FFTF RADIOACTIVE SOLID WASTE HANDLING AND TRANSPORT

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INTRODUCTION

The equipment necessary for the disposal of radioactive solid waste from the Fast Flux Test Facility (FFTF) is scheduled to be available for operation in late 1982. The plan for disposal of radioactive waste from FFTF will utilize special waste containers, a reusable Solid Waste Cask (SWC) and a Disposable Solid Waste Cask (DSWC). The SWC will be used to transport the waste from the Reactor Containment Building to a concrete and steel DSWC. The DSWC will then be transported to a burial site on the Hanford Reservation near Richland, Washington. Radioactive solid waste generated during the operation of the FFTF consists of activated test assembly hardware, reflectors, in-core shim assemblies and control rods. This radioactive waste must be cleaned (sodium removed) prior to disposal. This paper provides a description of the solid waste disposal process, and the casks and equipment used for handling and transport.

FFTF SOLID WASTE

Solid waste is being generated from the LMFBR test program now underway at the FFTF. The stainless steel and inconel materials used to make up the fueled and non-fueled test assemblies are to be removed from the FFTF for disposal on the Hanford Reservation.

Fueled FFTF core components (Fig. 1) that are to be dismantled in the Interim Examination and Maintenance (IEM) Cell are first cleaned in the IEM sodium removal system. This water vapor argon system uses a 150°F (65°C), 2-3% moist argon gas to convert metallic sodium remaining on the core component to sodium hydroxide. This process is then followed by a series of demineralized water rinses to carry away the sodium hydroxide products. Following the final rinse cycle, dry argon is used to remove excess moisture. After sodium cleaning, the pins are removed from the assembly. The remaining assembly hardware (inlet nozzle, duct and handling socket) is placed in one sector of a six-position waste insert.

Non-fueled core components and test assemblies (Fig. 2) are not cleaned in the IEM Cell. The FFTF test assemblies longer than 12 feet (3.7m) are first cut into 12-foot lengths in the IEM Cell. They are then placed into waste inserts and loaded into the SWC.

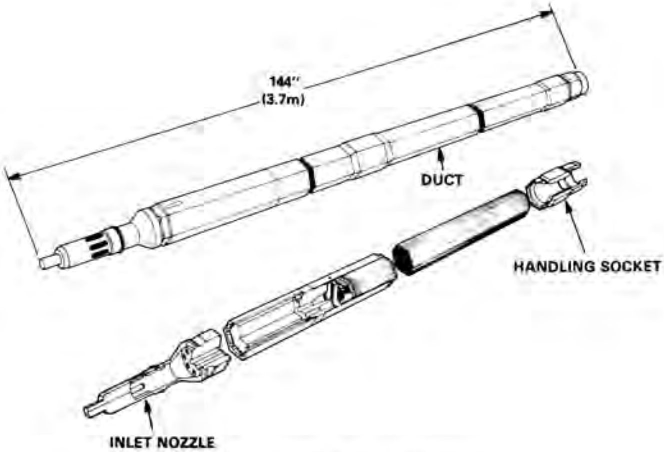

Fig. 1. FFTF FUEL ASSEMBLY

Other non-fueled components (reflectors and control rod assemblies) are loaded directly into waste inserts at the Solid Waste Transfer Pit (SWTP) using FFTF fuel handling systems. The SWTP is a shielded transfer station that is located in a building adjacent to the FFTF containment building. These sodium wetted components are

