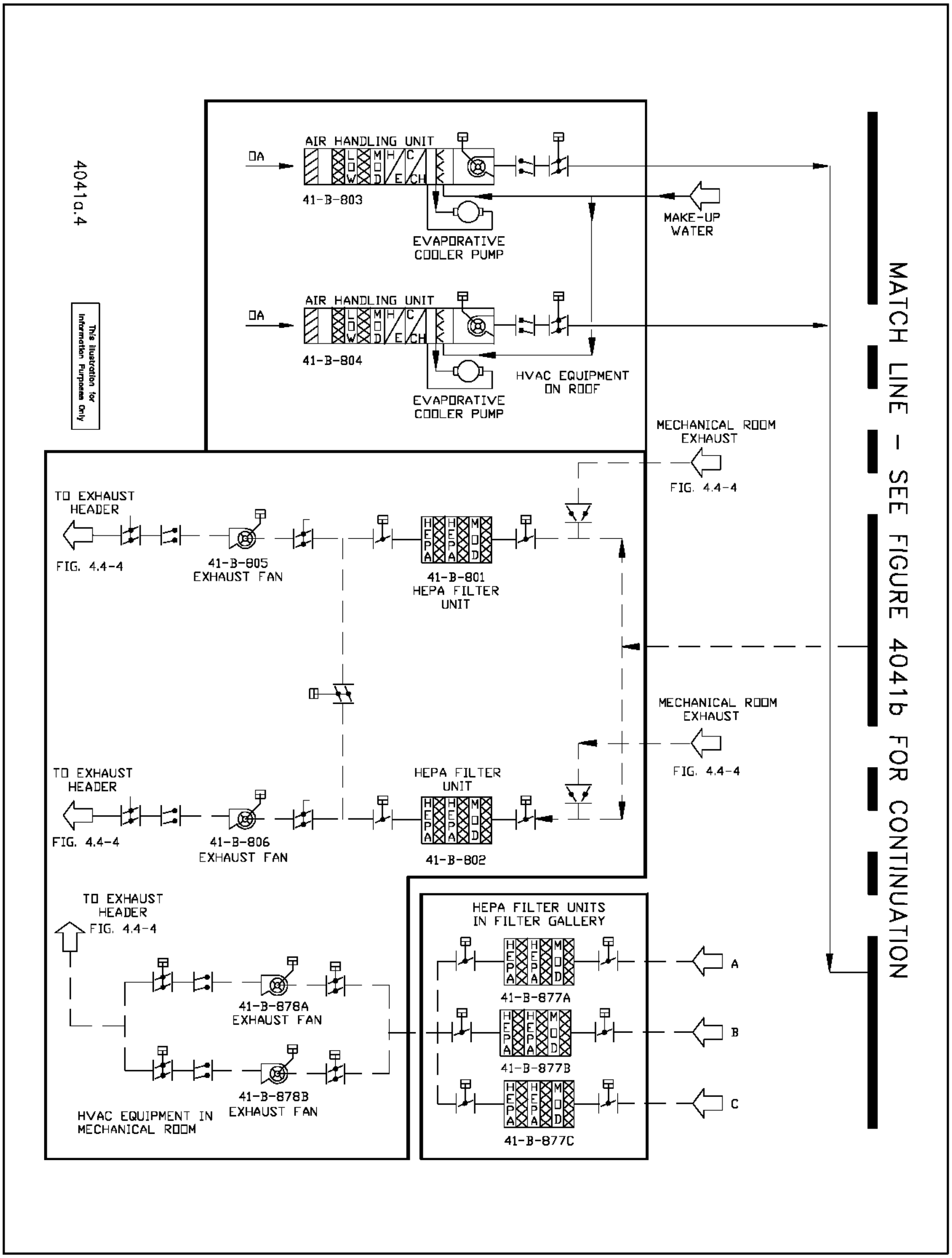

Figure 4.4-2a WHB RH Handling HVAC Flow Diagram

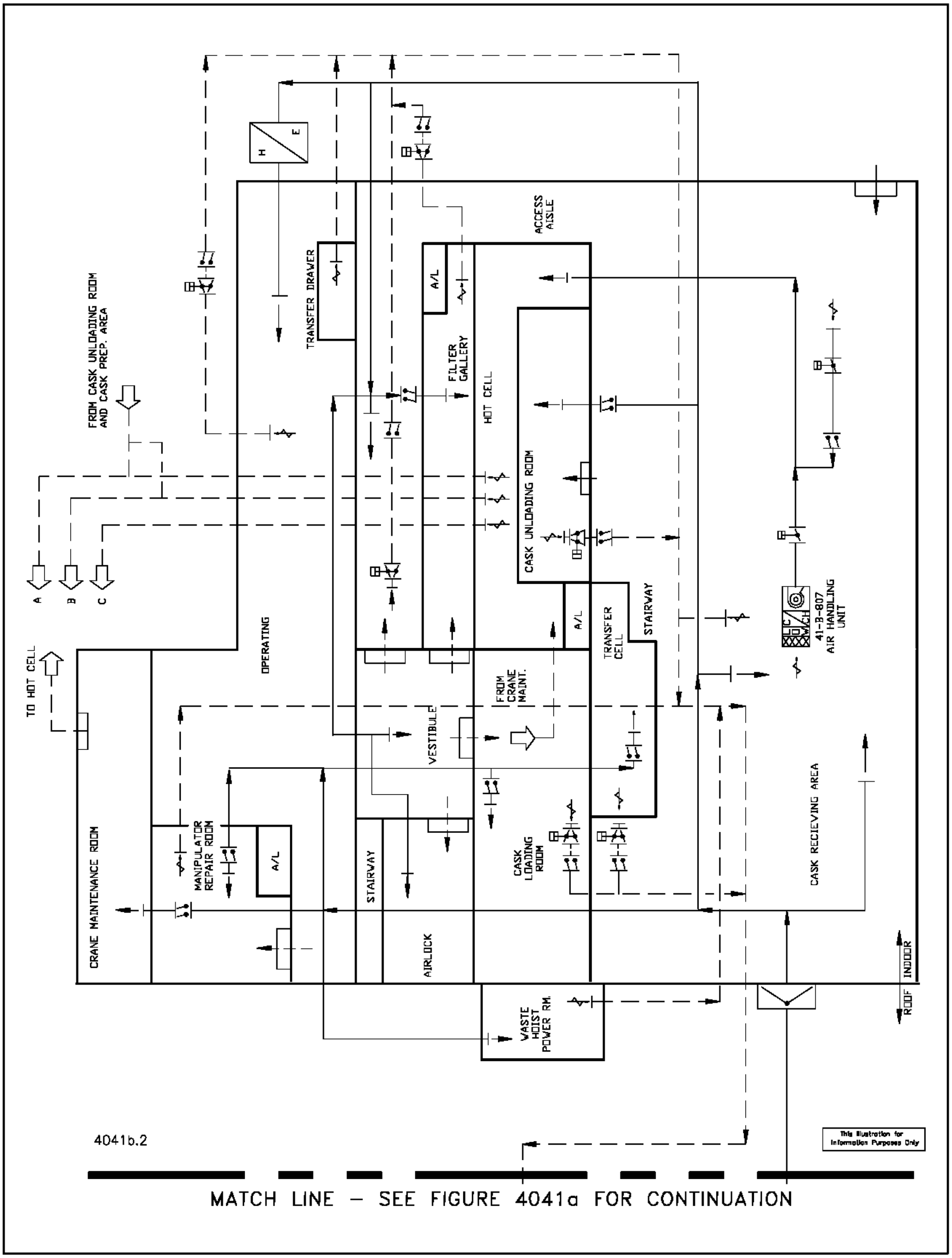

Figure 4.4-2b WHB RH Handling HVAC Flow Diagram

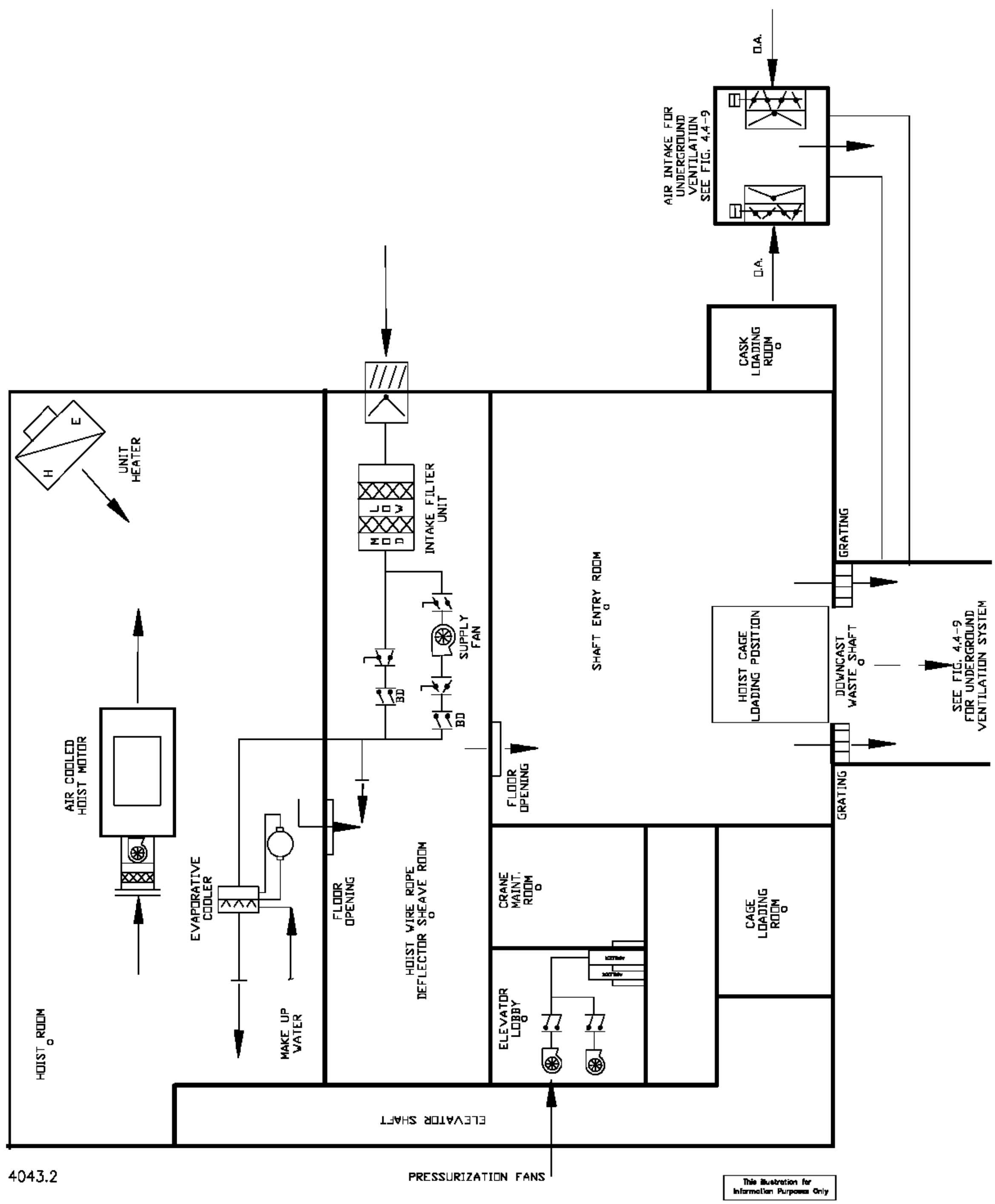

Figure 4.4-3 Waste Handling Shaft/Hoist Tower HVAC System Flow Diagram

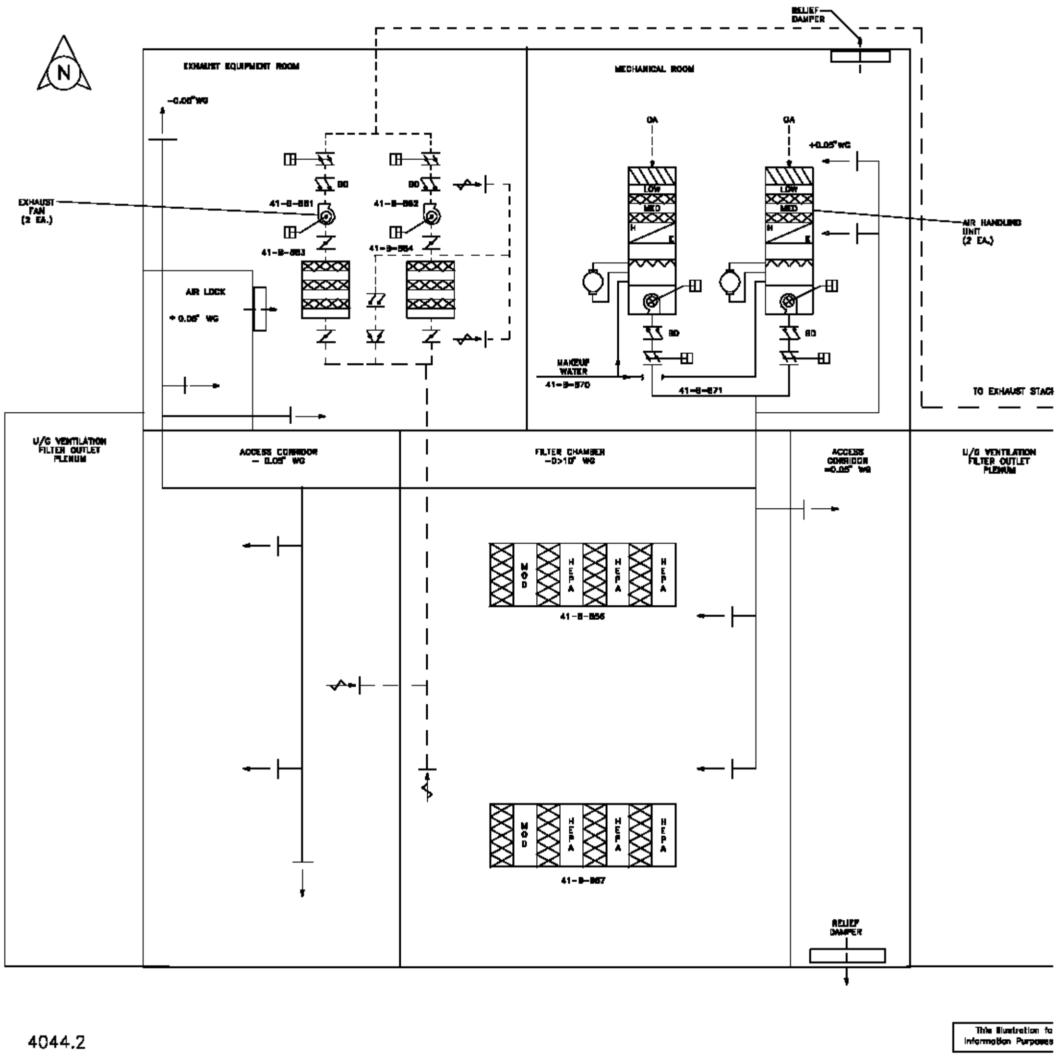

Figure 4.4-4 Exhaust Filter Building HVAC Flow Diagram

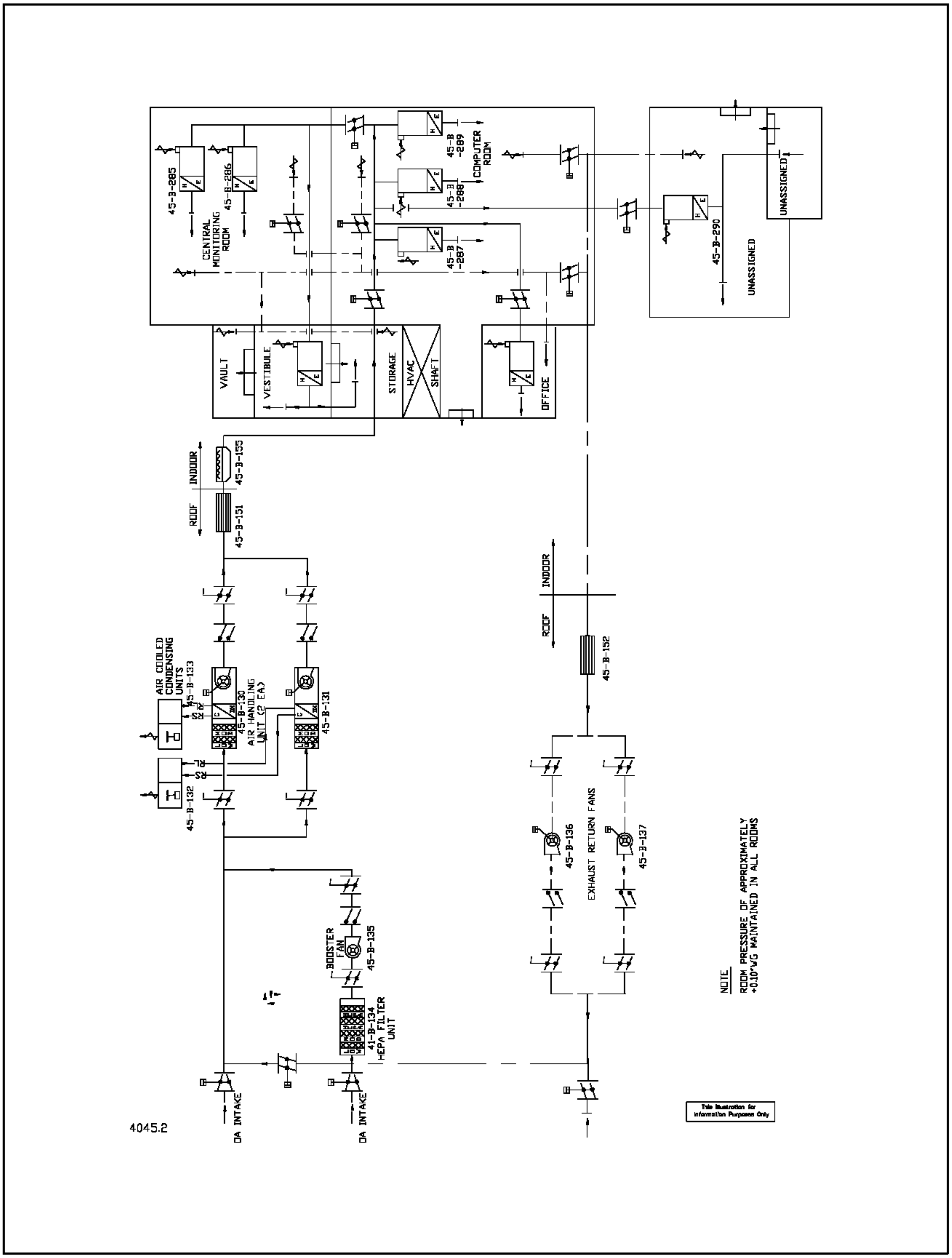

Figure 4.4-5 Support Building CMR Area HVAC Flow Diagram

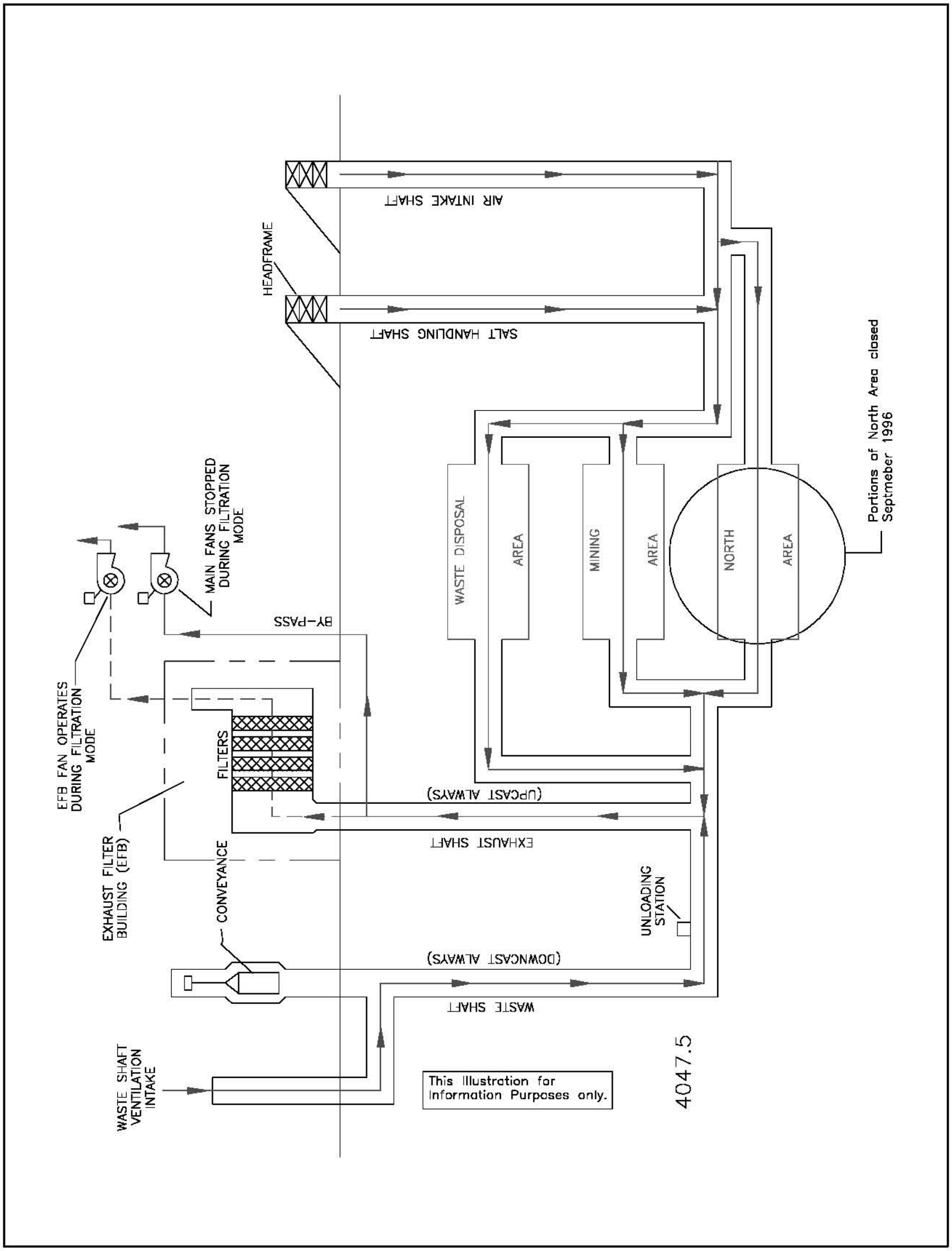

Figure 4.4-6 Underground Ventilation Air Flow Diagram

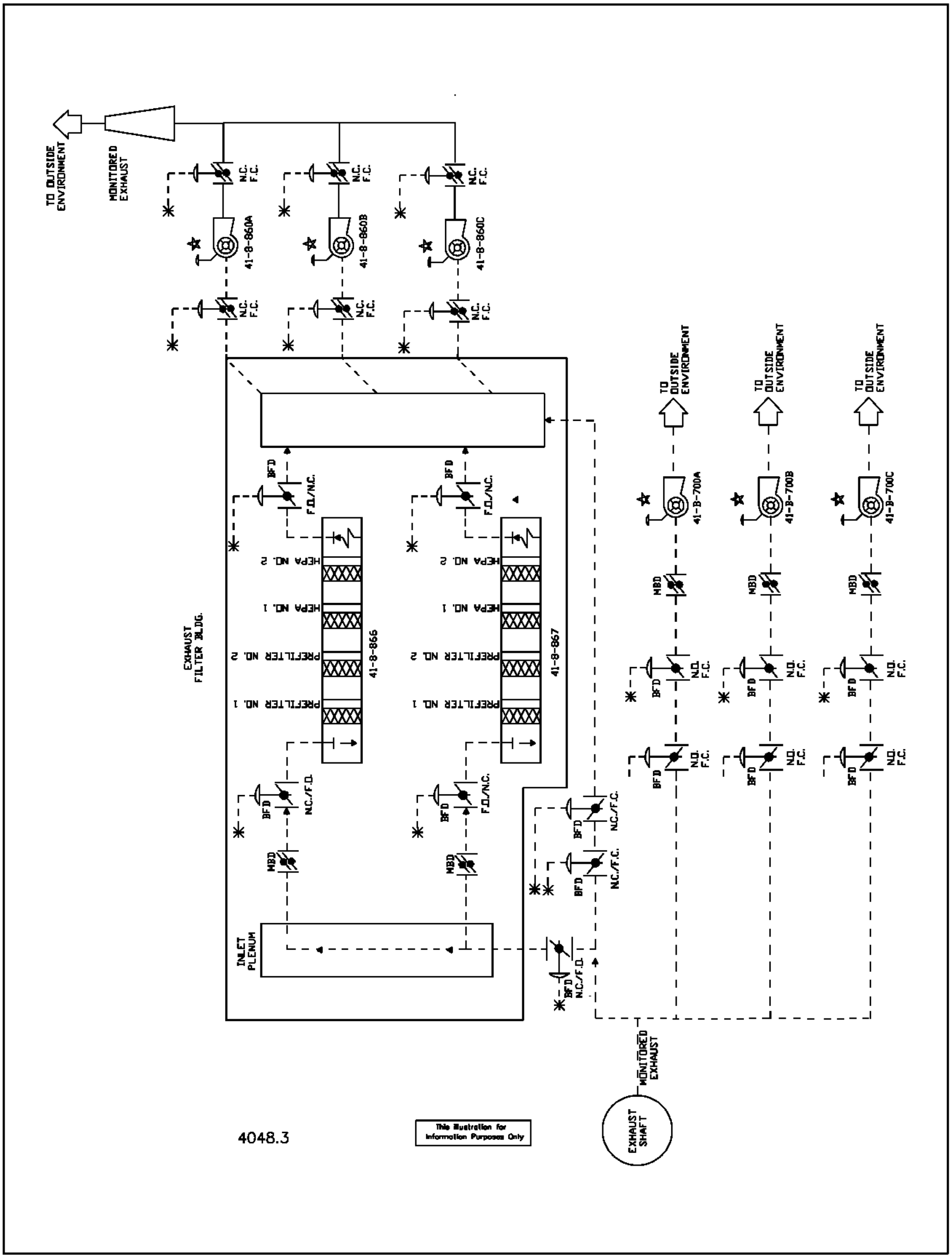

Figure 4.4-7 Main Fan and Exhaust Filter System Schematic

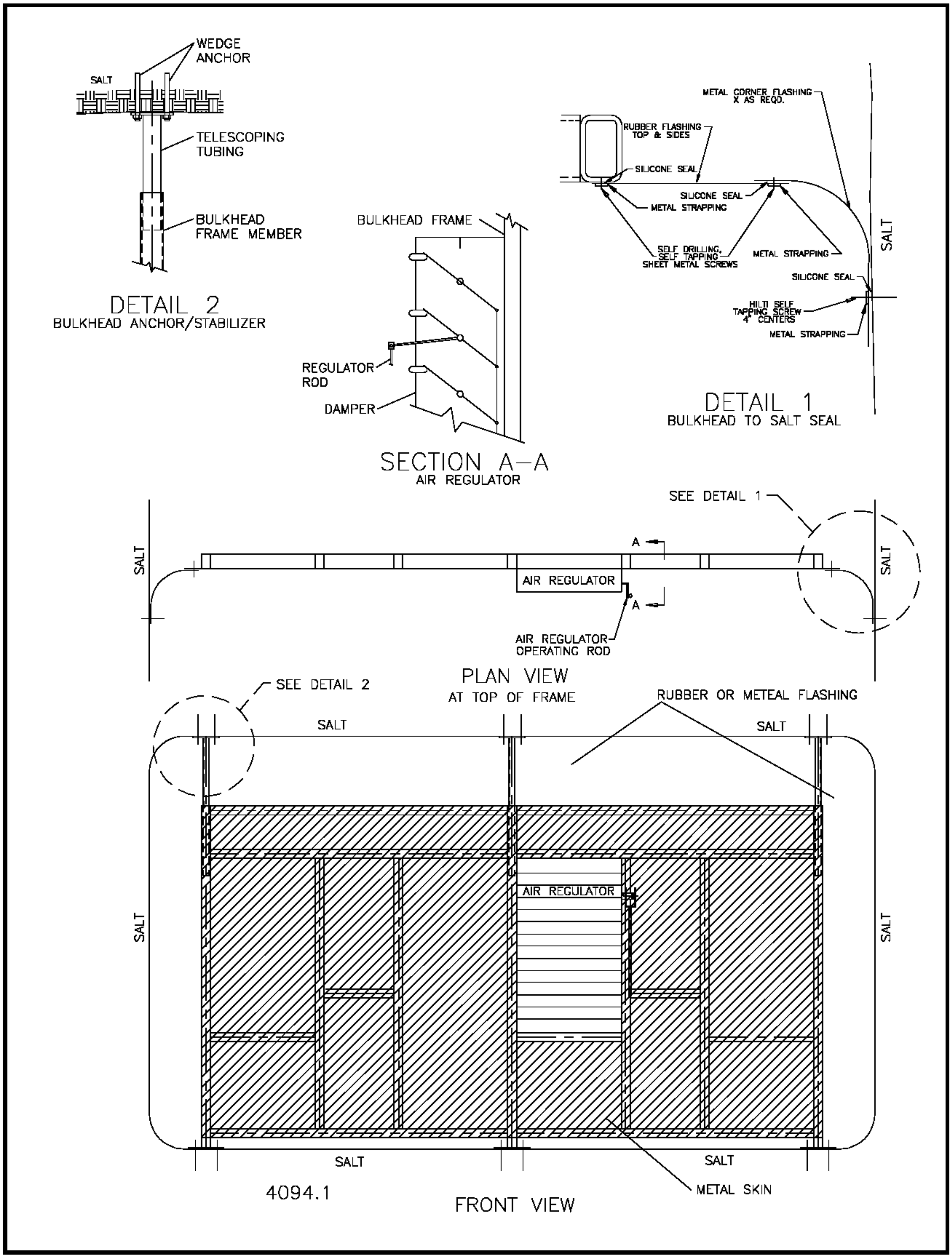

Figure 4.4-8 Typical Bulkhead Design and Components

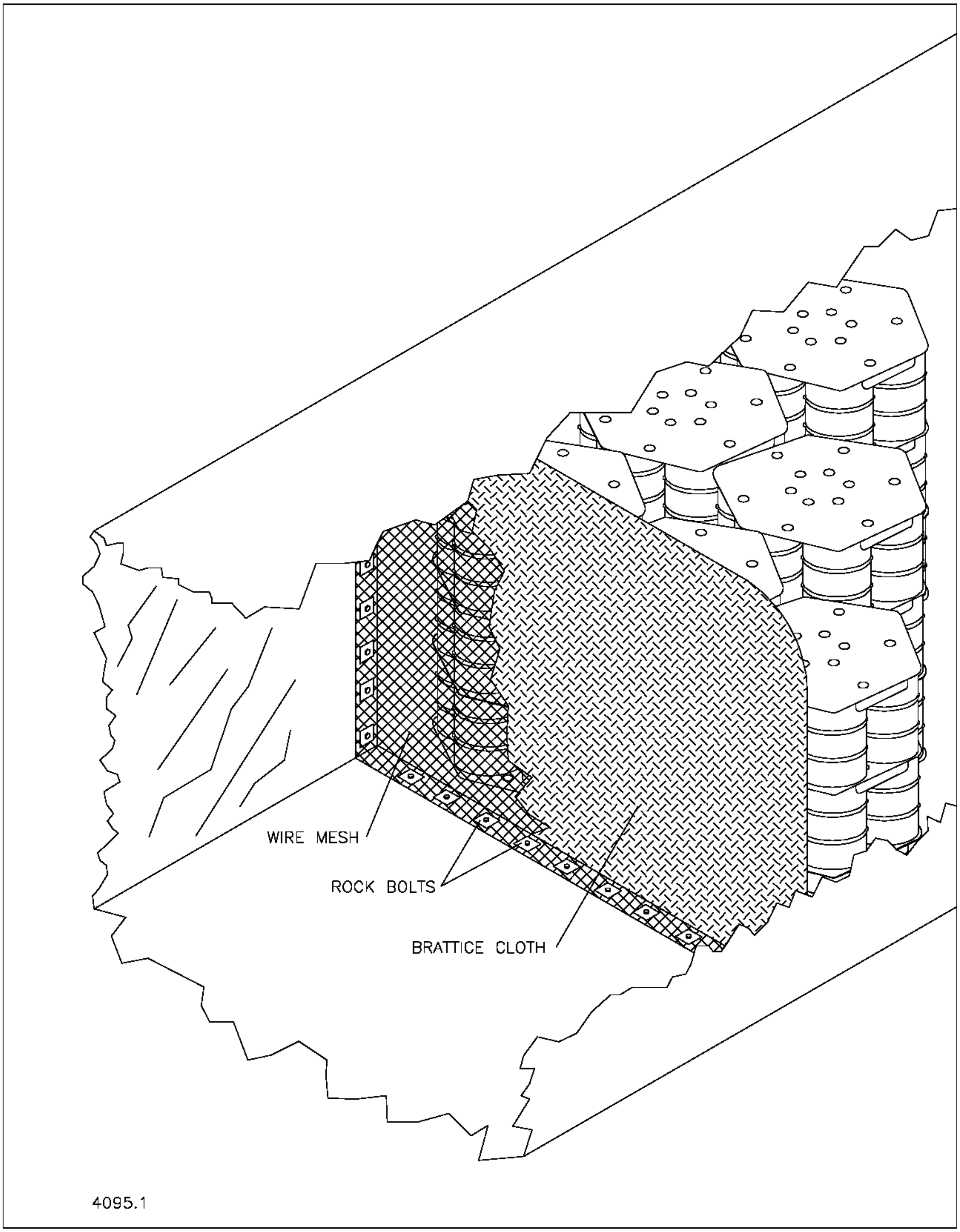

Figure 4.4-9 Typical Room Barricade

4.5 Safety Support Systems

4.5.1 Fire Protection System

The WIPP fire protection system is designed to ensure personnel safety, mission continuity, and property conservation. Building designs incorporate features for fire prevention (e.g., control and extinguishment) Also, fire hazards are controlled throughout the WIPP. The plant design meets the "improved risk" level of protection defined in DOE O 420.1[1] and satisfies the applicable sections of the National Fire Protection Association codes, DOE Orders, and federal codes to the extent described in DOE/WIPP-3217, WIPP Fire Hazard Analysis Report.[2]

To meet these objectives, the WIPP facility design incorporates the following features:

- Most buildings and their support structures are protected by fixed, automatic fire suppression systems designed to the specific, individual hazards of each area.
- Noncombustible construction, fireproof masonry construction, and fire resistant materials are used whenever possible.
- Fire separations are installed where required because of different occupancies per the Uniform Building Code (UBC).
- In buildings where compartmentalization is required, vertical openings are protected by enclosing stairways, elevators, pipeways, electrical penetrations, etc., to prevent fire from spreading to upper floors.

The exhaust ventilation systems which remove hot fire gases, toxic contaminants, explosive gases, and smoke are designed with a high fire integrity. The subsurface and surface structures are served by these systems.

The components of the electric service and distribution systems are listed by Underwriters' Laboratory, or approved by Factory Mutual Engineering Corporation, and are installed to minimize possible ignition of combustible material and maximize safety.

