EQUIPMENT DESIGNS FOR THE SPENT LWR FUEL DRY STORAGE DEMONSTRATION

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ABSTRACT

In conjuction with the Spent Fuel Handling and Packaging Program (SFHPP) equipment has been designed, fabricated and successfully utilized to demonstrate the packaging and interim dry storage of spent LWR fuel. Surface and near surface storage configurations containing PWR fuel assemblies are currently on test and generating baseline data. Specific areas of hardware design focused upon include storage cell components and the support related equipment associated with encapsulation, leak testing, lag storage, and emplacement operations.

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INTRODUCTION

Demonstration of packaging and interim dry storage of spent LWR fuel has been carried out at the E-MAD facility, located on the Nevada Test Site, in conjunction with the Spent Fuel Handling and Packaging Program (SFHPP). The objective of this Department of Energy (DOE) program was to develop and test the capability to satisfactorily encapsulate spent nuclear fuel assemblies from commercial power plants and to establish the suitability of one or more surface or near surface concepts. Activities associated with the accomplishment of this objective included an intensive design effort necessary for the fabrication of components and equipment (including required modifications to the existing facility) to complete the receipt, inspection, lag storage, encapsulation, leak testing, and emplacement of spent fuel assemblies.

The designs generated for this program fall into two general categories; storage cell related and process support related. The storage cell related designs which are presented in this paper are the drywell and Sealed Storage Cask cells and the canister/shield plug package. The process support related component and equipment designs presented include the lag storage pit, storage cell locations, weld pit, canister welding system, evacuation and backfill system, leak check system and transfer system. Reference 1 describes the E-MAD facility and the utilization of the components and equipment described here for the processing of spent fuel assemblies from receipt at the facility through the emplacement into storage.

DRYWELL STORAGE CONFIGURATION

The drywell storage configuration is shown in Figure 1. The stepped drywell design consists of a steel liner grouted into a 66 cm (26 in.) diameter hole approximately 7 m (23 ft.) deep. The lower section of the liner is fabricated from 45.9 cm (18 in.) diameter standard schedule, carbon steel pipe. The upper section consists of a 132 cm (52 in.) long piece of 55.9 cm (22 in.) diameter, SCH 60, carbon steel pipe. The shield plug from which the canister is suspended is supported by the stepped section or ledge in the drywell liner. Attached to the outside of the liner are nine thermocouple wells as shown in Figure 2.

A 213 cm (84 in.) square by 68.6 cm (27 in.) thick concrete shield pad surrounds the drywell liner at ground level as shown in Figure 1. These drywell shield pads are interconnected with concrete aprons to prevent rail settlement under loads imposed by the railroad equipment used to transfer a canister package between the Hot Bay and a drywell. The shield pad also has a 45.7 cm (18 in.) deep annulus, 91.4 cm (36 in.) O.D. around the upper section of the liner in which a portable shield adapter, shown in Figure 3, is installed during canister package transfer operations to reduce the radiation does rate as the canister is lowered into or raised from the drywell. The shield cask on the rail transfer vehicle engages about one inch into the shield adapter to limit radiation streaming. Following installation of a canister package,