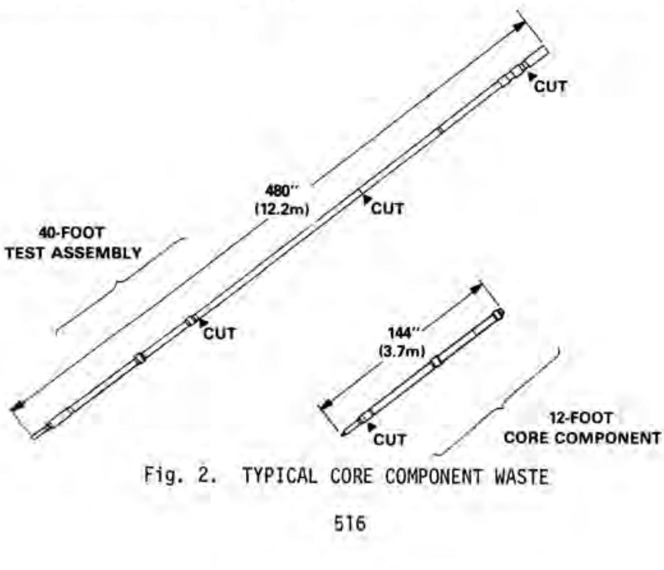

Fig. 2. TYPICAL CORE COMPONENT WASTE

maintained under an argon cover gas. The waste inserts (Fig. 3) are fabricated with a six-position insert. Each sector of the insert is loaded through the use of a turntable system positioned inside the SWTP receiving vessel. Waste inserts with these sodium-wetted components are then transported to the Maintenance and Storage Facility (MASF) in the SWC. The waste inserts are provided with a drain feature at the lower end of the unit. This facilitates sodium removal with the contents still loaded into the waste insert. Activities relating to the handling, transport and subsequent loading of the solid waste into the DSWC are applicable to all types of solid waste identified here, regardless of the origin of the waste or where it is cleaned.

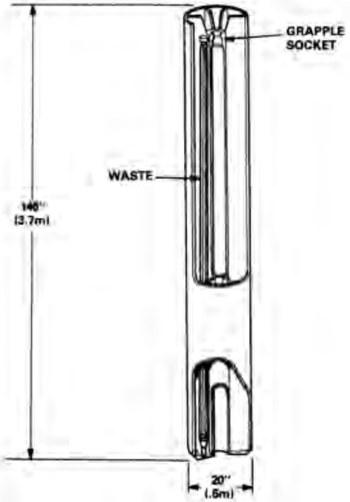

Fig. 3. SIX-POSITION WASTE INSERT

The solid waste material to be removed from FFTF will be predominately stainless steel hardware. In some cases, entire inconel reflector assemblies will also be handled.

The primary radioactivants comprising this solid waste are:

- 312.5-day half-life isotope ^{54}Mn, which results from a (n,p) reaction in iron;
- 71.3-day half-life isotope ^{58}Co, which results from a (n,p) reaction in nickel;
- 115-day half-life isotope ^{182}Ta, which results from a (n,γ) reaction in the tantalum impurity in steel;

and,

- 5.27-year half-life isotope ^{60}Co, which results from both a (n,γ) reaction with the cobalt impurity in steel, and a (n,p) reaction with nickel in both steel and inconel.

Each of these radioisotopes emit relatively high energy photons which require significant amounts of shielding.

HANDLING AND TRANSPORT PLAN

Irradiated solid waste from FFTF core component test activity will be first loaded in solid waste inserts of the type shown in Fig. 3. These carbon steel inserts are approximately 20 inches (0.51m) in diameter by 146 inches (3.71m) long. Each is provided with a grapple handling socket and a six-position divider inside the cavity of the insert. Each one-sixth sector of the waste insert can accommodate one complete twelve-foot FFTF reflector assembly. Each insert occupies a volume of approximately 25 cubic feet ($0.7m^3$).

The solid waste inserts are configured to be handled and transported with the SWC. This cask has the capability to grapple and hoist the waste insert from the floor of the IEM Cell (Fig. 4). The SWC is fitted with an integral valve that mates directly with existing fuel handling floor valves at FFTF. Once loaded, the SWC is lifted from the IEM Cell valve and loaded onto the Multi-Purpose Rail Transporter (MPRT), shown in Fig. 5. The MPRT is used to transport the SWC through the Containment Building Equipment Airlock and into the Reactor Service Buildings adjacent to the FFTF Reactor Containment Building.

The waste insert is loaded into the DSWC at the FFTF Cask Loading Station (CLS). The general equipment arrangement for this operation is shown in Fig. 6. The DSWC is positioned on the elevator of the CLS and is fitted with a shielding adapter. The DSWC closure plug is then removed using a plug handling fixture. With the SWC positioned over the valve, the waste insert is lowered into the DSWC. The closure plug is then installed and secured to the DSWC.

After the DSWC is removed from the CLS, it is secured inside special overpack units and transported 24 miles (38 kilometers) to the Hanford burial site on a special truck transporter. The burial configuration, shown schematically in Fig. 7, provides an asphalt ramp and storage surface for the casks to be stored on 10-foot (3m) spacing. The casks are then buried up to 8 feet (2.4m) below the natural grade of the storage area. Each cask is designed for either above-ground or underground storage, and for retrieval at Hanford for up to 20 years. The six-position solid waste container can be retrieved intact for waste processing and packaging as required to meet required disposal criteria.