Adequate provisions for the safe exit of personnel are available for all potential fire occurrences with evacuation alarm signals provided throughout occupied areas.

Building evacuation plans help ensure the safe evacuation of building occupants during emergency conditions. The WIPP Emergency Management Program[3] contains the underground emergency procedures, the underground evacuation routes, and the designated assembly areas.

The WIPP Fire Protection System consists of four subsystems. They are:

- Fire Water Supply and Distribution System
- Fire Suppression System
- Fire Detection and Alarm System
- Radio Fire Alarm Reporter (FAR) System

All fire protection systems are classified as Design Class IIIB.

4.5.1.1 Fire Water Supply and Distribution System

The Fire Water Supply and Distribution System consists of two fire pumps, a pressure maintenance (jockey) pump, and a compound loop yard distribution system. One fire pump is electric motor driven and the other pump is diesel engine driven. Both pumps are rated for 1,500 gal (5678 L) per minute at 125 psi (8.8 kg/cm^2). The system is required to provide fire water at a rate of 1,500 gal (5678 L) per minute for two hours for a total of 180,000 gal (681,354 L).

The Fire Water Supply System receives its normal water supply from one of two on-site 180,000 gal (681,354 L) ground-level storage tanks, which are part of the Water Distribution System. The second tank supplies water to the Domestic/Utility Water System, which is a separate system from the Fire Water Supply System, and also reserves approximately 100,000 gal (378,540 L) of water for use as fire water. Utilization of the water in the second tank by the Fire Water Supply System is achieved by the installation of a suction piping spool piece.

Operation of the two fire pumps and the jockey pump is controlled by changes in the distribution system pressure. The pumps are arranged for sequential operation. Under normal conditions, the jockey pump operates to maintain the designed system static pressure. Should there be a demand for fire water which exceeds the capacity of the jockey pump, system pressure will drop and the electric fire pump will start. If system pressure continues to drop, the diesel pump will start.

The yard distribution system consists of a compound loop arrangement serving all areas of the site. The system supplies fire water to all facilities containing a sprinkler system. In addition, the system supplies fire hydrants, which are located at approximately 300 ft (91 m) intervals throughout the site. The system contains numerous sectionalizing and control valves, which are locked, sealed, and visually checked monthly.

All major components of the Fire Water Supply and Distribution System are UL- listed and FM-approved.