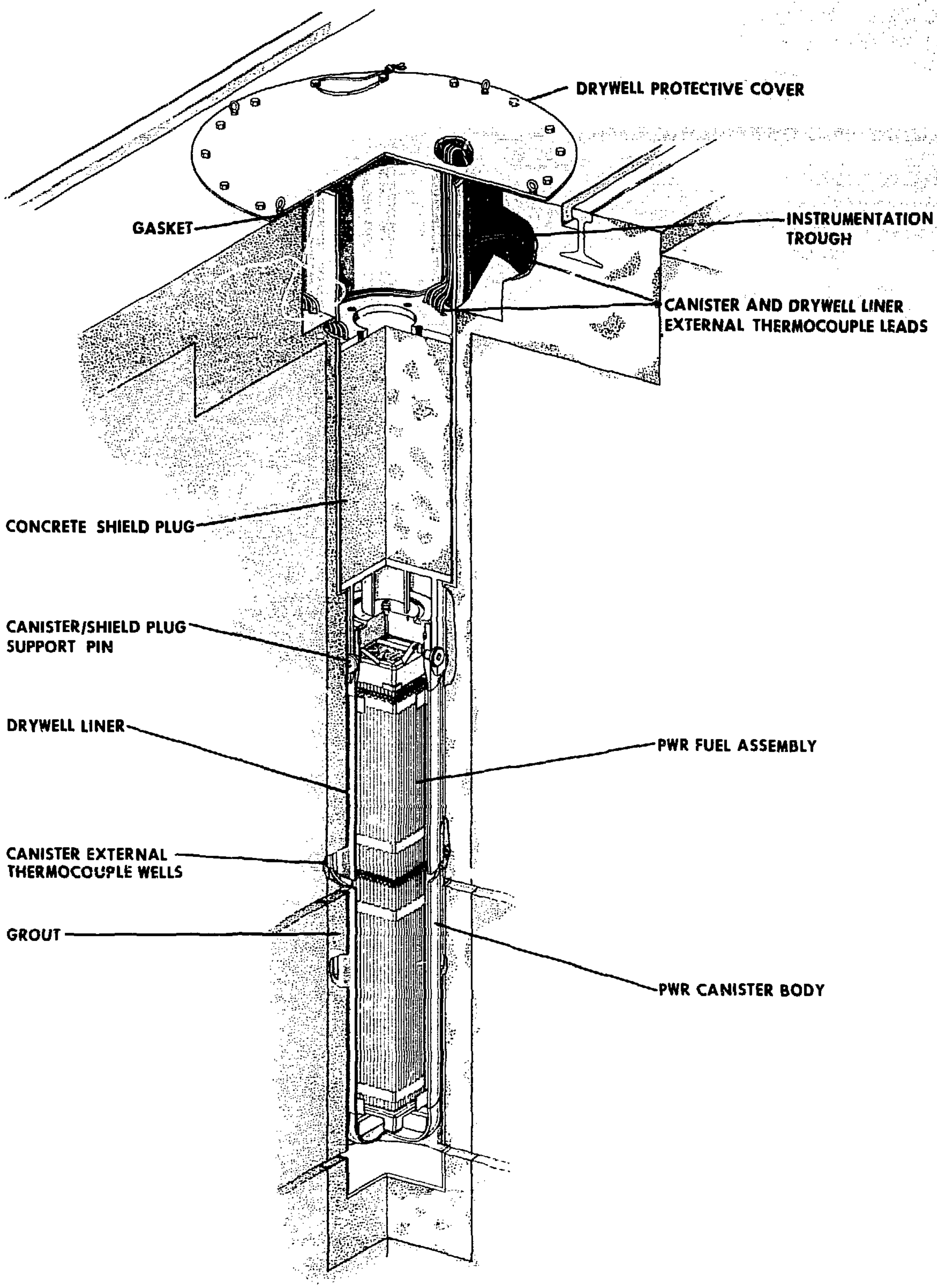


Figure 1. SFHPP Demonstration Drywell Storage Configuration

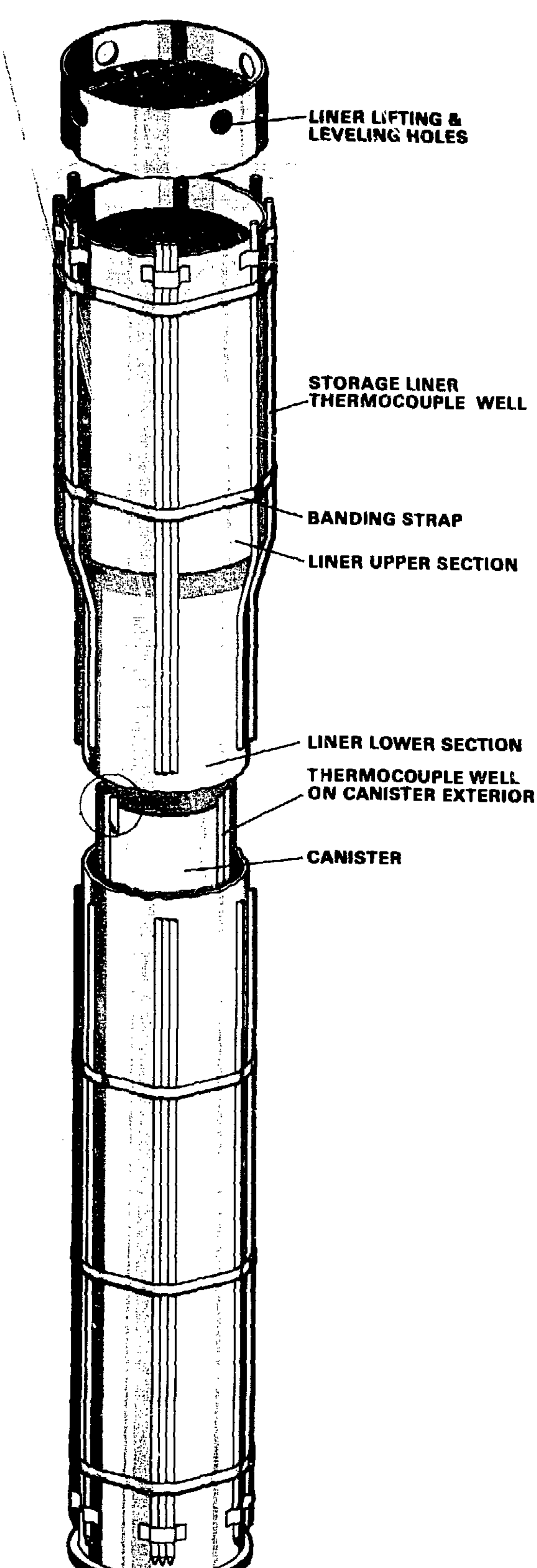


Figure 2. Storage Cell Liner and Canister Thermocouple Well Arrangement

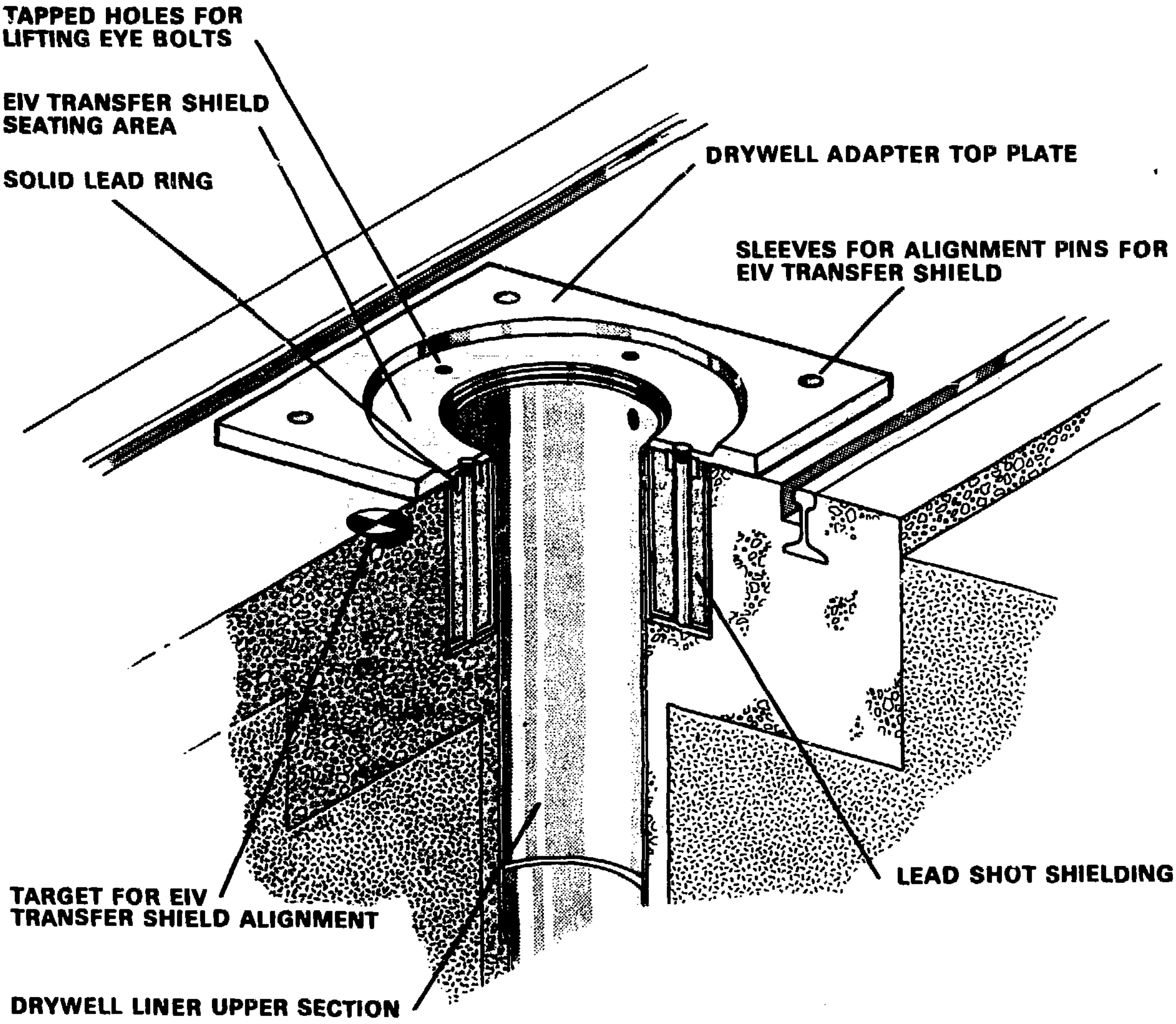


Figure 3. Drywell Portable Shield Adapter

final drywell assembly is accomplished by removing the shield adapter and the canister shield plug lifting bail; inserting the canister and liner thermocouples into the thermocouple wells; sealing the thermocouple lead bundle at the shield pad instrumentation pass-through; and bolting the elastomer gasketed cover to the shield pad.

SEALED STORAGE CASK CONFIGURATION

The Sealed Storage Cask (SSC), shown in Figure 4, is a reinforced concrete cylindrical structure, 2.6 m (104 in.) in diameter and 6.4 m (252 in.) high. Embedded in the structure is a carbon steel liner with the same internal configuration as the drywell liner described in the preceding section. Welded to the lower end of the liner is a 91.4 cm (36 in.) diameter by 33 cm (13 in.) thick steel and concrete shield.

The shield plug from which the canister is suspended is supported the same way as in the drywell. Embedded in the periphery of the concrete structure are four handling trunnions of which only two are required to handle the assembled weight of the SSC of approximately 90.7 te (100 tons). A neoprene gasket between the concrete and the cask cover bolted to the top of the SSC seals the cask interior. The canister assembly shown in Figure 4 depicts the fuel assembly support cage that would be used to support two BWR fuel assemblies within the canister.

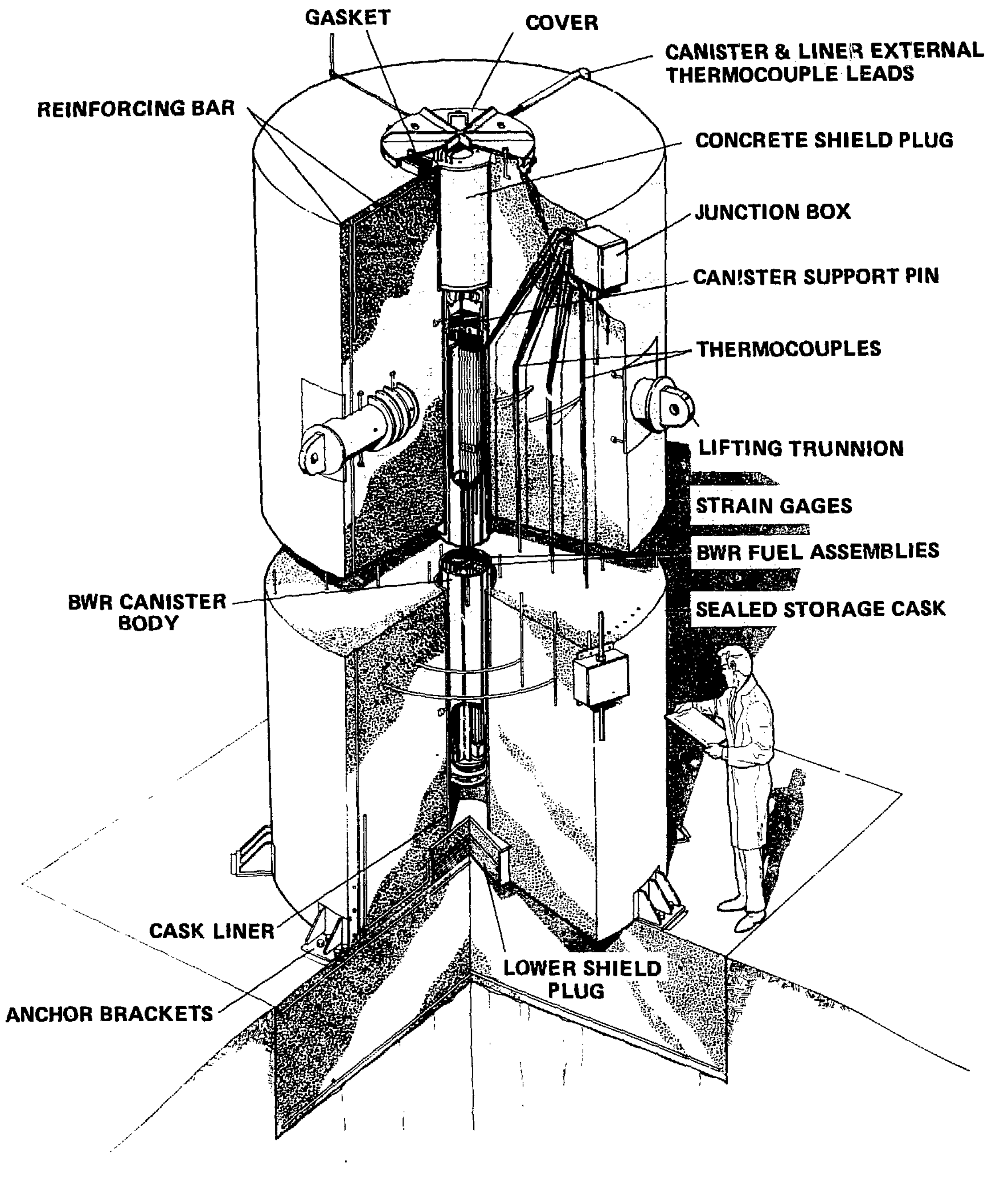


Figure 4. SFHPP Demonstration Sealed Storage Cask Configuration

The SSC is transportable by truck to permit loading a canister package into the SSC in the E-MAD Hot Bay and then subsequently moving it to a storage site foundation pad outside the E-MAD building. The SSC is then lifted off the truck and placed onto the foundation pad by means of a mobile crane as shown in Figure 5. At the storage site, the cask is attached to the reinforced concrete foundation pad. The pad is 4.9 m (15 ft.) square and a minimum of .91 m (3 ft.) thick. Eight bracket plates are bolted to embedments in the pad. This method of attaching the cask to the pad precludes cask overturning for a horizontal seismic loading of 0.25 g. This loading, although less than the Design Basis Earthquake (DBE) loading (0.7 g), is satisfactory considering the low probability of a seismic event of greater magnitude and the absence of any detrimental consequences due to cask overturning. If the SSC should overturn as a result of a higher seismic load (up to the DBE), analysis has shown that the concrete cask will remain intact, the liner cover plate bolted to the top of the SSC will retain the canister assembly within the concrete cask, and sufficient heat dissipation will still be available to prevent excessive fuel temperatures. Furthermore, a pair of lifting trunnions would always be in the correct orientation to permit uprighting.

CANISTER/SHIELD PLUG PACKAGE

The canister/shield plug package for the SFHPP Demonstration consisted of a single PWR fuel assembly contained within a sealed canister assembly which is mated to a shield plug by four canister support pins. When a fuel assembly is contained in the canister, the canister and shield plug are handled and stored as a package. Each of the components of the canister package is described below.

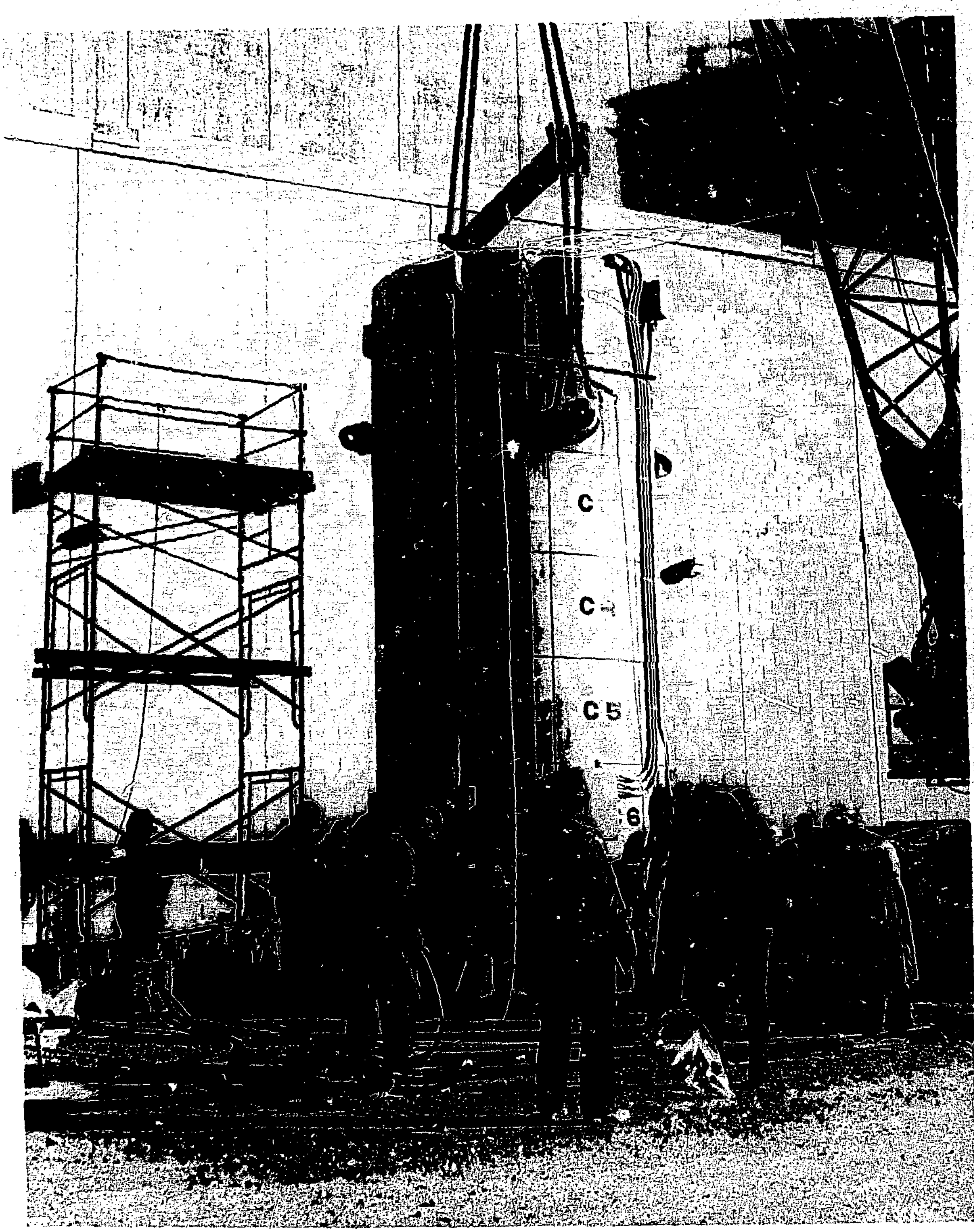


Figure 5. Sealed Storage Cask Containing Canister Package Being Lowered onto Foundation Pad by a Mobile Crane

Spent Fuel Assemblies

The four fuel assemblies used for the SFHPP Demonstration were from the Turkey Point Reactor Unit No. 3. These assemblies were shipped dry, one at a time, in a NAC-1 shipping cask from the Turkey Point plant to the Battelle Columbus Laboratory for initial characterization, and then shipped to the Nevada Test Site.