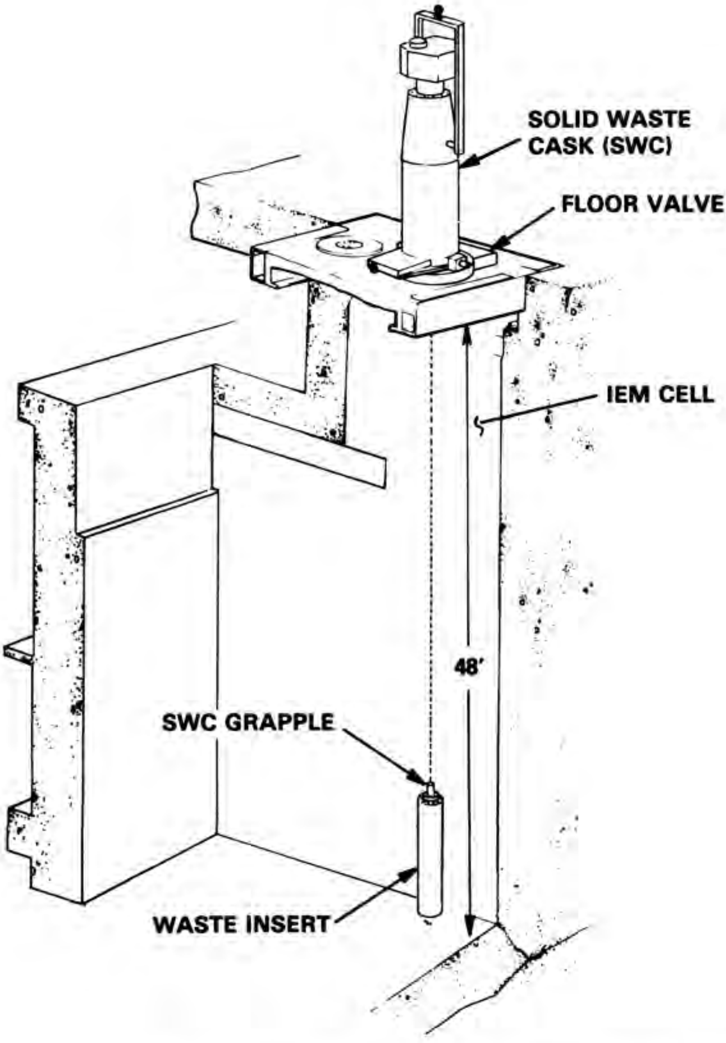

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Fig. 4. INTERIM EXAMINATION AND MAINTENANCE CELL