4.5.1.2 Fire Suppression System/Fire Detection and Alarm System

The fire suppression system consists of several different fire extinguishing systems or equipment that service the surface buildings and facilities and the underground areas. These may include any one or more of the following fire extinguishing capabilities: automatic wet pipe sprinkler system, fire hose connections, automatic dry chemical extinguishing system, and portable fire extinguishers. The automatic wet pipe sprinkler system is the primary suppression system for fire protection at the WIPP. The fire detection and alarm system consists of multiple systems, each utilizing most or all of the following components: heat sensing fire detectors, smoke detectors, sprinkler system water flow alarm devices, manual fire alarm systems, control panels, audible warning devices, and visual warning devices. A complete description of the type of fire suppression system provided at each WIPP surface structure and the underground is provided in the WIPP Fire Hazard Analysis Report.[2]

4.5.1.3 Radio Fire Alarm Reporter System

The radio fire alarm reporter (FAR) system provides notification of fire alarm and trouble signals to the CMR for structures not connected to the CMS local processing units and for structures which could have significant program or monetary impact. This system consists of radio transmitters that relay alarm and trouble signals via an FM signal to a central base station/receiver. The signal is displayed in the CMR.

4.5.1.4 Fire Protection System Design, Installation, Testing and Maintenance

The following NFPA [4] standards apply at the WIPP facility:

- The fire water supply and distribution system (pumps and hydrants) are designed, installed, tested, and maintained according to NFPA [4] 20, NFPA [4] 24, and NFPA [4] 25.

- The automatic wet pipe sprinkler systems are designed, installed, tested, and maintained in accordance with NFPA [4] 13 and NFPA [4] 25.

- The dry chemical fire suppression systems are designed, installed, tested and maintained in accordance with NFPA [4] 17.

- The fire detection and alarm systems are designed, installed, tested, and maintained in accordance with NFPA [4] 72.

- The radio fire alarm reporter system is designed, installed, tested, and maintained in accordance with NFPA [4] 72 and NFPA [4] 1221.

4.5.2 Plant Monitoring and Communications Systems

The plant monitoring and communications systems include on-site and plant to off-site coverage. The systems are designed to provide immediate instructions to facility personnel to assure personnel and WIPP facility safety, WIPP facility security, and efficient WIPP facility operations under normal and emergency conditions.