These fuel assemblies are 15 x 15 lattice array, Westinghouse assemblies containing fuel rods with Zircaloy cladding. These assemblies were chosen on the basis of providing the desired decay heat level of slightly above 1 kW at the time of emplacement. Some of the characteristics of these fuel assemblies are listed below.

TABLE 1: PWR FUEL ASSEMBLY CHARACTERISTICS

Total Assembly Length	4.1 m (161.3 in.)
Assembly Cross-Section	21.4 cm (8.43 x 8.43 in.)
Active Fuel Length	36.6 cm (144 in.)
Total Assembly Weight	~ 635 kg (1400 lbs.)
Initial Uranium Loading per Assembly	457 kg (1007 lbs.)
Initial U-235 Enrichment	2.56 w/o
Fuel Burnup at Time of Discharge from Reactor	~ 25,000 MWD/MTU
Date of Refueling Shutdown	October 25, 1975
Decay Heat Level at Time of Emplacement into Storage at E-MAD	~ 1.1 kW

Canister

The canister design can accommodate either one PWR assembly or two BWR assemblies, depending on the particular internal cage assembly used. The PWR canister, shown in Figure 6, consists of the canister body and the closure lid.

The canister body is made up of the main body, an ellipsoidal end cap, and the upper body. The main body is a standard 35.6 cm (14 in.) O.D., 9.5 mm (.375 in.) wall, Type 304 stainless steel pipe 39.1 cm (154 in.) long. A standard 9.5 mm (.375 in.) wall, stainless steel ellipsoidal end cap is welded to the bottom of this pipe. A cruciform-shaped fixture fabricated of 19 mm (.75 in.) thick stainless steel is welded into the end cap. This fixture supports the PWR fuel assembly and serves as a loosely toleranced keyway into which the fuel assembly bottom nozzle fits. The upper body consists of 35.6 cm (14 in.) O.D., 23.8 mm (0.937 in.) wall, 304 stainless steel pipe approximately 22.9 cm (9 in.) long. This section is welded to the top of the main body and contains all the machined mating features for the closure lid. Welded to the inside of the canister body is a stainless steel fuel assembly support cage which provides lateral support over the entire length of the fuel assembly. Thermocouple wells are attached to the outside of the canister body to receive thermocouples after the canister is placed into a storage configuration.

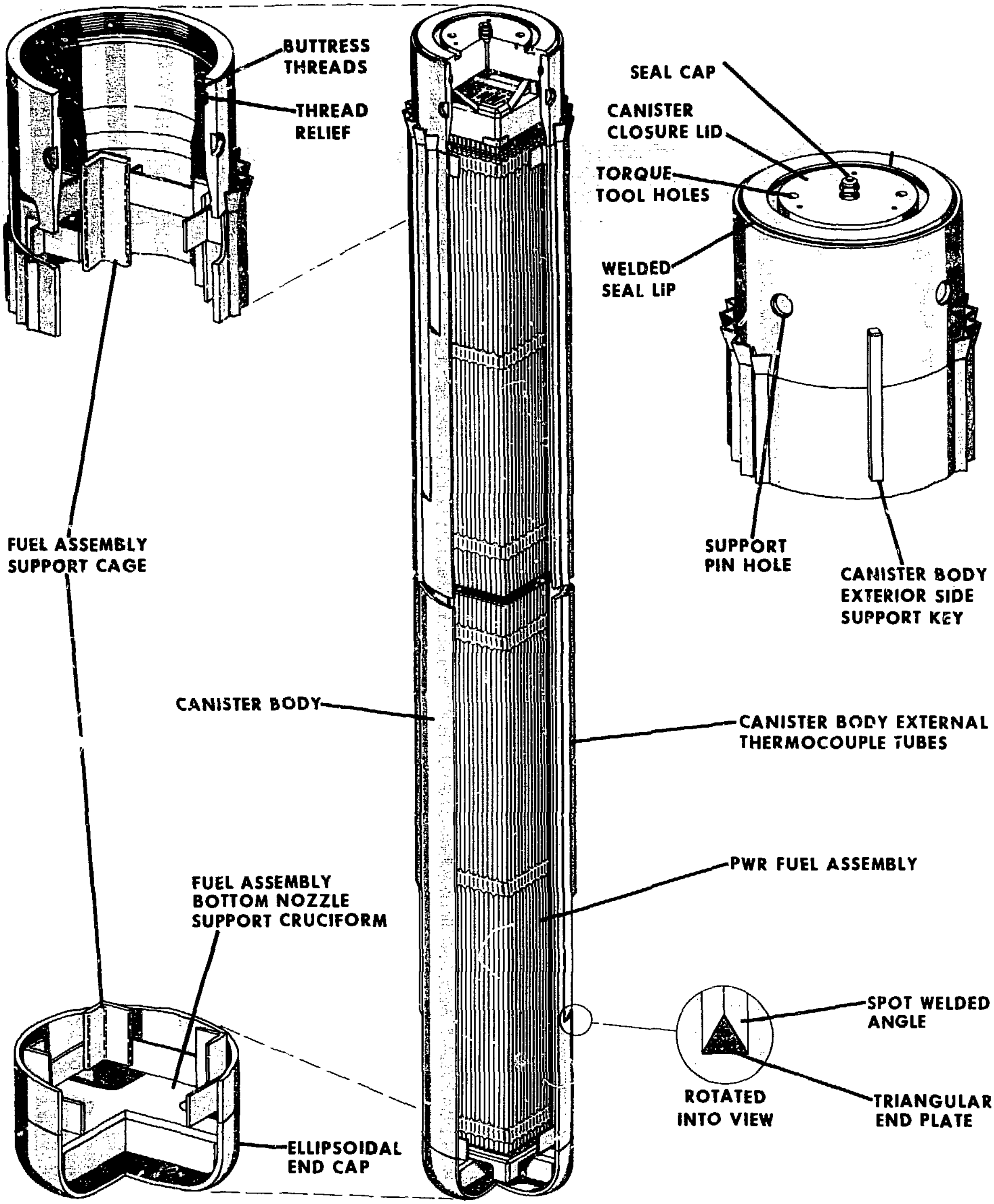


Figure 6. SFHPP Demonstration Canister

The closure lid of the canister assembly, shown in Figure 7, is basically a flat disc, 8.9 cm (3.5 in.) thick and 31.7 cm (12.5 in.) in diameter of Type 304 stainless steel. This disc has approximately 2.54 cm (1 in.) of buttress threads machined near the top, which mate with threads machined into the canister upper body. The top outside surface of the closure lid is machined to form the weld preparation for the seal weld made after the fuel assembly is installed. Features on the top surface of the closure lid include a machined groove for the mounting of the seal welding machine and aligning it with respect to the machined weld preparation, holes into which the closure lid lifting and torquing fixtures fit, and a fitting with a mechanically sealed cap through which helium is introduced into the canister. The bottom portion of the closure lid serves as a lead-in for the installation of the lid into the canister body.

Shield Plug

The shield plug, shown mated with the canister in Figure 8, is a standard 50.8 cm (20 in.) O.D. carbon steel pipe approximately 85.4 cm (34 in.) long with a 2.54 cm (1 in.) thick steel plate welded to the top and bottom. The volume between the two end plates is filled with concrete for shielding. Extending from the bottom plate of the assembly is a standard 40.6 cm (16 in.) O.D., 2.54 cm (1 in.) wall, carbon steel pipe approximately 30.5 cm (12 in.) long. This pipe extension contains four tapped holes 90° apart which accept the