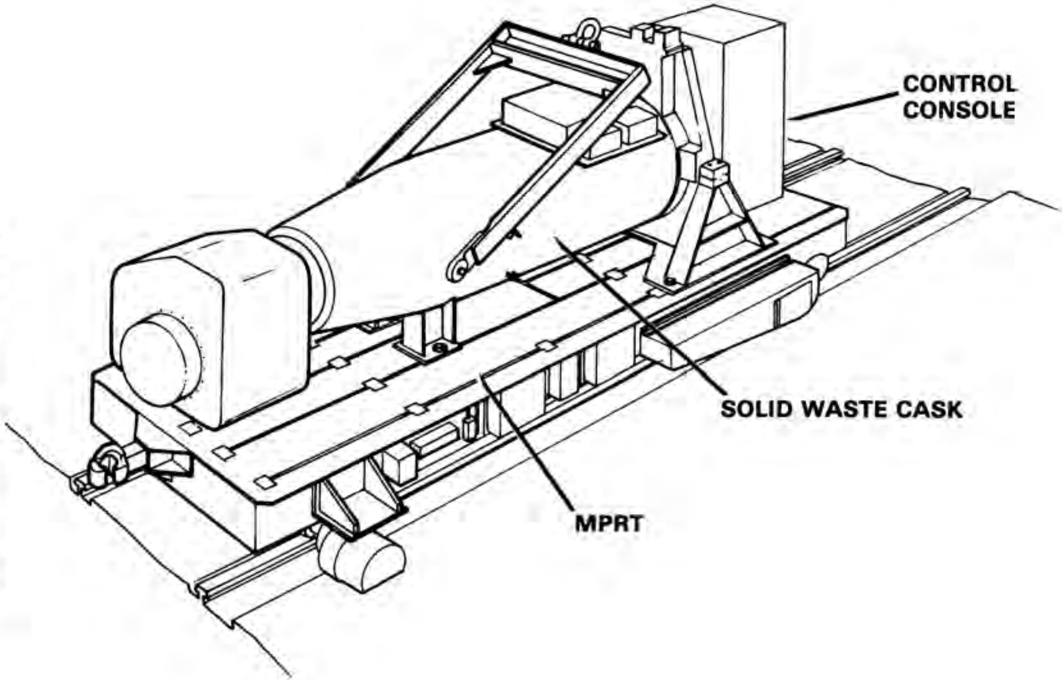

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Fig. 5. SODIUM WASTE CASK ON MPRT

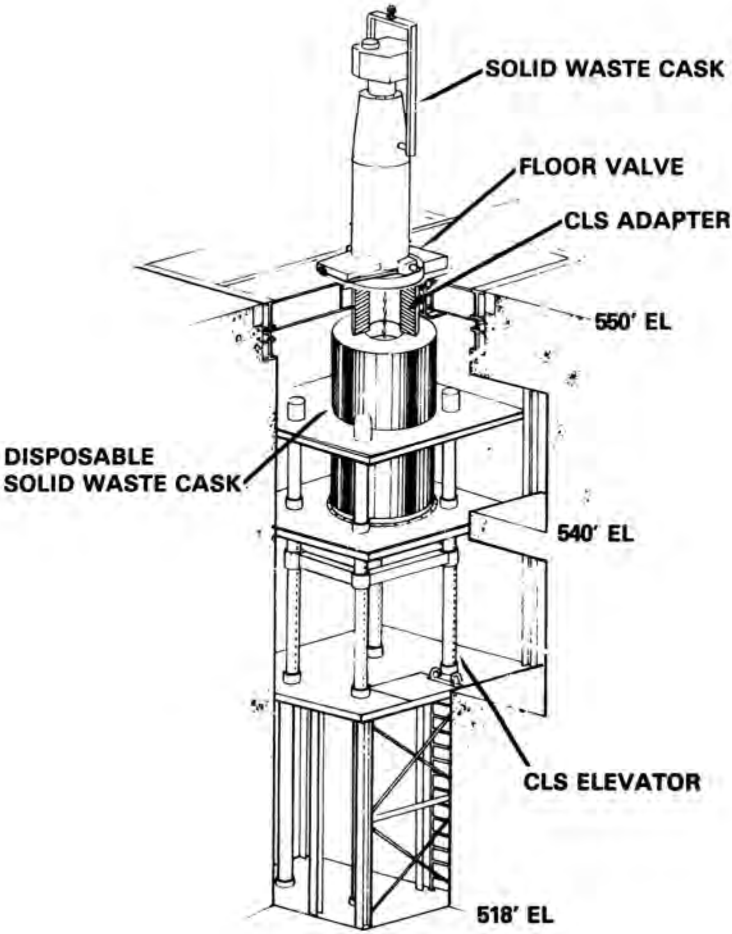

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Fig. 6. CASK LOADING STATION