Plant Monitoring and Communications includes the following systems:

- Central monitoring system

- Plant communications

  - Touch tone phones

  - Mine pager phones

  - Plant PA (including the Site Notification System) and alarm systems

  - Radio

4.5.2.1 Central Monitoring System

The CMR is the central location for the collection and monitoring of real time site data, automatically and manually, during normal and emergency conditions. The CMR was not intended to be designed or operated in a manner similar to the control room of a nuclear power plant. Most of the underground and surface data monitored in the CMR is gathered, processed, stored, logged, and displayed by the CMS, which collects the data continuously from approximately 1,500 remote sensors.

The CMS is a Design Class IIIA, computer-based monitoring and control system. It is used for real-time site data acquisition, display, storage, alarm and logging and for the control of site components. The CMS monitors the following systems:

- Radiation monitoring, with input from selected area radiation monitoring system (ARMS) detectors, selected continuous air monitoring systems (CAMS), radiation effluent monitoring systems (REMS).
- Electrical power status, including back-up diesel operation.
- Fire alarm system, including system status parameters.
- Ventilation system, including damper position, fan status, flow measurement, and filter differential pressure.
- Meteorological data, including wind speed and direction, temperature, and barometric pressure.
- Facility systems, including air compressors, vacuum pumps, and storage tank levels.

The CMR has three operator stations, including an engineer’s station, which display alarms, status, trends, graphics, and interactive operations. The CMS electronic data storage devices are located in the computer room adjacent to the CMR. Operator's stations and an engineer's station are located in the CMR, and the backup operator's stations are located in the security control room, computer room, and underground operations connex (S-550).

The CMR has special features to allow its use during both normal and emergency conditions. These features include two-hour fire walls and redundant ventilation systems, including HEPA filtration of intake air to allow occupancy during radiological releases. The CMR sources of back-up AC electrical power include an uninterruptible power supply (UPS), with a minimum life expectancy of 30 minutes, and the diesel generator (on-site fuel storage capacity is sufficient for the operation on one engine generator at full load for one day) used to power priority loads (including the CMR) as discussed in Section 4.6.