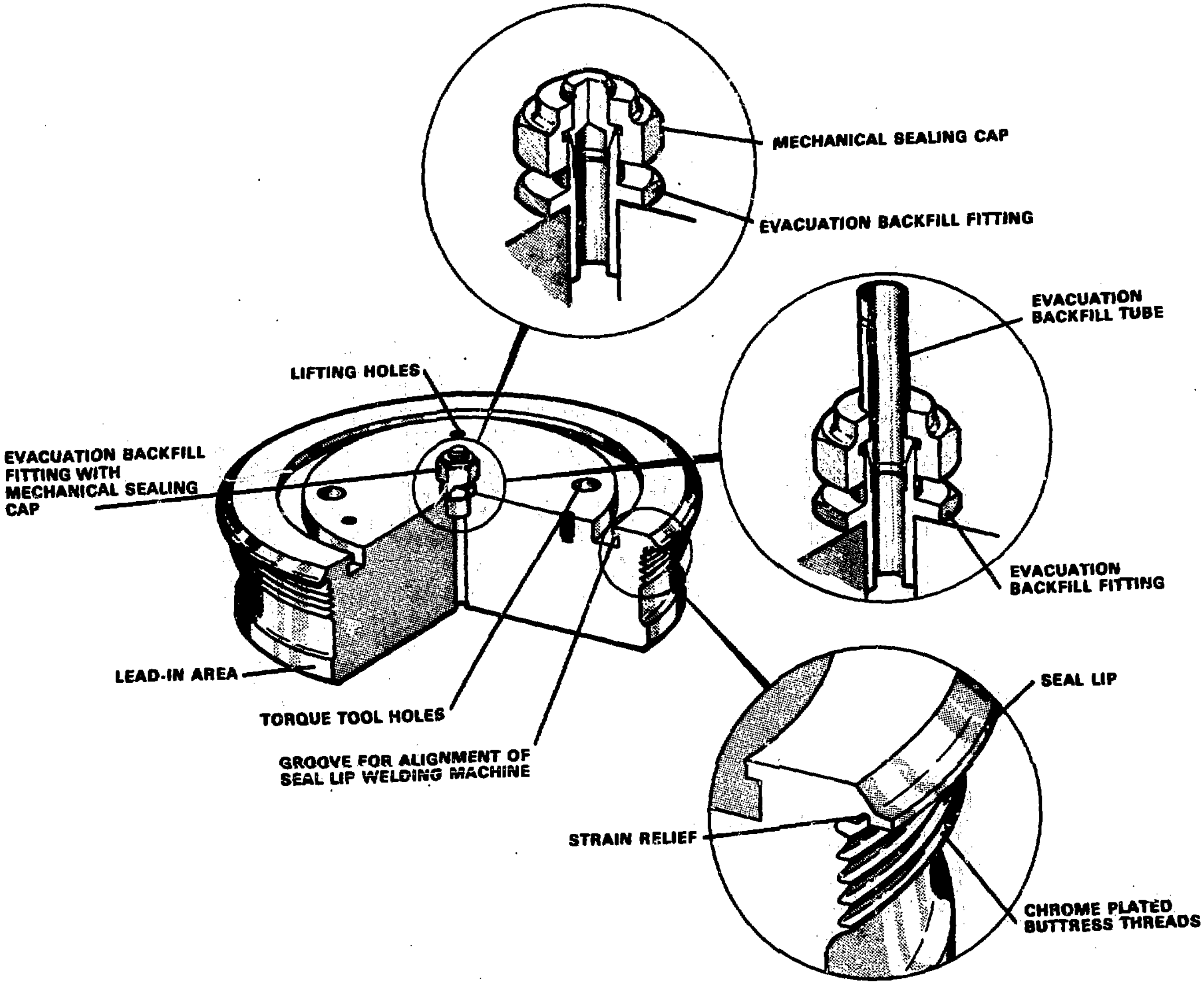


Figure 7. Canister Closure Lid

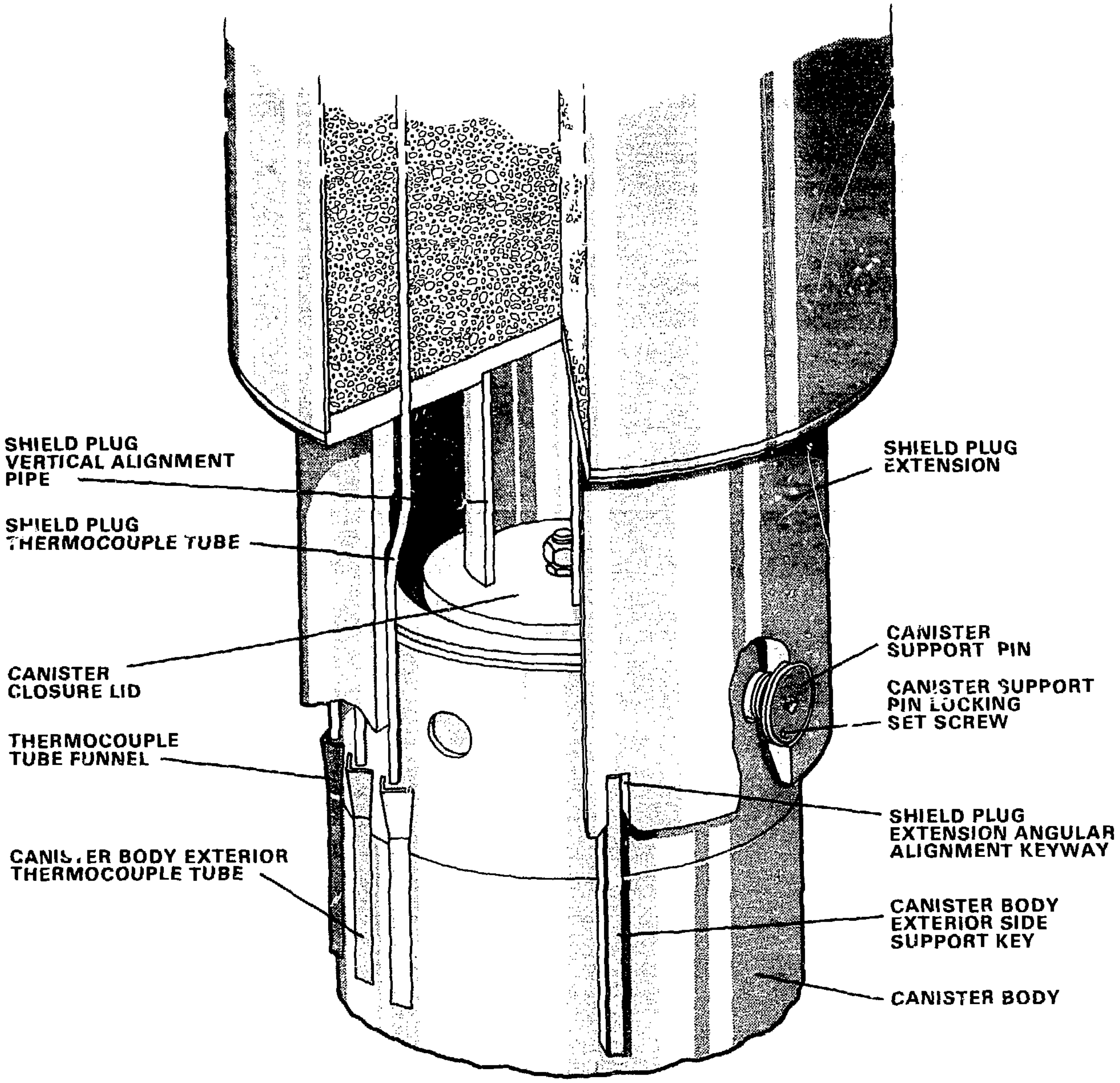


Figure 8. Canister and Shield Plug Mating Arrangement

canister support pins. It is through these pins that the canister is secured to the shield plug. The pins protrude from the inside of the extension into four flat-bottomed holes in the upper portion of the canister. During canister package handling operations, a lifting bail is bolted to the top plate of the shield plug. This bail is removed after the canister package is emplaced in the lag storage pit, a drywell, or a sealed storage cask.

Canister Package Mechanical Testing

As part of the SFHPP Demonstration development work, a shaker table test was performed which imposed E-MAD design basis earthquake loadings (corresponding to a horizontal ground acceleration of 0.7 g) on a prototype drywell liner, canister, shield plug, and a dummy fuel assembly configuration. The test arrangement is shown in Figure 9. Post-test inspections were performed on test article components including the dummy fuel assembly. These inspections included visual examinations, dimensional checks, and liquid penetrant inspections of welds. These inspections showed that the total amount of wear and impact damage on the test article components was negligible. Thus, the canister will retain its leak-tight integrity when subjected to a seismic event having an intensity greater than that simulated by the test.

In addition to the seismic test, a hydrostatic test of a sealed canister was performed. This test qualified the canister design for a pressure of 2070 Kpa (300 psi) at 371°C (700°F).

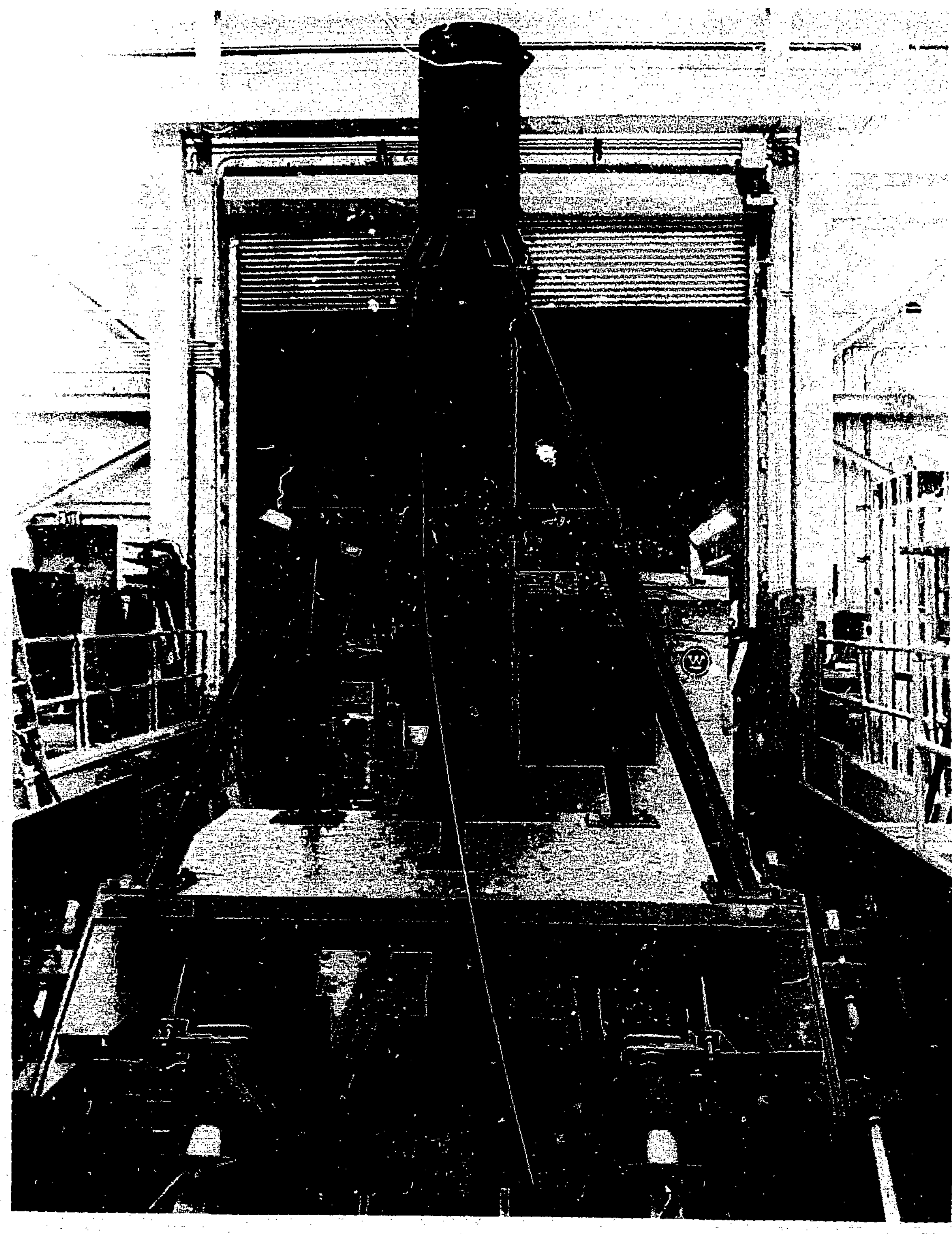


Figure 9. Prototype Canister Package in Drywell Liner on Shaker Table for Seismic Testing

LAG STORAGE PIT

The most significant modification to the E-MAD Hot Bay was the lag storage pit as shown in Figure 10. The lag storage pit is utilized to store spent fuel assemblies in canisters prior to final closure welding and during the interval before final storage emplacement. The pit is below the Hot Bay floor adjacent to the west wall and has a storage capacity of 24 canisters, arranged in three separate 2 x 4 arrays as shown in Figure 10. The three individual concrete lined vaults are 6.8 m (22.5 ft.) deep by 3.6 m (11.7 ft.) long by 1.7 m (5.7 ft.) wide, are separated by 73.7 cm (29 in.) thick concrete walls, and are capped by 116.8 cm (46 in.) thick concrete top shields. Each top shield contains eight stepped, steel-lined holes for shield plugs which support the canisters containing fuel. Within each vault the center to center canister spacing is 91.4 cm (36 in.). This spacing is sufficient to preclude achievement of criticality under any flooding condition. A steel seismic grid structure is provided in each vault to give lateral support to the canisters under seismic conditions and assure that spacing will be maintained.