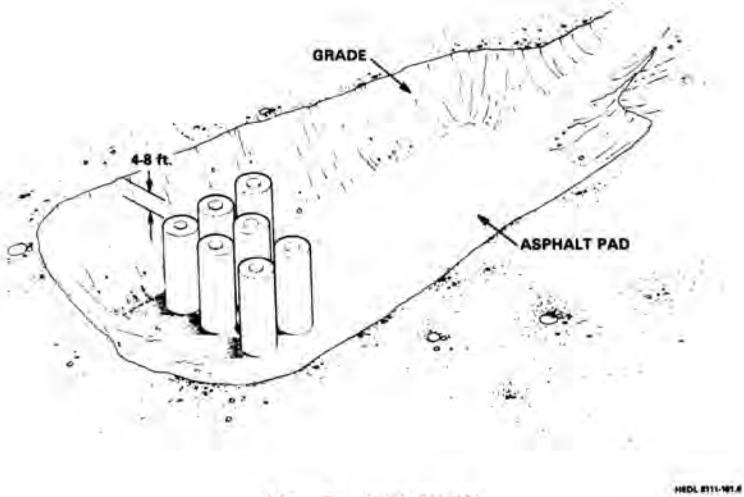


Fig. 7. DSWC BURIAL

SOLID WASTE CASK

The Solid Waste Cask (SWC), shown in Fig. 8, is a steel cask used to handle and transport FFTF solid waste inserts. This cask weighs 98,500 pounds (44,580 kg) and stands 20.5 feet (6.2m) high. The cask system consists of a cask body, closure valve, hoist module and chain locker, control console and pneumatic system. The hoist module consists of a drive motor, drive train, chain sheave, link chain and grapple assembly. Drive components are located outside the pressure boundary to facilitate maintenance and decontamination. The chain locker, located between the cask body and the hoist module, collects the chain during grapple raising operations. The chain locker and grapple assembly contain heavy steel sections to shield against radiation streaming through the top of the cask. The pneumatic system provides the capability to purge and inert the cask cavity with argon and provide a controlled atmosphere during all handling and transportation modes. Shielding of the irradiated waste is provided by 15-inch (0.38m) solid steel in the cask sidewalls, fabricated from a steel forging. This type of construction proved to be more cost effective than a conventional lead-filled steel shell design.

A 22-inch (0.56m) gate valve is provided at the lower end of the cask. The gate valve is provided with a combination translating/elevating mechanism. This facilitates the use of conventional static O-rings to seal the pressure boundary when the valve is closed. The elevating mechanism also actuates locking dogs which