4.5.2.2 Plant Communications

The dial phone system includes a private automatic branch exchange (PABX) network providing conventional on-site and off-site telephone services. Major uses of this subsystem include the reporting of occurrences (DOE O 232.1A)[5] and communications between the CMR and the following:

- Roving operators and instrumentation technicians.
- The Emergency Operations Center (EOC).
- Various departments such as Health Physics, Transportation, and Security.

The mine pager phones make up an independent, hard wired, battery-operated system for two-way communications between the surface and underground operations.

The plant public address (PA) and alarm systems provide for the initiation of surface and underground evacuation alarms and public address announcements from the CMR and local stations. The plant PA and alarm systems includes the site-wide PA and intercom installations, the Site Notification System for remote locations, and an additional underground evacuation alarm system. These alarms are supplied with backup power if the off-site power supply fails. The PA system master control console is located in the CMR, with paging stations located in the Support Building, WHB, water pumphouse, Guard and Security Building, salt handling hoist house and head frame, EFB, safety and emergency services facility, Engineering Building, Warehouse/Shops Building, and underground..

Radio includes two-way and paging on-site and off-site radio systems. These systems include base stations in the CMR, security control room, emergency operations center, and mobile and portable units.

4.5.2.3 Radiation Monitoring System

The Radiation Monitoring System includes five basic subsytems to ensure adequate information on plant radiation for protection of plant personnel and the surrounding environment under normal operation, off-normal events, and recovery from off-normal events. The subsystems are: Continuous Air Monitoring (CAM) System, Fixed Air Sampling (FAS) Systems, Area Radiation Monitoring (ARM) Systems, Radioactive Effluent Air Monitoring (REMS) Systems, and the Plant Vacuum (PV).

The five subsystems are coordinated into a single design package. Signals are provided to the CMR to provide continuous surveillance and display or log alarm status on the CRT or printer for selected CAM, REMS and ARM stationary monitors. Status of the PV system is also available at the CMR.

References for Section 4.5

1. DOE O 420.1, Facility Safety.
2. DOE/WIPP-3217, WIPP Fire Hazard Analysis Report, June 2002.
3. WP 12-9, WIPP Emergency Management Program.
4. National Fire Protection Association Codes and Standards.
5. DOE O 232.1A, Occurrence Reporting and Processing of Operations Information.

4.6 Utility and Auxiliary Systems

4.6.1 Electrical System

Unless otherwise indicated, all electrical system components are Design Class IIIB. The electrical system is designed to provide: normal and backup power to WIPP electrical equipment, grounding for electrically energized equipment and other plant structures, lightning protection for the plant, illumination for the plant surface facility, and for related underground operations.

Standard industrial electrical distribution equipment is used throughout. Equipment used includes medium voltage switchgear buses, medium voltage to low voltage step-down unit substations, motor control centers, small distribution transformers and panels, relay and protection circuitry, station batteries along with associated synchronous inverters, diesel generator sets, and the cabling, enclosures, and other structures required to locate and interconnect these items.

The electrical system is designed to supply power at the following nominal bus voltages:

- 13.8 kVac, nominal, 3-phase, 3-wire, 60-Hz - Power supply for the main plant substation, underground switching stations, and surface and underground unit substation transformers.
- 4.16 kVac, nominal, 3-phase, 3-wire, 60 Hz - Power supply for the main exhaust fan drive motors.
- 2.4 kVac, nominal, 3-phase, 3-wire, 60 Hz - Power supply for the drive motor for the M-G set, which provides the backup supply for the salt handling shaft drive motor.
- 480/277 Vac, nominal, 3-phase, 4-wire, 60 Hz - Power supply for motor control centers, the AIS drive motor, solid state direct current converter systems for the SH and waste hoists, underground filtration fans, lighting and power distribution transformers.
- 120/208 Vac, nominal, 3-phase, 4-wire, 60 Hz - Power supply for control systems, instrumentation, lighting, communication, and small (fractional horsepower) motor-driven equipment.
- 120/208 Vac, nominal, 3-phase, 4 wire, 60 Hz - Uninterruptible power supply (UPS) for control and instrumentation which must be continuously energized under all plant operating modes.

4.6.1.1 Normal Power Source

The WIPP facility normal power is supplied by a public utility company, and is the preferred power source supplying power to the WIPP facility at all times.

The electrical utility company supplies electrical power from their 115 kV Potash /Kerrmac Junction open wire transmission line from the North and Whitten/Jal Substation open wire line from the South. The North line is about 9 mi (14.4 km) long while the South line is about 19 mi (30.5 km) long. The Potash Junction and Whitten Substations each have two feeders from multiple generating stations and loss of one generating source does not interrupt power to the WIPP facility.

The Utility substation at the WIPP facility is located East of the Property Protection Area. Area substations are located at the various surface facilities. Underground conduits, cable duct banks, and buried cables connect the Plant substation with the area substations.

4.6.1.2 Backup Power Source

In case of a loss of utility power, backup power to selected loads can be supplied by either of the two on-site Design Class IIIB 1,100 kW diesel generators. These generators provide reliable 480-V power, and are sized to feed the loads listed in Table 4.6-1. Backup power is fed through buses A and B (Figure 4.6-1). Each of the diesel generators can carry all preselected monitoring loads (see Section 4.6.1.3 for a discussion of essential loads) plus operation of the AIS hoist for personnel evacuation, and other selected loads in accordance with WP 04-ED series Facility Operations procedures.[1]

Upon loss of normal power, the diesel(s) is started manually by the facility operator within 30 minutes using the electric starter/batteries. Only one diesel may be loaded at a time.[2] The starter system is a 24 V battery system with a 300 amp-hour capacity. The diesel generators may be started from the local control panel or from the CMR. Monitoring of the diesel generators and associated breakers is possible at the CMR, thus providing the ability to feed selected facility loads from the backup power source, in sequence, without exceeding generator capacity. The on-site total fuel storage capacity is sufficient for the operation of one engine generator at full load for one day, and additional fuel supplies are readily available within a few hours by tank truck allowing on-line refueling and continued operation.

The diesel generators and the generator load center are located outside between the Safety and Emergency Services Building and EFB. A 480-V backup power indoor switchgear is located in the main electrical room in the Support Building. Area substations are located at various surface facilities.

Operation of backup power supplies and the selection of loads is addressed in the WP 04-ED series Facility Operations procedures.[1]

4.6.1.3 Uninterruptible Power Supply (Essential Loads)

The central UPS provides power to essential equipment (Table 4.6-2) located in the Support Building and the Waste Handling Building. The central UPS is located in the Support Building. In addition, individual UPSs provide transient-free power to strategically located LPUs for the radiation monitoring system on the surface, in selected areas in the exhaust shaft, and underground passages and waste disposal areas.

The purpose of the central UPS is to supply (120/208 Vac, 222 A) transient-free, reliable power to the essential loads listed in Table 4.6-2. This ensures continuous power to the radiation detection system for airborne contamination, LPUs, computer room, central monitoring room, and primary analytical chemistry laboratory instruments, even during the interval between the loss of off-site power and initiation of backup diesel generator power.

In case of loss of AC power input to the UPSs, the dedicated batteries can supply power to a fully loaded UPS for 30 minutes. The AC power input to the UPS will be restored within approximately 30 minutes via operator action.

All monitoring loads fed from the UPS system are shown on Washington Tru Solutions (WTS) Drawing panel schedules for 41P-DP03/10, 41P-DP03/11, 45P-DP03/15, and 41P-DP03/17.[3] The connected load, as measured, is shown in Table 4.6-2.

4.6.1.4 Safety Considerations and Controls

Failure of the normal distribution system or any of its components will not affect safe conditions of the WIPP facilities. Upon loss of normal off-site power, the EFB isolation valves fail to the filtration mode. The simplified single-line diagram for the normal and manually switched backup loads is shown in Figures 4.6-2a and 4.6-2b (switching devices and equipment are symbolically represented).

4.6.2 Compressed Air

The compressed air system is Design Class IIIB. The system is diverse in the types and sizes of compressors used, and redundancy is provided for the main plant air compressors, salt hoist house, and the underground. All are electrically driven except for the diesel powered backup compressor in the underground.

The piping system consists of runs of 2, 4, and 6 in (5, 10, and 15 cm) pipe connecting the two compressor buildings to the WHB, Support Building, EFB, salt hoist house, and Safety Building. A pipe-run down the waste shaft serves the underground. Each building and the underground can be isolated from the system.

There are two general types of compressors in use at the WIPP. The majority are reciprocating, but the primary main plant air compressors and the underground backup compressor are rotary screw type. All are either single- or two-stage units; the backup main plant air compressors are the non-lubricated type for oil free output air.

The primary main plant air compressors are two single stage rotary screw units of 250 horsepower with a maximum capacity for each unit of 1,155 cfm (32.7 m^3/m) at a system pressure of 125 psi (8.8 kg/cm^2). Cooling for these compressors is accomplished with a fin and tube heat exchanger and cooling fan placed in the lubricating oil system.

The secondary main plant air compressors are two, two-stage, double acting reciprocating units of 200 horsepower and maximum capacity of 1,000 cfm (28.32 m^3/m) at 125 psi (8.8 kg/cm^2). These compressors are the only water cooled units on site, using a closed loop system, pumping a mixture of water and ethylene glycol antifreeze through a fin and tube heat exchanger with four electrically driven cooling fans.

A twin tower desiccant air dryer with prefilters and after filters is located just downstream of the compressors at each of the above installations to provide clean, moisture-free, compressed air dried to a dew point of 0°F (-18°C). A 1,000 gal (3785 L) capacity air receiver is located just downstream of the dryer at each location and connected to the site piping system.

The WHB and EFB employ desiccant air dryers similar to the large units installed at the main compressor buildings but much smaller. These dryers provide additional filtering of the air and lower the dew point to -40°F (-40°C). The Plant Air System ends at these dryers and the Instrument Air System begins. Instrument quality air is then used to operate dampers and control systems for the underground ventilation system and HVAC systems in the above mentioned buildings.

The salt hoist house has a backup installation similar to those described above but uses a refrigerated air dryer instead of the desiccant type. This unit provides air for operation of the hoist brakes in the event of a loss of plant air.

The maintenance shop, AIS hoist house, warehouse, and Engineering Building each have a stand alone compressor installation for vehicle maintenance, hoist operation, HVAC system operation, and other utility purposes. These buildings are not supplied by the plant air system.