The Lag Storage Pit is designed to be cooled by natural circulation, but fans are provided to enhance cooling. Hot Bay air enters the vaults 6.4 m (21 ft.) below floor level through nine individual pipes connected to a common 91.4 cm (36 in.) diameter inlet manifold. This inlet manifold is connected to a 91.4 cm (36 in.) diameter downcomer at each end of the pit. Air exits the vaults 1.3 m (51 in.) below floor level through nine 45.7 cm (18 in.) diameter exhaust pipes which terminate 3 m (10 ft.) above floor level. The

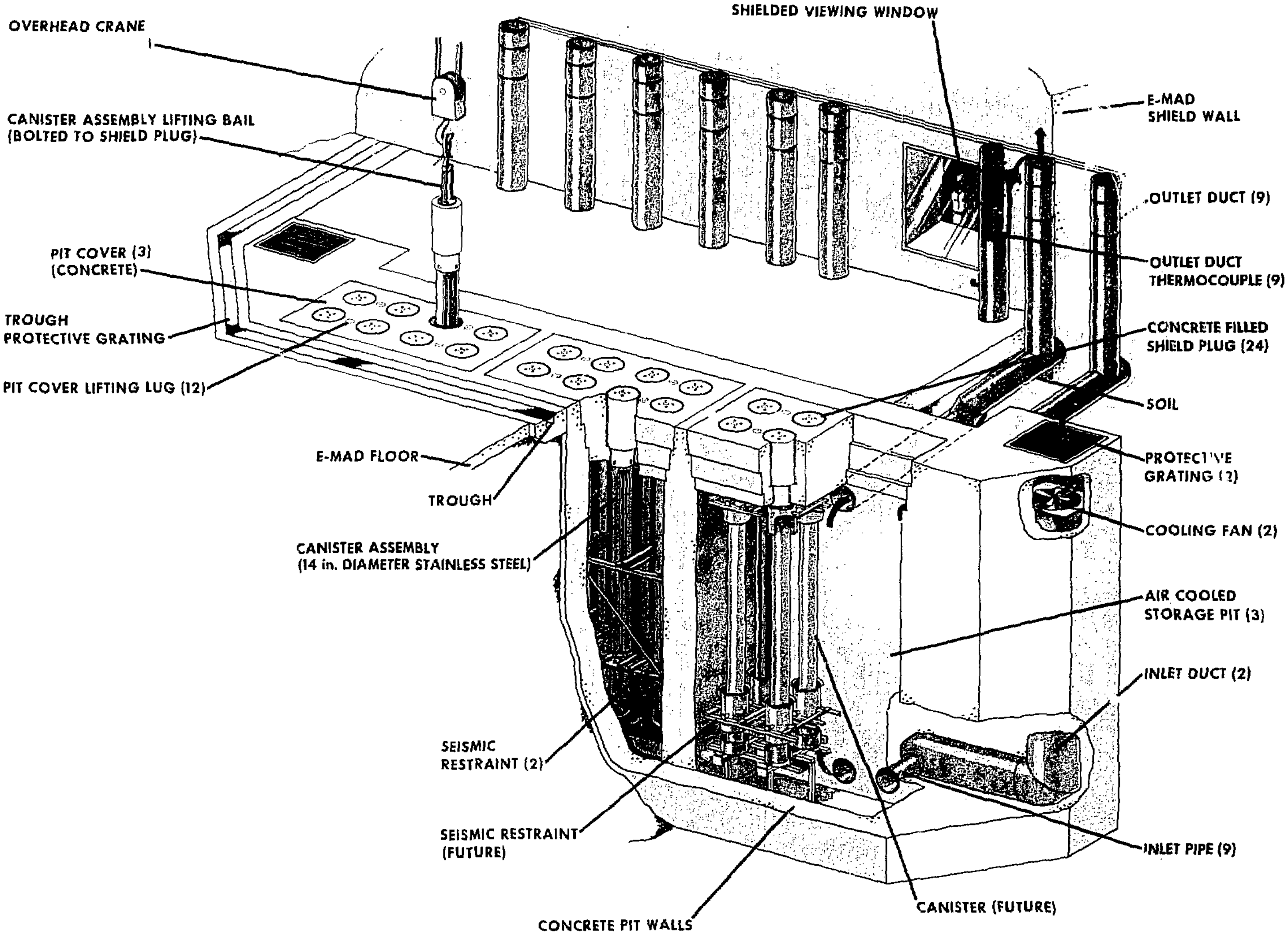


Figure 10. E-MAD Lag Storage Pit

exhaust ducts have multiple bends to reduce radiation streaming. The pit was designed to accommodate 24 fuel assemblies each having a decay heat level of 3 kW.

STORAGE CELL LOCATIONS

Additional modifications were made outside of the Hot Bay to provide the storage site for the encapsulated fuel. Two concrete sealed storage casks and associated support pads were constructed adjacent to the west side of the E-MAD building as indicated in Figure 11. Four drywells were also constructed west of the E-MAD building. Because the existing railroad equipment was to be used to move a fuel canister from the Hot Bay to the drywells, the drywells are centered between the rails of a new rail spur which ties into the existing trackage north of the E-MAD building as shown in Figure 11. An additional switch was installed to permit construction of an additional rail spur, parallel to and west of the new spur, to permit future expansion of the storage site if desired. The three northernmost drywells on the new spur are spaced 7.6 m (25 ft.) apart while the southernmost drywell is 15.2 m (50 ft.) from the adjacent drywell. The 15.2 m (50 ft.) spacing provides thermal isolation from the other drywells while the 7.6 m (25 ft.) spacing is prototypical of a full scale facility.

WELD PIT

The weld pit, shown in Figure 12, is a remote work station to accomplish closure lid installation, seal welding, weld inspection, leak checking, and shield plug attachment. The functional requirements for the weld pit were:

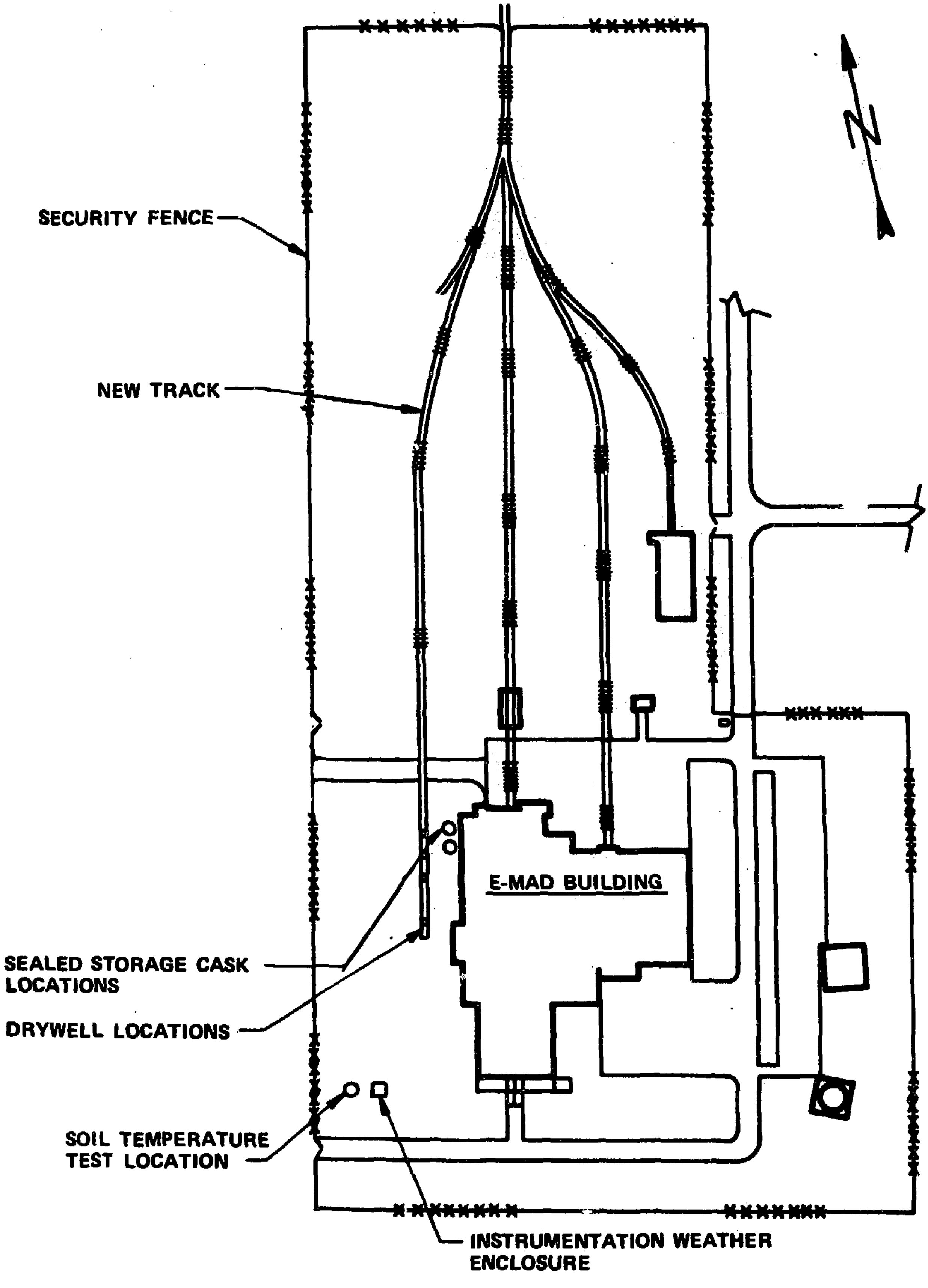


Figure 11. Locations of SFHPP Demonstration Drywells and Sealed Storage Casks

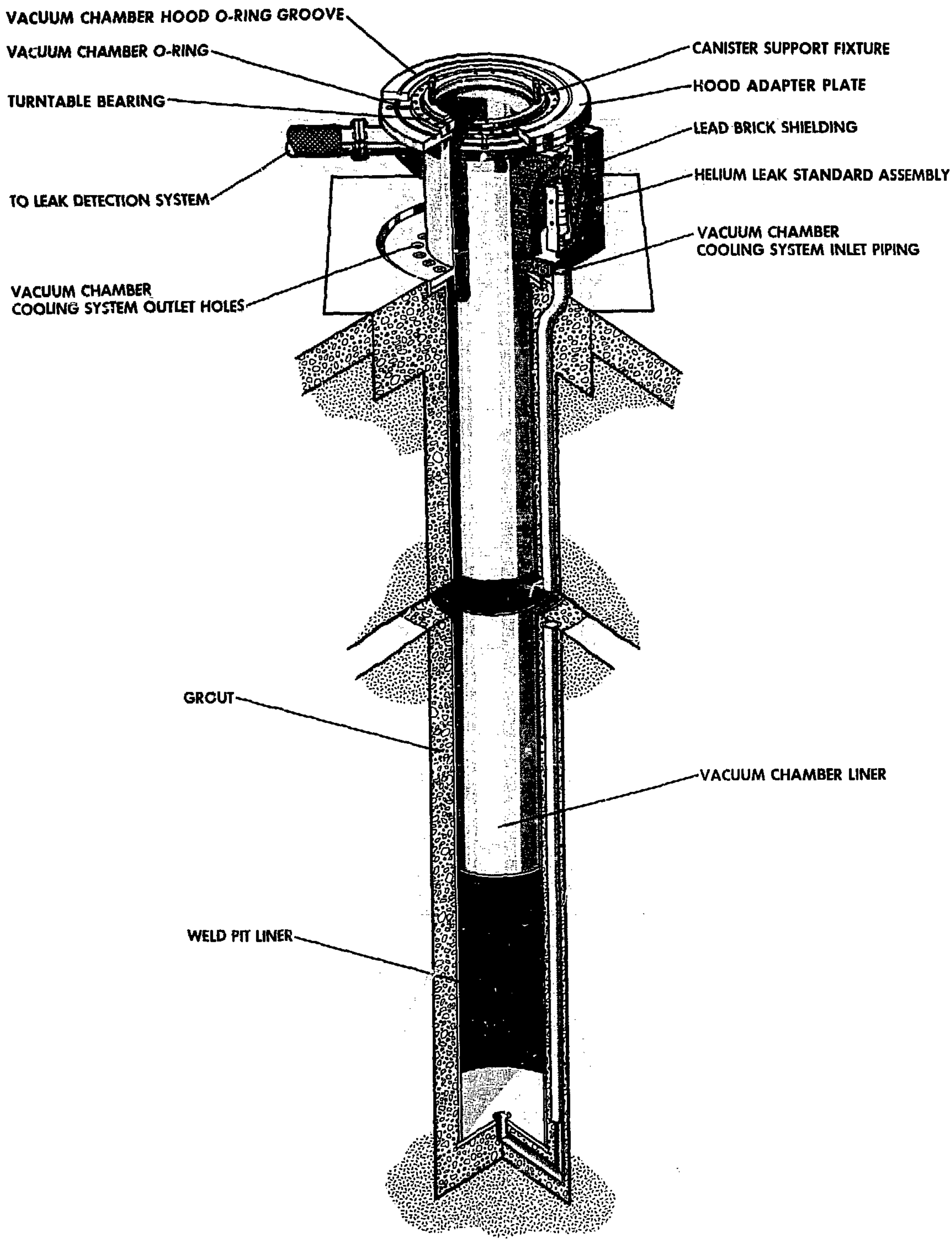


Figure 12. E-MAD Weld Pit Configuration

- Provide a work station with rotational capability and visual access to the top of the canister from the first floor operating gallery and located within reach of the master slave and Wall Mounted Handling System manipulators and the main Hot Bay crane.