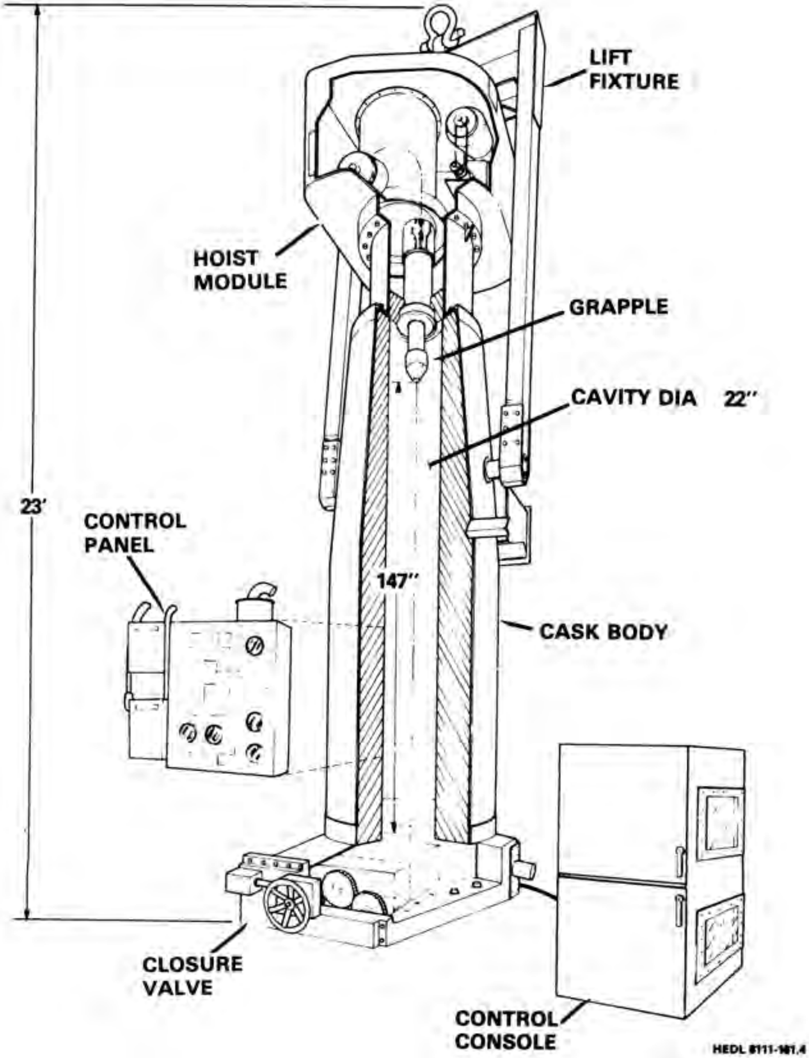


Fig. 8. SOLID WASTE CASK

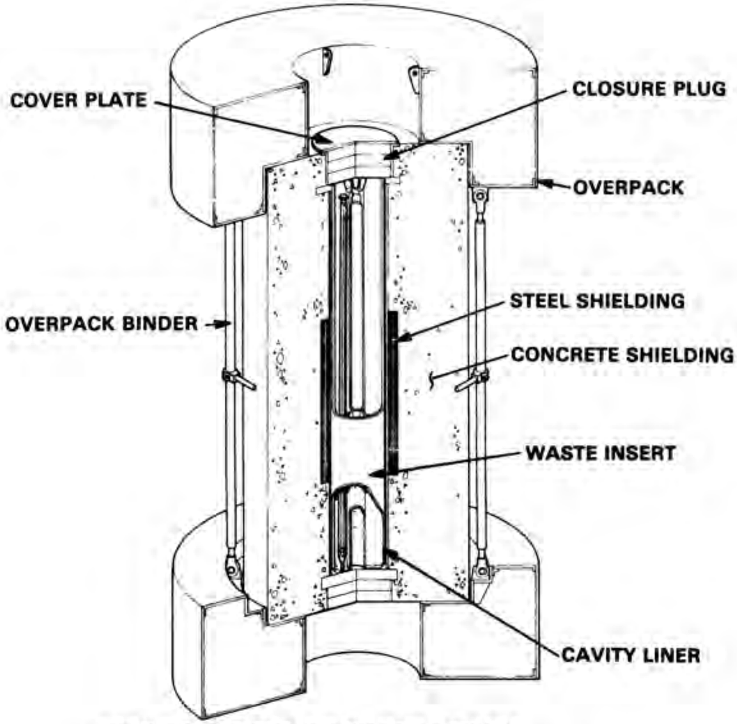
secure the heavy gate during transport of the cask. This feature also prevents the transfer of transportation loads to the gate valve drive members. Heavy steel sections are provided in the valve body and gate for shielding purposes.

The hoist and grapple permit handling of waste containers with the cask in a vertical position. These are remotely operated and controlled by a Programmable Logic Controller (PLC) and computer with a multiple-entry keyboard for programming the various operating parameters. The PLC and computer are housed in a control console detached from the SWC for personnel safety. The SWC provides an integral pressure boundary capable of sustaining a pressurized inert gas atmosphere over the waste. The pressure boundary is designed to prevent the release of airborne radioactive particles or gases. The bottom of the cask is sealed with the manually operated gate valve that was designed to mate directly to a floor valve at each operating station. The cask with payload can be transported either in a horizontal attitude on a transporter or vertically with an overhead crane. When loaded through the IEM Cell ceiling valve, steel solid waste containers are lifted 48 feet (14.6m) from the floor of the IEM Cell.

DISPOSABLE SOLID WASTE CASK

FFTF solid waste is moved from the IEM Cell in waste inserts (containers) through use of the Solid Waste Cask (SWC). The SWC transports these inserts out of the containment building so that they may be loaded into a Disposable Solid Waste Cask (DSWC). The DSWC, shown in Fig. 9, is a reinforced concrete cask fabricated with a carbon steel liner which serves as a pressure boundary. Shielding is provided by the reinforced concrete sidewalls, steel end plugs, the liner and auxiliary shielding around the center portion of the liner. By adjusting the thickness of the radial auxiliary sheilding and the density of the concrete, the DSWC can be configured to accommodate various payload source terms.

Prior to starting the design activity for this cask, a parametric study was conducted to select the most cost effective configuration for the disposal cask. Efforts were made to reduce the unit cost of the disposable portion of the FFTF solid waste handling system and reuse as much equipment and components as possible. For the purpose of this study, two (2) design basis payloads were considered. The first, "Reference," payload was identified to represent the 1512-watt heat load and irradiation source equivalent to six FFTF Reflector Assemblies. The second was identified as "Nominal" payload and was to represent an 800-watt decay heat level equivalent to six driver assemblies without fuel pins. Most of the casks to be procured to support FFTF solid waste handling and related activities will be of the "nominal" type.



CASK DIMENSIONS: 171.5" LONG x 84" DIA
(227.5" LONG WITH OVERPACK)
CAVITY: 147.5" LONG x 22" DIA
SHIELDING: CONCRETE AND STEEL
CASK WT: 100,000 POUNDS WITH PAYLOAD
OVERPACK: RIGID URETHANE FOAM

Fig. 9. FFTF DISPOSABLE SOLID WASTE CASK

Key design parameters selected for the casks were:

- Loaded Weight-----------100,000 pounds (45360 kg)
- Closure Plug Weight-----1,900 pounds (862 kg)
- Outer Diameter----------84 inches (2.13m)
- Cavity Dimensions:
  Diameter--------22 inches (0.56m)
  Length----------147.9 inches (3.75m)

Vertical transport and handling of the DSWC was selected to reduce support equipment costs and the additional handling time. The additional resources necessary to rotate the cask to the horizontal position prior to transport and then up-end it in the field were, therefore, not required.