Compressed gases sub-systems are installed in three site locations. The dosimetry laboratory uses nitrogen in processing the thermo-luminescent detectors. The counting laboratories use P-10, hydrogen, and liquid nitrogen in various analytical procedures. Mine Rescue uses high-pressure oxygen to refill breathing pack bottles. The commercial gas bottles are installed with Safety Binding and supply manifolds. Rescue uses compressed air for Scott Air Packs.

4.6.3 Water Distribution System

The Water Distribution System is designed to receive water from a commercial water department, transport the water to the WIPP Site, provide storage for the required reserve of fire water, chlorinate and store domestic water, and distribute domestic water for use by personnel, processes, HVAC and irrigation.

4.6.4 Sewage Treatment System

The sewage treatment facility collects and treats sanitary waste and non-radioactive liquids from the surface. Provisions also exist for the facility to receive non-hazardous effluents typically resulting from observation wells and the de-watering of mine shafts.

References for Section 4.6

1. WP 04-ED series Facility Operations procedures.

2. Air Quality Permit No. 310-M-2.

3. Main UPS System Panel Schedules 41P-DP03/10, 41P-DP03/11, 45P-DP03/15, 45P-DP03/17.

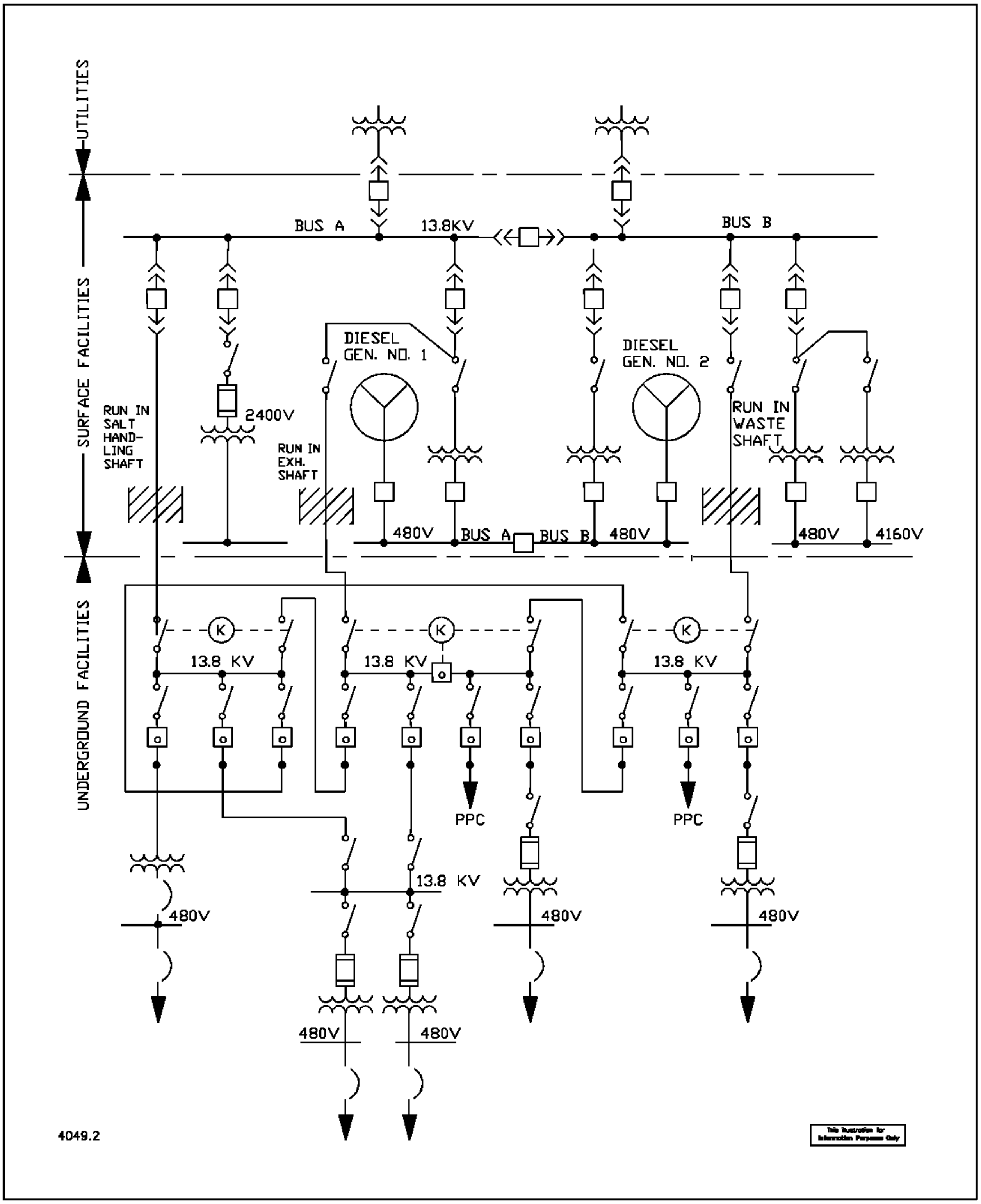

Figure 4.6-1, Electrical Distribution System

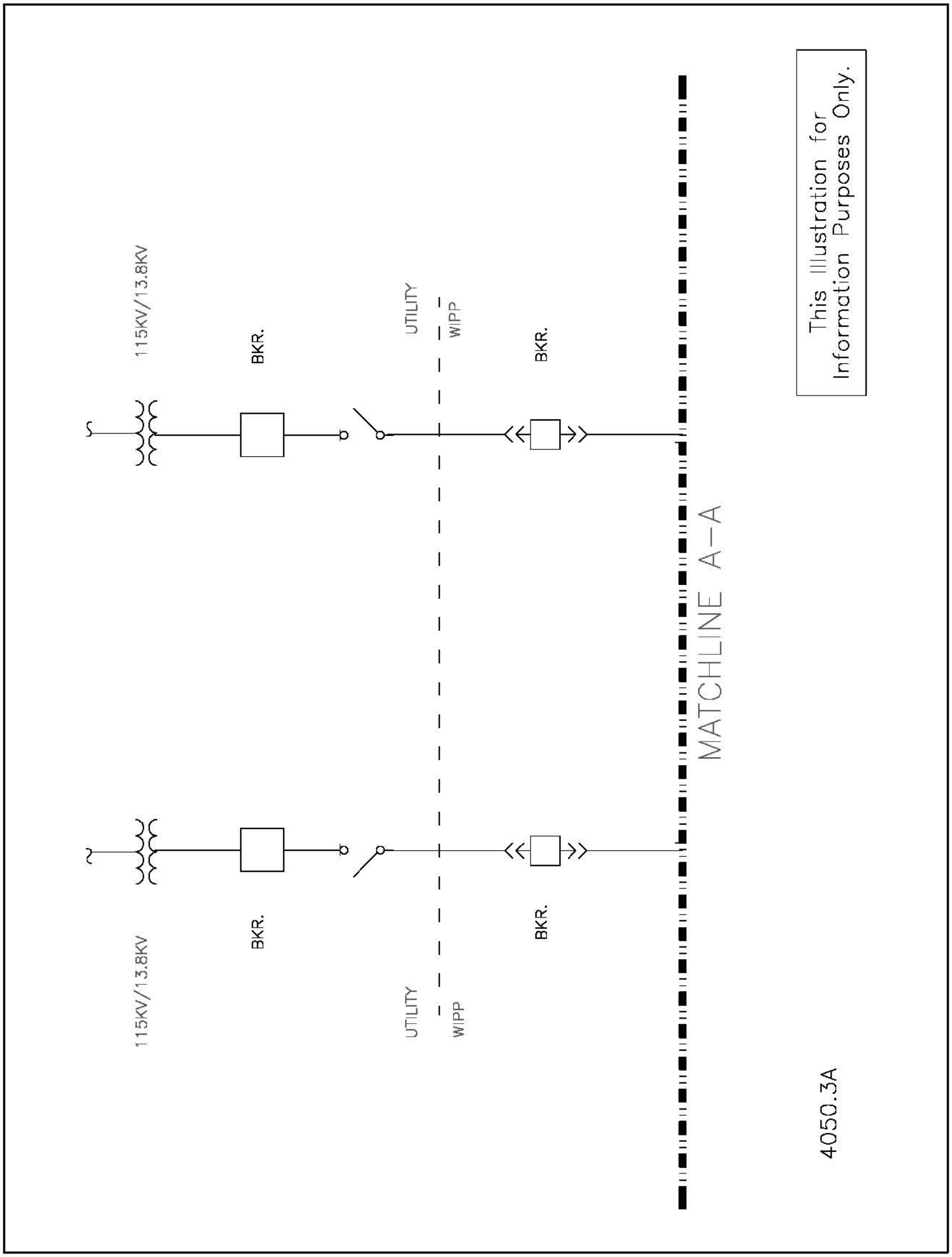

Figure 4.6-2a 13.8 kV Power Distribution System Single Line Diagram

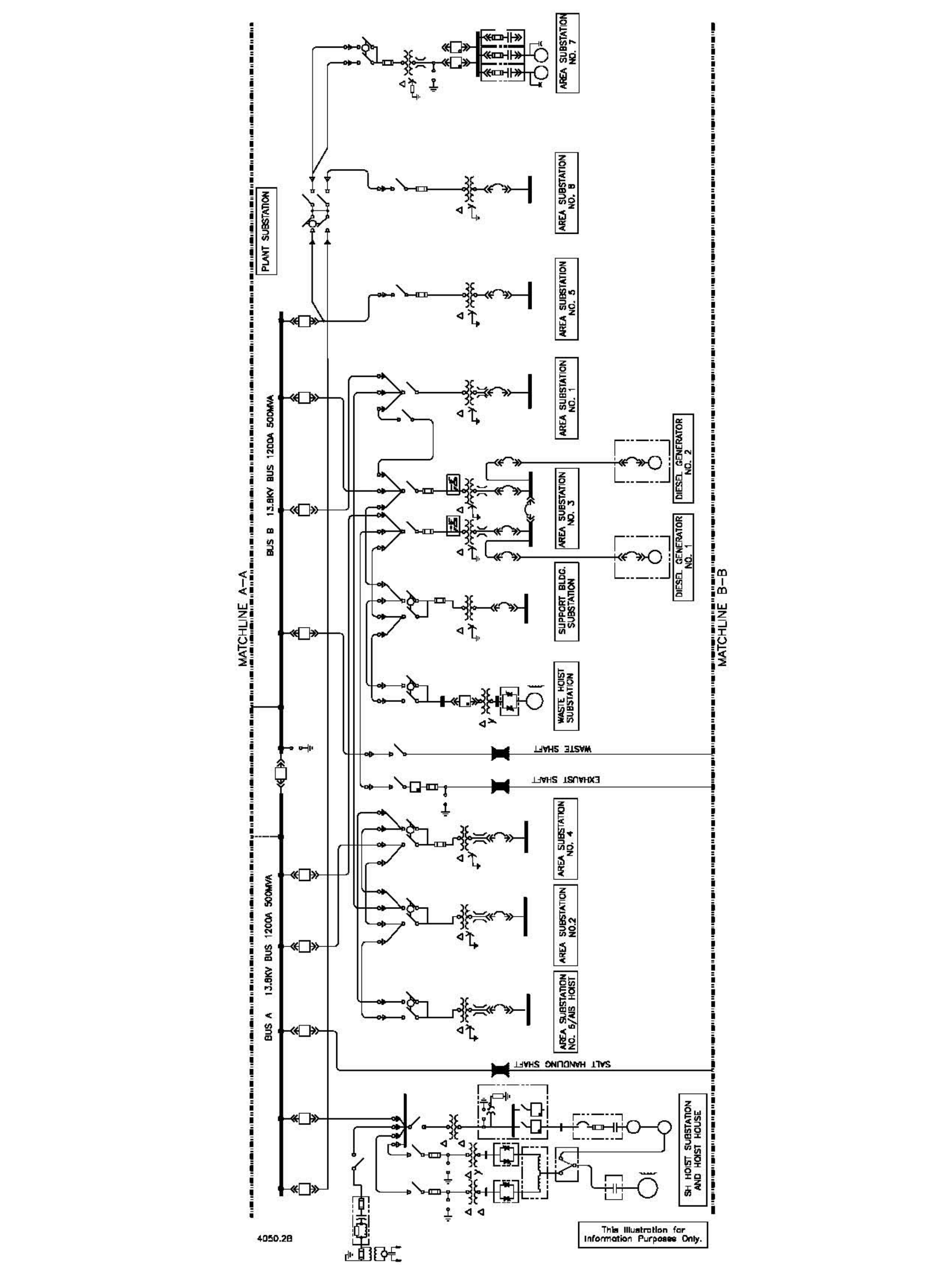

Figure 4.6-2b 13.8 kV Power Distribution System Single Line Diagram

Table 4.6-1 Diesel Generator Load

Manually Switched Backup		
Loads	**kW**	**Remarks**
Uninterruptible Power System* Central Monitoring System* WHB Continuous Air Monitors*	72	
Central Monitoring Room HVAC System Utilities	20	
Fire Protection Systems in the Waste Handling Building Support Building	30	Battery power is provided in fire protection system until the diesel generator is started and loaded.
Fire Pump	160	
Communications Systems	16	
Guard & Security Building	35	
Air Intake Shaft Hoist (If necessary for U/G evacuation)*	330	The diesel generators load is reduced to 900 kW prior to operating the AIS hoist.
WHB Lighting	45	
WHB Cranes	80	After the diesel generator is started cranes are energized as required to land their loads.
WHB Vacuum Pumps	50	
Main Air Compressors (1-200 hp)*	160	
U/G Exhaust Fans (1-235 hp)*	188	
Waste Handling Building Fans*	100	
U/G Sandia other Experimental Loads	400	
Safety & Emergency Services Building (EOC)*	10	
* Priority Back-up loads. Other loads picked up depending on actual kW loading of diesel or by load shedding.		

Table 4.6-2 UPS Loads

LOAD ON CENTRAL UPS	
• Radiological Monitoring System (ARM & CAM), • Central Monitoring System - CMS equipment in the Support Bldg. and in Waste Handling Bldg, • Communication System in Waste Handling and Support Bldg, • Seismic Trip in Waste Handling Bldg. • Network computers and equipment in the Support Bldg. Computer Room.	
Total Connected Load	88 kW
Running Load	30 kW
Loads on Individual UPS Units	
• CMS equipment in facilities other than Waste Handling and Support Buildings. • Selected Surface and Underground Radiological Monitoring Units, • Emergency Operations Center and Safety and Emergency Services Facility Guard and Security Building, • Safety Communication and Alarm System in facilities other then Waste Handling and Support Buildings.	
Total Independent Backup System Load	66 kVA

4.7 Radioactive Waste (Radwaste) and Hazardous Waste Management

Since the WIPP facility operational philosophy is to remain radiologically clean, decontamination operations following detection of contamination may generate some radioactive waste. The plant derived waste could originate in both the surface and underground facilities. Because derived wastes can contain only those materials present in the waste from which they were derived, no additional characterization of the derived waste is proposed for disposal purposes. Characterization of derived waste will be based on process knowledge. High activity waste is not expected to be generated during any normal operating sequences.

4.7.1 Liquid Radwaste System

Water used as a fire suppressant is the largest potential source of liquid radwaste. The fire potential in waste handling areas is remote, and contaminated water from fire fighting is not expected. All suspect liquids are collected, sampled and analyzed for radioactivity, and if the liquid exceeds the uncontrolled release limit of DOE Order 5400.5,[1] it is collected and made acceptable for disposal in the WIPP. Another source would be any liquid used for decontamination. All non-fire water liquid radwaste is collected in portable tanks or drums, and handled in accordance with procedure WP 05-WH1036, Site Derived Mixed Waste Handling.[2]

4.7.2 Solid Radwaste System

The solid radwaste system provides for the collection and packaging of site-derived solid radwaste including waste generated in performing radiochemistry in the Health Physics Laboratory. It is anticipated that all site-derived waste will be contact handled, due to its low activity and the nature of the potential for sources of site-derived solid waste at the WIPP facility.

The maximum estimated solid radwaste volumes derived at the WIPP facility are listed below.

	Estimated Annual Volume	
Source	cubic feet	(cubic meters)
Health Physics Laboratory	4	(0.11)
Solid Waste	205	(5.81)
Decontamination efforts	200	(5.66)
Sweeping	8	(0.23)
TOTAL	417	(11.8)

These maximum solid radwaste volumes are extremely conservative and actual volumes are expected to be much less. Solid radwaste is collected in standard Type A containers with filter vents, and accounted for in the WWIS.

4.7.3 Hazardous Waste System