- The depth and diameter will accommodate known and projected PWR and BWR fuel assembly canister sizes.

- Provide a vacuum chamber with a removable top for leak checking of the sealed canister.

- Provide a means of cooling a fuel canister to limit the canister closure temperature to 149°C (300°F), for fuel assembly decay heat levels up to 3 kW, during welding and leak testing operations.

The weld pit is located in the southeast corner of the Hot Bay 1.8 m (6 ft.) out from the east gallery wall. The 5 m (16.5 ft.) long pit liner is flush with the Hot Bay floor and was fabricated from 61 cm (24 in.) diameter, Schedule 20, carbon steel pipe with a flat steel plate welded to the bottom of the pipe. The liner was grouted into a 91.4 cm (36 in.) diameter hole drilled through the Hot Bay floor. A 97.8 cm (38.5 in.) diameter flange is welded to the upper end of the liner to provide support for the vacuum chamber. A 76 mm (3 in.) diameter pipe, welded to the bottom plate of the liner and running parallel with the liner vertical axis, provides a forced air cooling path.

The canister is supported in the weld pit by two lugs, welded to the canister body, which mate with corresponding slots in the upper structure of the vacuum chamber. The upper support structure is mounted on a large bearing set in the main flange which allows rotation of the canister by the master slave manupliators during most of the weld pit operations. The vacuum chamber is bolted to the pit liner through a flange connection. The flange contains holes to allow cooling air to exit the annulus between the vacuum chamber and the pit liner. With this configuration, the top of the canister is .9 m (3 ft.) above the Hot Bay floor and canisters of different lengths (up to 5.9 m (19.5 ft.)) can be accommodated while maintaining the top of the canister at the same elevation.

CANISTER WELDING SYSTEM

Sealing of the canister is accomplished by fusion welding of a small lip, machined as part of the closure lid, to the top surface of the canister body. This fusion weld is accomplished by a fully contained welding machine, Figure 13, designed specifically for remote operation on a cansiter.

The welding machine consists of a gas-cooled TIG torch attached to a support frame which is driven about the center of the closure lid via a planetary gear arrangement. The torch position (axial, radial, and angular)

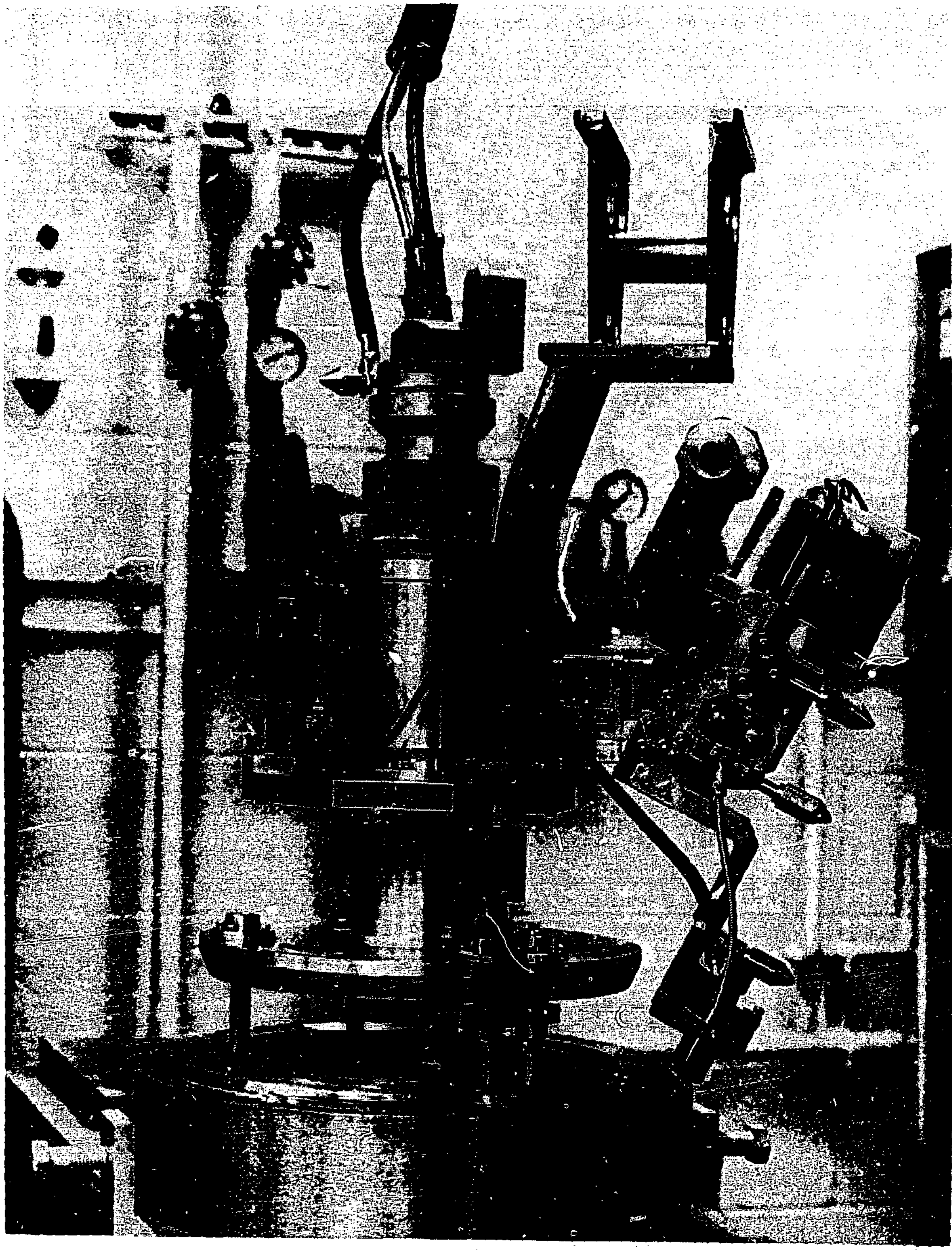


Figure 13. Canister Closure Lid Welding Machine

can be controlled and adjusted remotely from the power supply located outside the Hot Bay. The welding machine has special quick disconnect fittings for gas and weld current and a special cartridge assembly for a weld filler wire spool (not used for the fusion weld). The power, control, and gas supply lines for the welder are supported from a boom assembly located on the Hot Bay wall above the weld pit. These lines are connected to the power supply unit in the operating gallery through pass-throughs in the shield wall and through electrical connectors in the wall.

The welding machine interfaces with the closure lid seal lip by means of an "L" shaped groove machined into the top surface of the lid concentric with the seal lip (see Figure 7). The groove depth controls the elevation of the welding machine above the closure by way of three flat-bottom pins attached to the welding machine, which sit inside the groove. Three cam type locks, which fit into the groove, are rotated into the outside edge of the groove and under the small groove flange to secure the welding machine to the closure. The machining tolerances for concentricity between the groove and the seal lip are such that positioning and locking the machine in the groove automatically locates the welding torch in the proper radial position to make the weld.

EVACUATION AND BACKFILL SYSTEM

The canister evacuation and helium fill system is shown schematically in Figure 14. The system components are mounted on a mobile cart located in the Hot Bay near the weld pit. The helium supply and canister vacuum pump are connected by aluminum and stainless steel tubing and fittings through a series of electrically operated solenoid valves and a pressure sensor to a flexible stainless steel hose. This hose is attached to the fitting on the canister closure lid using the Wall Mounted Handling System. The pump and valves are remotely operated from a console located in the operating gallery. The pump inlet and exhaust are filtered to capture any radioactive particulates that might be drawn from the spent fuel assembly and to trap any oil expelled from the pump. Once the canister is evacuated, the valve to the pump is closed and the helium supply valve is opened. The helium bottle supplies helium at one atmosphere to the canister. After helium filling is complete, the flexible steel hose is removed and the fitting on the closure lid capped and torqued.

LEAK CHECK SYSTEM

The major components of the leak detection system, shown schematically in Figure 15, are the roughing pump attached to the weld pit vacuum chamber by a stainless steel tube to draw the initial vacuum around the canister; a mass spectrometer type helium leak detector to check for leakage of helium out of the canister; and a helium leak standard to check the calibration of the system. The roughing pump, vacuum blower, and associated valves and piping are mounted on a mobile cart located near the weld pit. The helium mass spectrometer leak detector located in the operating gallery is connected