The DSWC is a top-loading cask and is fitted with a carbon steel closure plug. The plug is designed to be handled remotely using a special plug handling fixture. After the waste insert is placed in the DSWC, the closure plug is installed. The reusable plug handling grappling ring is then removed from the top surface of the cask closure plug. The weight of the plug is sufficient to compress an elastomer gasket beneath the plug. This serves as a temporary seal until a steel retaining cover plate is welded to the top surface of the plug housing. After a check of the closure seal weld, the DSWC is ready to be removed from the cask loading station. Three (3) lift points are provided at the top surface of the cask. Three reusable lifting lugs are bolted to threaded coil loop inserts provided in the top surface of the cask. These inserts are cast in place during fabrication of the concrete cask assembly. The reusable lifting lugs are removed after transport of the cask to the disposal site and returned to storage to be used with the next DSWC.

The DSWC Transporter (Fig. 10) is a specially modified 70-ton (63,500 kg), 10x38-foot (3x11.6m) low boy road trailer. Kickplates and tiedown lugs are provided on the deck of the transporter to secure the DSWC. The DSWC is transported in a vertical attitude with an upper and lower overpack end-cap unit installed. One set of rachet binders is used to secure the overpack units around the cask. A second set of binders ties the overpack-cask assembly to the transporter when loaded; the maximum speed of the transporter is limited to 10 MPH over the twenty-four mile route from FFTF to the disposal site. The approximate size of the complete package is 135 inches (3.4m) in diameter by 222 inches (5.6m) long. The total weight is 126,000 pounds (57,150 kg). The Nominal and Reference DSWC configurations are designed for concrete densities of 145 and 164 pounds per cubic foot (2320 and 2640 kg/m^3), respectively. The auxiliary steel shielding is set at 2.8 and 3.2 inches (81.5 and 81.7mm), respectively. The auxiliary shielding is required only over the center 48 inches (1.2m) of the liner where the gamma ray source is most intense. Above and below this zone, steel studs are attached to the outside of the steel liner to anchor the steel sub-assembly to the reinforced concrete structure. After fabrication of the cask, the exterior surface of the cask is coated with epoxy for moisture protection.

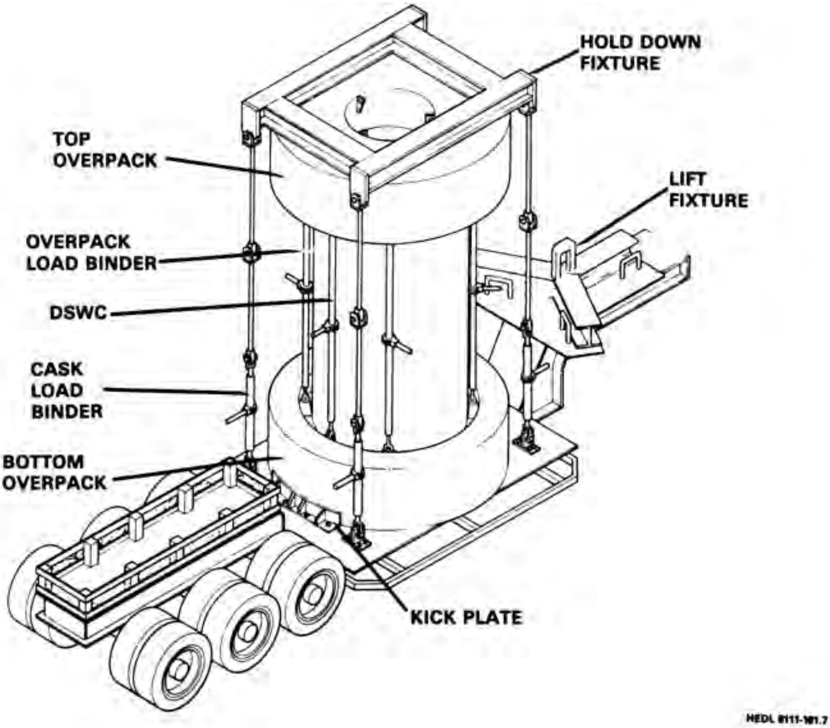


Fig. 10. DSWC WITH TRANSPORTER