Non-radioactive hazardous waste generated on-site typically includes absorbed liquids from spills and routine usage of maintenance products, including oils, coolants, and solvents. Safe storage of these materials and associated hazards are administered by the Site Generated Non-Radioactive Hazardous Waste Management,[3] the Industrial Safety Program,[4] and the WIPP Emergency Management Program.[5]

A Hazardous Waste/Material Storage Facility is provided for storage of various types of incoming and outgoing hazardous materials prior to shipment to a Treatment Storage and Disposal Facility, and is shown in Figure 4.1-2a.

References for Section 4.7

1. DOE Order 5400.5, Radiation Protection of the Public and the Environment, January 1993.

2. WP 05-WH1036, Site-Generated Mixed Waste Handling.

3. WP 02-RC.01, Site-Generated Non-Radioactive Hazardous Waste Management.

4. WP 12-IS.01, Industrial Safety Program.

5. WP 12-9, WIPP Emergency Management Program.

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4.8 Human Factors Engineering Considerations

This section summarizes the systematic inquiry of the importance to safety of reliable, correct, and effective human-machine interactions, considering the mission of the WIPP facility and the physical nature of the radioactive wastes that it will receive. The specific human errors that can contribute to accidental releases of hazardous materials are discussed in Chapter 5 as an integral part of each hypothesized accident. Based on the analysis of those accidents and the discussion below, it can be concluded that the WIPP waste acceptance criteria for transuranic wastes, facility design, and operational controls provide high confidence that all potential releases can be contained with passive safety features that eliminate the need for human actions requiring sophisticated human-machine interfaces.

To provide additional support for the conclusion that no detailed human factor evaluation of human-machine interfaces is required, a scoping assessment of the effectiveness of the human-machine interfaces that support important design functions of the Table 4.1-1 Design Class II and IIIA systems is summarized in Table 4.8.1. [It can be seen that most of the Design Class II and IIIA systems and equipment do not require human actions to initiate or sustain their function relative to the release of radiological or non-radiological waste materials.] In most cases these functions are accomplished with automatic passive mechanisms designed to provide containment for the waste materials.

Functions allocated to automatic passive mechanisms or automatic active systems may be influenced by human error during maintenance. However, using the graded approach, human-machine interfaces for maintenance activities at WIPP are judged to be adequate because they are deliberate, and there is ample opportunity to discover errors and correct them with no adverse safety consequences. The policy outlined in WP 10-2, Maintenance Operations Instruction Manual,[1] states that maintenance shall have a high degree of integration with other activities and shall have minimal impact on operations. Maintenance on specific systems is listed on the Plan of the Week, which Operations management must approve. A Plan of the Day meeting further ensures that coordination will be maintained. Finally, the facility is designed to provide adequate space and a favorable environment in which to accomplish maintenance activities.

The ability of the staff to accomplish their responsibilities in potential accident environments is addressed in Section 8.5. The limited magnitude of the hazard and the lack of dispersal driving forces provide very high confidence that the staffing and training presented in those sections will enable the staff to perform their responsibilities in potential accident environments. The graded approach to human factors engineering considerations is justified by the evaluation of the design and operation of the WIPP against three criteria given in Paragraph 8a of DOE Order 5480.23:[2]

- **Criteria (a) — Magnitude of Hazard.** The magnitude of hazardous materials that can be involved in an accident leading to a release is very limited. The radioactive material is delivered to the site in sealed canisters; and, the waste handling operations are designed to maintain that integrity throughout the entire process required to safely emplace those canisters in the site's underground waste disposal rooms. Inventory limits on individual canisters ensure that heat generated by radioactive decay can be easily dissipated by passive mechanisms. Finally, only a limited number of waste canisters have the possibility of being breached as a result of any one accident initiating event. As a result, the consequences of unmitigated releases from all accidents hypothesized in Chapter 5, including those initiated by human error, do not produce significant offsite health consequences.

- **Criteria (b) — Complexity of the Facility and/or Systems Being Relied on to Maintain an Acceptable Level of Risk.** The facility has no complex system requirements to maintain an acceptable level of risk. The facility is designed to minimize the presence and impact of other energy sources that could provide the heat or driving force to disperse hazardous materials. When something unusual happens during normal operations, such as support systems becoming unavailable, waste handling can be simply stopped and personnel evacuated until an acceptable operating condition is reestablished.

  Should an initiating event occur that breaches a waste canister, the plant design permits the immediate cessation of activity and isolation of the area where the breach occurs. Once isolation is achieved, there is no driving force within the waste or waste handling area that could result in a release of the waste material. Consequently, sufficient time is available to thoroughly plan and prepare for the remediation process prior to initiating decontamination and recovery actions.