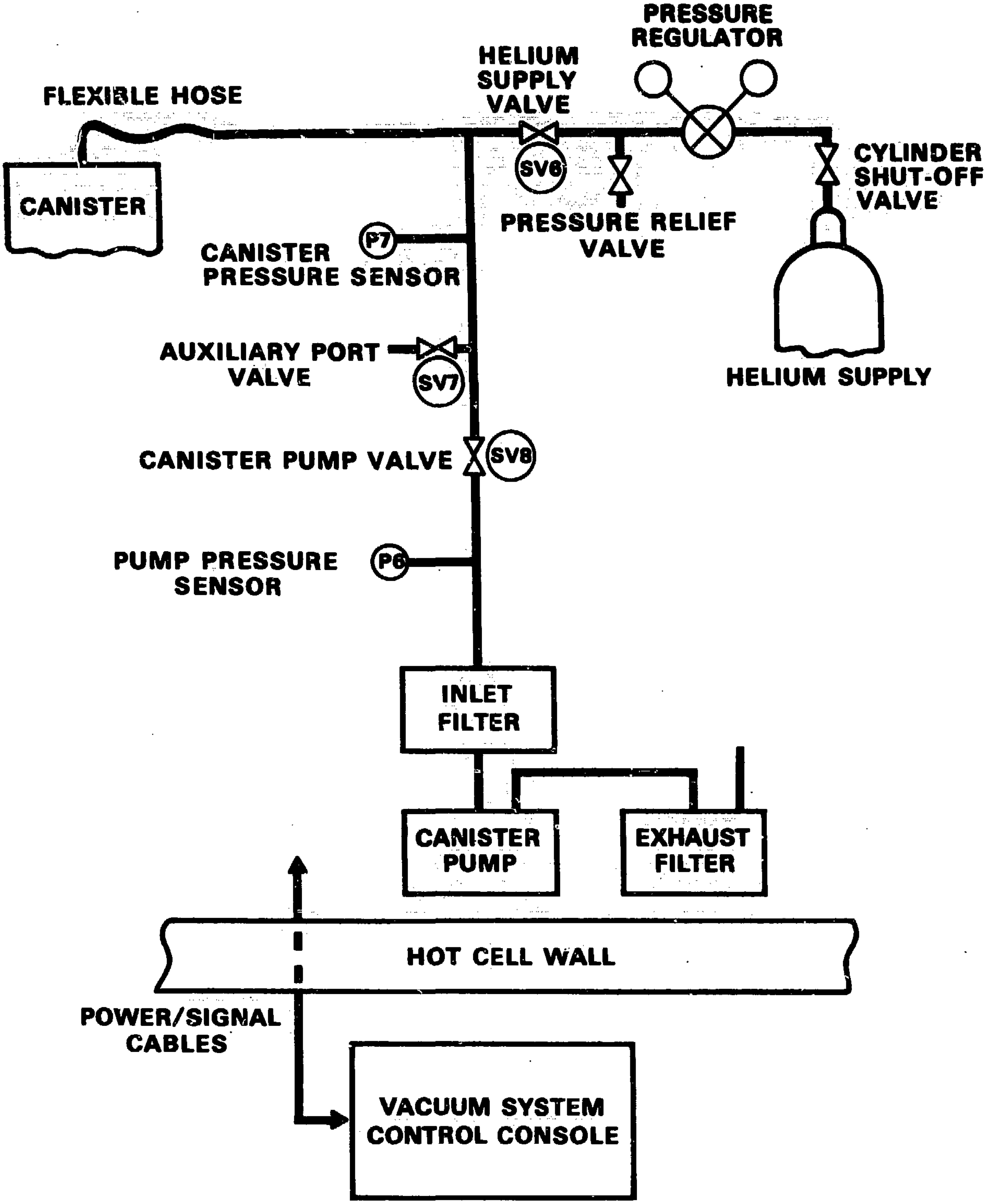


Figure 14. Schematic Diagram of the Canister Evacuation and Helium Fill System

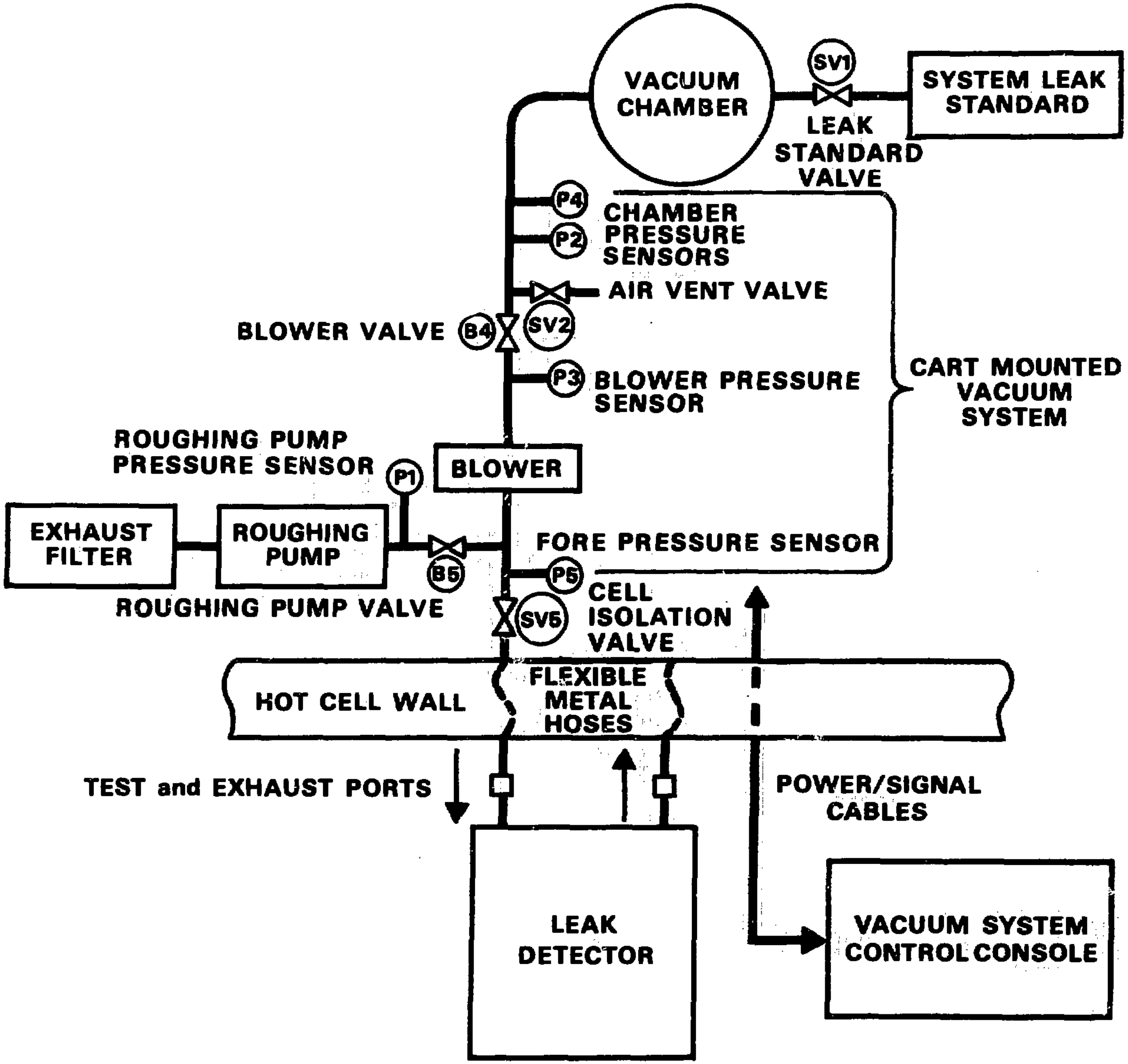


Figure 15. Schematic Diagram of Canister Leak Detection System

ahead of the roughing pump by a flexible stainless steel tube passing through the concrete shield wall. The roughing pump and leak detector exhaust into the Hot Bay. A helium leak standard is mounted near the weld pit and connected to the opposite side of the vacuum chamber from the roughing pump by a stainless steel tube. The standard leak is valved such that helium from that source is only supplied when needed. Lead shielding is provided between the equipment cart and the weld pit to protect system components from the effects of radiation from the fuel assembly in the weld pit.

The roughing pump draws a vacuum to seal the vacuum chamber and evacuates the chamber to a pressure of less than 0.5 millimeters of mercury at which time the electrically operated valve is activated to open the vacuum chamber to the mass spectrometer. The helium leak standard is opened and the combined standard leak and canister leak rates measured. The helium leak standard is then isolated and the canister leak rate alone measured. When the leak check is completed and the canister helium leakage is found to be less than 10^{-5} atm-cc/sec, the vacuum chamber is vented and the chamber hood removed.

TRANSPORT SYSTEM

The existing Railroad Transportation System (RTS), developed originally to support the nuclear rocket program, was adapted for use in the SFHPP Demonstration. The RTS consists of standard-gauge trackage, connecting E-MAD with other test areas within Area 25 of the Nevada Test Site, together with specially designed rolling stock and car couplers. The rolling stock is composed of the Manned Control Car (MCC), the Engine Installation Vehicle Vehicle (EIV), the L-3 Prime Mover, and other miscellaneous vehicles. The

MCC, EIV, and L-3 locomotive were coupled together as a train, to move unshielded, highly radioactive, spent rocket engines from engine test stands to the E-MAD facility. This same train configuration, shown in Figure 16, was used in the SFHPP Demonstration to transfer a canister package between the Hot Bay and a drywell.

The Manned Control Car (MCC) is a specially designed, 107-ton, shielded two-man control cab locomotive equipped with controls for operation of the Railroad Transport System. The MCC control system controls the MCC, EIV, and L-3. Utilizing a remote hookup to the L-3 controls, the MCC is capable of starting, accelerating, stopping, and shutting down the L-3. In addition, the MCC control system controls all the functions of the EIV. The MCC has diesel engines for traction power and primary electrical power generators. The MCC consists of an undercarriage, two engine compartments, and shielded control cab. The shielded control cab assembly is mounted on the engine compartment structure. Extensive gamma and neutron shielding is provided in the cab walls, roof, and floor. Operational visibility is provided for the two operators by using window assemblies of high-density glass and mineral oil in the front of the cab and high density glass in the cab door. For the nuclear rocket program, the cab shielding was designed to attenuate radiation levels on the order of 1×10^6 R/hr at a distance of approximately 100 feet to less than 25 mrem/hr in the cab. Other features of the MCC include a cab air conditioning system with HEPA filters, an emergency breathing apparatus for the crew, a radiation monitoring system to measure gamma radiation levels inside and outside the cab, and a fire control system for the engine compartments.

The L-3 Prime Mover is 373 kW (500 hp), 72.6 te (80 ton), diesel-electric locomotive that was modified for use in the nuclear rocket program. The L-3 normally provides the tractive force to move the MCC and EIV. However, as indicated above, the MCC does have emergency tractive power should the L-3 fail. The L-3 has a separate motor generator which starts automatically and provides a backup source of electrical power in the event the MCC motor generator fails. The L-3 is normally controlled from the MCC, however, independent operaton is possible. The L-3 also provides compressed air for braking and auxiliary compressed air. The L-3 has a fire control system for the engine compartment similar to that in the MCC.

The Engine Installation Vehicle (EIV) is a specially designed, 18.3 m (60 ft.) long, welded steel flatcar mounted on standard freight car trucks. The car is equipped with special bolsters, leveling jacks, and an inching drive system. The carriage and superstructure were designed for a maximum load of approximately 24,950 kg (55,000 lbs.). For the SFHPP Demonstration, the rocket engine handling equipment on the EIV carriage assembly was removed and replaced with a cylindrical transfer shield and support truss assembly as shown in Figures 16 and 17.

The transfer shield shown in Figure 17 is required to minimize personnel radiation exposure from the canister package during transfer between the transfer pit in the Hot Bay and a drywell in the storage area. The transfer shield/EIV assembly has the following features:

- A winch to raise and lower the canister package.