- **Criteria (c) — Stage of Life Cycle.** Human factors considered here is limited to that time necessary to properly emplace the transuranic waste designated for disposal at WIPP. The operations will be straightforward, proceduralized, and consistent. Moreover, operations will be continued for only the period of time needed to complete the disposal process.

  Once a panel is filled and sealed off, the natural properties of the salt and the location of the mine combine to provide passive isolation of the waste from the environment. The potential for human intrusion after the facility closure is beyond the scope of the human factors evaluation considered here.

References for Section 4.8

1. WP 10-2, Maintenance Operations and Instruction Manual.

2. DOE Order 5480.23, Nuclear Safety Analysis Report, August 1994.

Table 4.8-1 Human Factors Evaluation Requirements of Design Class II/IIIA SSCs Page 1 of 7

Table 4.1-1 Description			Functional Allocation	Human Errors Impacting Safety Function (Excluding Design, Maintenance, and Testing) and Consequence.	Human Factors Screening Results
System/Component	**Design Class**	**Design Class Function**			
PLANT BUILDINGS, FACILITIES, AND MISCELLANEOUS EQUIPMENT (SDD-CFOO)					
Waste Handling Building structure and structural components including tornado doors (Bldg. 411)	II	Provide physical confinement	Passive Mechanisms	None	Adequate
Auxiliary Air Intake Shaft and Tunnel (Bldg 465)	II	DBE, DBT	Passive Mechanisms	None	Adequate
Station A Effluent Monitoring Instrument Shed (Bldg 364)	II	Design Class Interface. (Houses Station A)	Passive Mechanisms	None	Adequate
Effluent Monitoring Rooms A and B (Building 413A and 413B)	II	Design Class Interface. (Houses Local Processing Units (LPU)s collecting data from Stations A and B)	Passive Mechanisms	None	Adequate
Station B Effluent Monitoring Instrument Shed (Bldg 365)	IIIA	Design Class Interface. (Houses monitoring equipment for Exhaust Filter Building duct)	Passive Mechanisms	None	Adequate
Support Building (Bldg 451)	IIIA	Design Class Interface. (Houses Central Monitoring Room (CMR))	Passive Mechanisms	None	Adequate
Exhaust Filter Building (Bldg 413)	IIIA	Design Class Interface. (Houses Exhaust Filtration System)	Passive Mechanisms	None	Adequate
EFB HEPA Filter Units & Isolation Dampers	II	Failure could prevent mitigation	Passive Mechanisms	None	Adequate
EFB Exhaust System	IIIA	Failure could prevent mitigation	Passive Mechanisms	None	Adequate

Table 4.8-1 Human Factors Evaluation Requirements of Design Class II/IIIA SSCs Page 2 of 7

Table 4.1-1 Description			Functional Allocation	Human Errors Impacting Safety Function (Excluding Design, Maintenance, and Testing) and Consequence.	Human Factors Screening Results
System/Component	**Design Class**	**Design Class Function**			
Building 412 (Originally TRUPACT Maintenance Facility)	IIIA	Design Class Interface. (Structural interface with WHB)	Passive Mechanisms	None	Adequate
PLANT MONITORING AND COMMUNICATION SYSTEM (SDD-CMOO)					
Central Monitoring System	IIIA	Monitors important facility parameters	Automatic with alarms and readout in CMS.	CMRO fails to monitor and back up automatic functions. No human mitigation of ongoing scenario	Adequate
ENVIRONMENTAL MONITORING SYSTEM (SDD-EM00)					
Volatile Organic Compound (VOC) Monitoring Equipment and sub-systems	IIIA	Monitors release of VOCs	N/A	No safety function - Periodic sampling for confirmatory monitoring in accordance with RCRA	Adequate
HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) SYSTEM (SDD-HV00)					
Exhaust Filtration System	II	Design Class Interface. (Control of radioactive effluent)	Passive Mechanisms.	None. Filters required to be online during waste handling.	Adequate
HEPA Filters	II	Control of radioactive effluent	Passive Mechanisms	None. Filters required to be online during waste handling.	Adequate
Tornado Dampers	II	Control of radioactive effluent	Automatic	None	Adequate
Exhaust Systems HV02, (Bldg 411, RH HVAC), and HV04 (Station A and Bldg 413, Exhaust Filter Building HVAC)	IIIA	Design Class Interface. (Provide filtration and maintain differential pressure)	Passive Mechanisms	None. Systems required to be online during waste handling.	Adequate

Table 4.8-1 Human Factors Evaluation Requirements of Design Class II/IIIA SSCs Page 3 of 7

Table 4.1-1 Description			Functional Allocation	Human Errors Impacting Safety Function (Excluding Design, Maintenance, and Testing) and Consequence.	Human Factors Screening Results
System/Component	**Design Class**	**Design Class Function**			
HVAC for the CMR	IIIA	Design Class Interface. (Maintains acceptable CMR environment)	Automatic	None	Adequate
RADIATION MONITORING SYSTEM (SDD-RM00)					
Stations A3, B2, C, and D1 (including UPSs)	II	Monitors radioactive effluents	Automatic with alarms and readout in CMS.	CMRO fails to verify operation and notify plant personnel. FSM fails to initiate facility emergency plans. No human mitigation of ongoing scenario.	Adequate
The remainder of the RMS SSCs (except PV00 equipment which is IIIB) are Design Class IIIA	IIIA	Monitors radioactive effluents	Automatic with alarms and readout in CMS.	CMRO fails to verify operation and notify plant personnel. FSM fails to initiate facility emergency plans. No human mitigation of ongoing scenario.	Adequate
UNDERGROUND HOIST SYSTEM (SDD-UH00)					
Waste Hoist and Equipment	IIIA	Failure could cause radioactive material release	Automatic (See WIPP/WID-96-2178 Rev. 0)	None	Adequate

Table 4.8-1 Human Factors Evaluation Requirements of Design Class II/IIIA SSCs Page 4 of 7

Table 4.1-1 Description			Functional Allocation	Human Errors Impacting Safety Function (Excluding Design, Maintenance, and Testing) and Consequence.	Human Factors Screening Results
System/Component	**Design Class**	**Design Class Function**			
UNDERGROUND VENTILATION SYSTEM (SDD-VU00)					
Exhaust duct elbow at the top of the Exhaust Shaft	II	Design Class Interface. (Channels exhaust air to the EFB)	Passive Mechanisms	None	Adequate
HEPA Filters and Isolation Dampers	II	Control of radioactive effluent	Passive Mechanisms	None	Adequate
Exhaust Fans for the filtration mode	II	Design Class Interface. (Channels exhaust air through the EFB)	Passive Mechanisms	None	Adequate
Exhaust System Instruments and Hardware	IIIA	Design Class Interface. (Supports Exhaust Filtration System)	Passive Mechanisms	None	Adequate
(6) High Pressure Fans for Bulkhead 309 (Pressure Chamber)	IIIA	Maintain buffer zone between RMA and non-RMA	Passive Mechanisms	None	Adequate
WASTE HANDLING EQUIPMENT (SDD-WH00)					
Facility Cask	II	Provides permanent shielding	Passive Mechanisms	None	Adequate
25-Ton Crane - CUR	IIIA	Failure could cause radioactive materials release	Active - In use manual	Failure could lead to initiating event for RH Accident Release	Adequate
Telescoping Port Shield	II	Provides permanent shielding	Passive Mechanisms	None	Adequate
Shield Bell	II	Provides permanent shielding	Passive Mechanisms	None	Adequate
CUR Floor Shield Valve	II	Provides permanent shielding	Passive Mechanisms	None	Adequate
Hot Cell Shield Valve	II	Provides permanent shielding	Passive Mechanisms	None	Adequate

Table 4.8-1 Human Factors Evaluation Requirements of Design Class II/IIIA SSCs **Page 5 of 7**

Table 4.1-1 Description			Functional Allocation	Human Errors Impacting Safety Function (Excluding Design, Maintenance, and Testing) and Consequence.	Human Factors Screening Results
System/Component	**Design Class**	**Design Class Function**			
Transfer Cell Ceiling Shield Valve	II	Provides permanent shielding	Passive Mechanisms	None	Adequate
Hot Cell Transfer Drawer	II	Provides permanent shielding	Passive Mechanisms	None	Adequate
Hot Cell Viewing Windows	II	Provides permanent shielding	Passive Mechanisms	None	Adequate
140/25 ton crane	IIIA	Programmatic Impact	Active - In use manual	Failure could lead to initiating event for RH Accident Release	Adequate
Cask Lifting Yoke (140/25 ton crane)	IIIA	Programmatic Impact	Active - In use manual	Failure could lead to initiating event for RH Accident Release	Adequate
15-ton Overhead crane- Hot Cell	IIIA	Failure could cause radioactive materials release	Active - In use manual	Failure could lead to initiating event for RH Accident Release	Adequate
Bridge and Trolley/Par 6000 Manipulator (Hot Cell)	IIIA	Programmatic Impact	Active - In use manual	Failure could lead to initiating event for RH Accident Release	Adequate
Master-Slave Manipulators (Hot Cell)	IIIA	Programmatic Impact	Active - In use manual	None	Adequate
Hot Cell Grapple Rotating Block	IIIA	Programmatic Impact	Passive Mechanisms	Failure could lead to initiating event for RH Accident Release	Adequate
6.25 ton Overhead Fixed Hoist - Facility Cask Loading Room	IIIA	Failure could cause radioactive materials release	Passive Mechanisms	None	Adequate
Facility Cask Rotating Device	IIIA	Programmatic Impact	Passive Mechanisms	None	Adequate

Table 4.8-1 Human Factors Evaluation Requirements of Design Class II/IIIA SSCs Page 6 of 7

Table 4.1-1 Description			Functional Allocation	Human Errors Impacting Safety Function (Excluding Design, Maintenance, and Testing) and Consequence.	Human Factors Screening Results
System/Component	**Design Class**	**Design Class Function**			
Facility Grapples (Hot Cell & Facility Cask Loading Room)	IIIA	Failure could cause radioactive materials release	Active - In use manual	Failure could lead to initiating event for RH Accident Release	Adequate
Shielded Insert	IIIA	Failure could cause radioactive materials release	Active - In use manual	None	Adequate
The Horizontal Emplacement and Retrieval Equipment (HERE)	IIIA	Programmatic Impact	Active - In use manual	Failure could lead to initiating event for RH Accident Release	Adequate
Transfer Cell Shuttle Car	IIIA	Failure could cause radioactive materials release	Active - In use manual	Failure could lead to initiating event for RH Accident Release	Adequate
10-160B Drum Carriage Lift Fixture	IIIA	Failure could cause radioactive materials release	Active - In use manual	Failure could lead to initiating event for RH Accident Release	Adequate

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