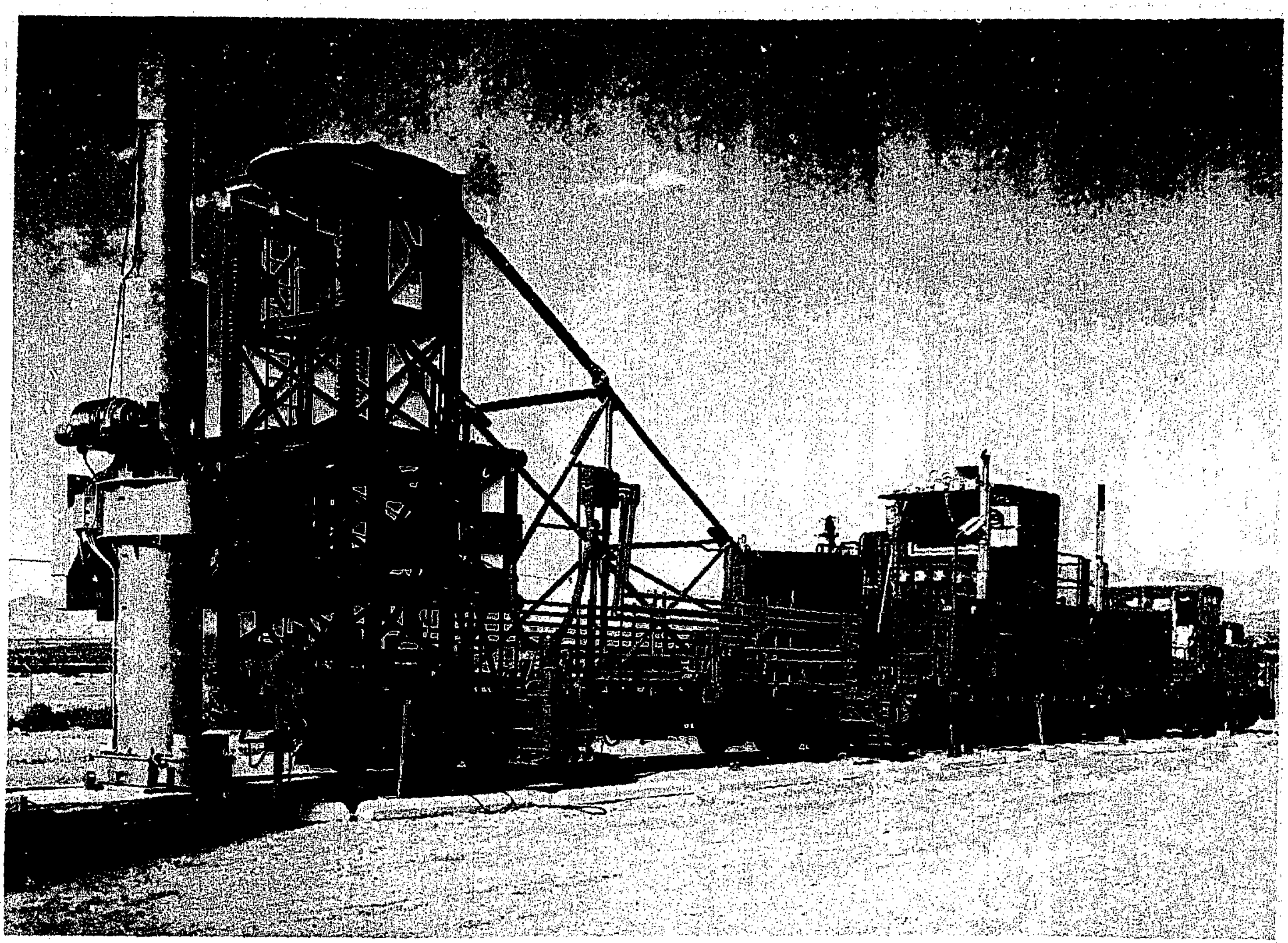
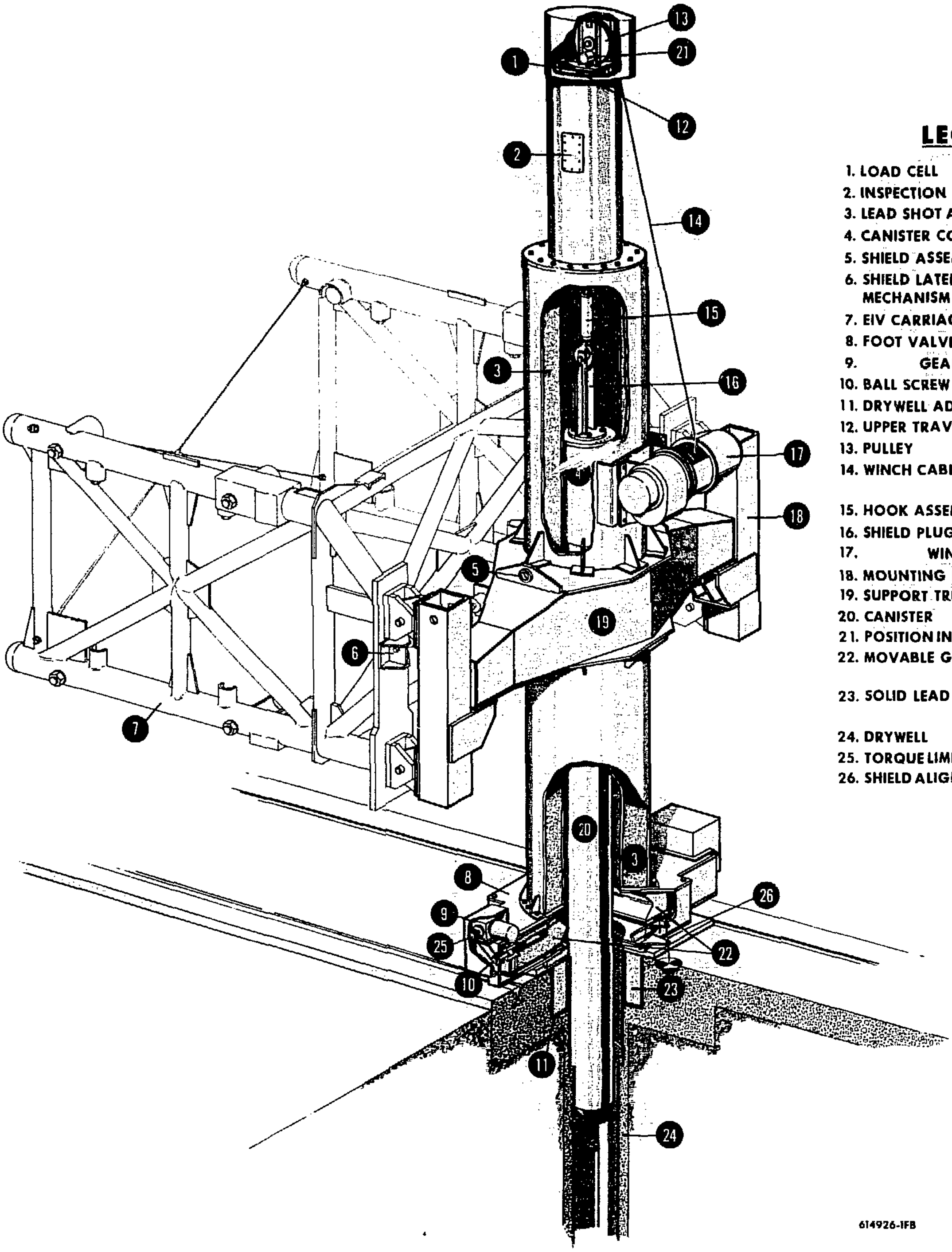


Figure 16. Engine Installation Vehicle After Addition of the Transfer Shield for the SFHPP Demonstration



LEGEND

1. LOAD CELL
2. INSPECTION PORT
3. LEAD SHOT AND OIL
4. CANISTER CONCRETE SHIELD PLUG
5. SHIELD ASSEMBLY LIFTING EYE
6. SHIELD LATERAL ADJUSTMENT MECHANISM
7. EIV CARRIAGE
8. FOOT VALVE ASSEMBLY
9. GEAR MOTOR
10. BALL SCREW
11. DRYWELL ADAPTER
12. UPPER TRAVEL LIMIT SWITCH
13. PULLEY
14. WINCH CABLE
15. HOOK ASSEMBLY
16. SHIELD PLUG LIFTING BAIL
17. WINCH
18. MOUNTING BRACKET
19. SUPPORT TRUSS
20. CANISTER
21. POSITION INDICATOR
22. MOVABLE GATES
23. SOLID LEAD SHIELDING
24. DRYWELL
25. TORQUE LIMITER
26. SHIELD ALIGNMENT POINTER

Figure 17. EIV Transfer Shield Configuration

- A foot valve to open and close the bottom of the shield to permit pickup and discharge of a canister package while providing shielding during transport.

- A carriage drive system on the EIV that can move the shield vertically, longitudinally, and laterally with respect to the EIV.

- An electrical control system to prevent operator error and damage to equipment or exposure of personnel to excessive radiation levels.

The shield assembly consists of two concentric steel cylinders with the 16.5 cm (6.5 in.) annular space between the cylinders filled with lead shot. The lead shot is installed from the top of the shield annulus and is vibrated and tamped into place. The void space in the lead shot is filled with neutron absorbing oil. The shield assembly provides sufficient heat dissipation to the surrounding air to accommodate a fuel assembly with a decay heat level in excess of 3 kW.

The shield support truss is attached to existing mounting holes on the carriage of the EIV. The EIV vertical, longitudinal, and lateral carriage drives are used to position the shield with respect to the transfer pit and a drywell. The total shield assembly is approximately 7.6 m (25 ft.) high and .91 m (3 ft.) in diameter. The foot valve extends approximately .91 m (3 ft.) on either side of the vertical centerline. The transfer shield assembly weighs approximately 22,680 kg (50,000 lbs.).

The winch and cable assembly were designed to raise and lower a canister package having a weight of approximately 1814 kg (4000 lbs.). The winch, with a rated capacity of 2.3 te (2.5 tons), is an electric motor driven hoist attached to the side of the shield assembly (see Figure 17). The cable is a 6 x 37 class, steel core, very high strength, steel cable which has a breaking strength greater than 10.9 te (12 tons). The cable is routed from the hoist drum up to the top of the shield assembly, around 29.8 cm (11.75 in.) diameter sheave, and then down into the transfer shield interior to the hook. The hook assembly will handle a safe working load 10 te (11 tons). The entire lifting mechanism was load tested prior to canister package handling operations to assure adequate operational capability. The hoist has the capability for hand cranking for raising or lowering a canister assembly in the event of power failure.

The foot valve consists of two gates which are filled with a 21 cm (8.3 in.) thickness of lead shot. A "V" shaped interface between the gates limits radiation streaming. Each gate in the foot valve, supported by cam rollers, is individually driven by a 186 watt (.24 hp) electric motor (with gear reducer) connected by a chain drive to a ballscrew. Limit switches control the travel of the two gates and a slip clutch is provided to protect the mechanism in the event of a limit switch malfunction. The foot valve gates also have the capability for hand cranking in the event of power failure.

An electrical control system is provided to permit remote operation of the EIV and the transfer shield components. Control panels are provided in the Manned Control Car (MCC) cab and at the back end of the EIV (opposite end of the EIV from the shield). A third portable control panel can be used to operate the system from the E-MAD gallery when the EIV is located in the Hot Bay. Operation is normally from the MCC panel. The control panels are interlocked such that once control is assumed at one control panel, the other panels are inoperative and neither of the other panels can take over control from the first panel.

An emergency bypass switch is provided on the panel in the MCC and the panel on the EIV, but not on the portable panel. Operation of this key operated switch at either panel bypasses a number of the control system interlocks in the event of a control system malfunction that prevents the canister package from being placed in a "safe" location (transfer pit, drywell, or completely inside the transfer sheild). Activation of the bypass switch in the MCC causes the sounding of an alarm autside the MCC to alert observers to the fact that the system interlocks have been bypassed. An alarm is not sounded if the bypass switch on the EIV panel is activated since this panel is not normally used and observers would be aware of what was being done at the EIV panel if it were being used to control the system.

The electrical control system has a number of automatic interlocks to prevent exposure of personnel to a bare (unshielded) canister during manned access activities. The interlocks and sensing switches limit winch and foot valve travel, limit shield travel via the EIV carriage motion mechanisms, and prevent inadvertent winch, foot valve, or shield motions. Also, indicators provide information to the MCC operator on the weight of the load on the winch cable and the approximate position of the load. Details of the control system are provided in Reference 2.

In addition to the encapsulation and storage cell components, equipment was designed for two supporting experiments called the Soil Temperature Test (STT) and the Fuel Temperature Test (FTT). These tests, together with the thermal data obtained from the STT and FTT as well as the storage cell tests, are discussed separately.[3]

REFERENCES

1. R. J. Bahorich et al., "Spent LWR Fuel Encapsulation and Dry Storage Demonstration," Trans. Am. Nucl. Soc., This Meeting (1980).

2. Safety Assessment Documents for the Spent Fuel Handling and Packaging Program Demonstration at the Nevada Test Site, U.S. Department of Energy, NVO-198, December, 1978.

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ABSTRACT

In conjuction with the Spent Fuel Handling and Packaging Program (SFHPP) equipment has been designed, fabricated and successfully utilized to demonstrate the packaging and interim dry storage of spent LWR fuel. Surface and near surface storage configurations containing PWR fuel assemblies are currently on test and generating baseline data. Specific areas of hardware design focused upon include storage cell components and the support related equipment associated with encapsulation, leak testing, lag storage, and emplacement operations.