DESIGN CONSIDERATIONS, SHIELDED CANISTER TRANSPORTER FOR TRANSPORT OF WASTE CANISTERS AT THE DEFENSE WASTE PROCESSING FACILITY, SAVANNAH RIVER

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ABSTRACT

Waste processing at the Savannah River Plant (SRP) Defense Waste Processing Facility (DWPF) requires that vitrified waste canisters be transferred from the process area to an on-site storage area. The Shielded Canister Transporter (SCT) is a vehicle with a shielding cask which is used for transfer of these canisters.

The SCT is comprised of a self-propelled vehicle with a canister shielding cask and its associated equipment for cask positioning and canister handling. The cask is in a vertical position for bottom loading transfer of canisters from below grade storage areas. The vehicle is operator controlled and the cask and canister handling systems are computer controlled.

INTRODUCTION

The Defense Waste Processing Facility (DWPF) processes high level waste, at the Savannah River Plant (SRP) by vitrifying the waste and placing it in stainless steel canisters for storage. The vitrified glass waste canisters are then stored on-site on an interim basis in the glass waste storage building. The SCT is a self-propelled rubber-tired vehicle with shield cask and associated handling equipment (Fig. 1) which transports the canisters from the DWPF processing facility to the on-site waste storage building.

The SCT is designed for outside, year-round operation on paved roads at the DWPF. The SCT is designed for three round trips of loading and depositing a canister in an 8 hour shift with a maximum travel of 1524m per trip. The SCT is designed for ease of repair with redundant or manual back up systems which are used in the event of a component failure.

One operator controls the SCT while driving the vehicle between buildings with canister loading and unloading carried out by computer control.

SCT Component Description

The SCT is comprised of the following primary components:

- Cask Assembly (Fig. 2) - Provides shielding during opening of the storage hatch and transport of canisters.

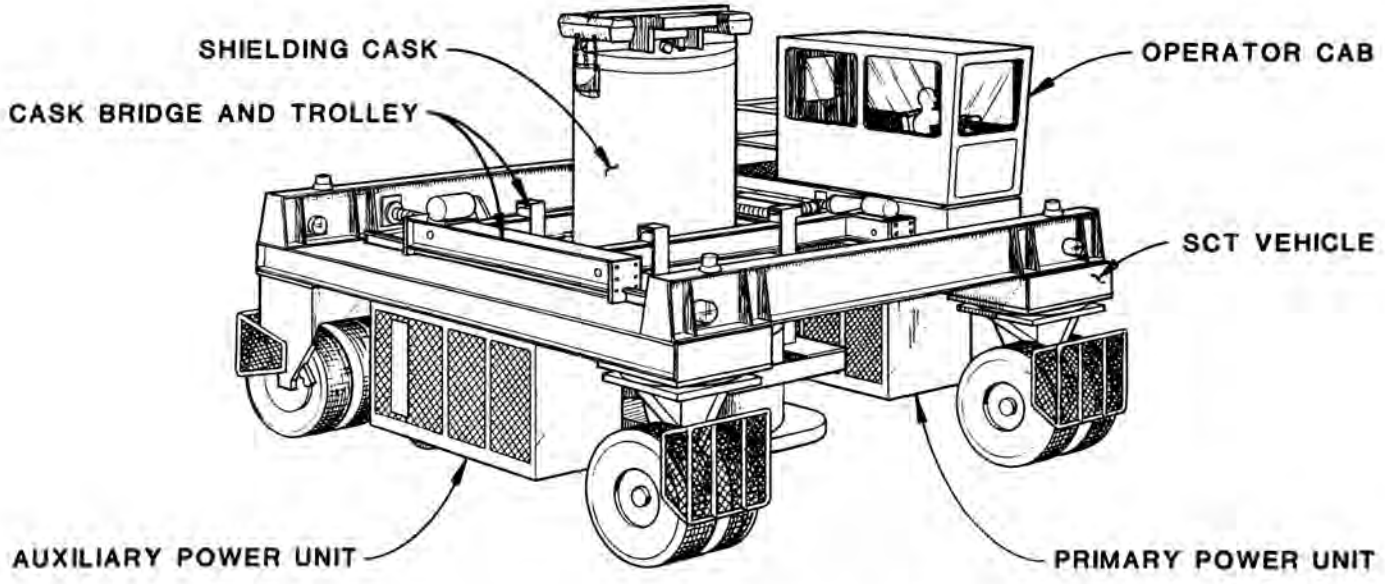

Fig. 1. Shielded Canister Transporter (SCT)

- o Cask Support and Positioning System (see Fig. 2) - Supports the Cask Assembly, and lifts and translates the cask for positioning during canister loading.

- o Vehicle (see Fig. 1) - Transports the cask and canister from the loading building to the storage building.

All components are designed for handling a waste canister which is a stainless steel vessel 3m long 0.6m diameter and weighs 2,359kg fully loaded.

Cask Assembly

The shielding cask is a vertical transfer cask constructed of carbon steel with 37cm thick walls, 1.4m outside diameter, 4.9m long, with a horizontal bottom shield door. The assembly has an adjacent shield cavity for housing the floor hatch shield plug after it is removed during opening a canister hatch. For additional shielding protection during canister loading and shield plug removal, a horizontal flange of 18cm steel is mounted at the base of cask and shield plug cavity.

The cask shielding door is 27cm thick carbon steel operated by two electric motor drive jack screws. The door moves on full length slides of

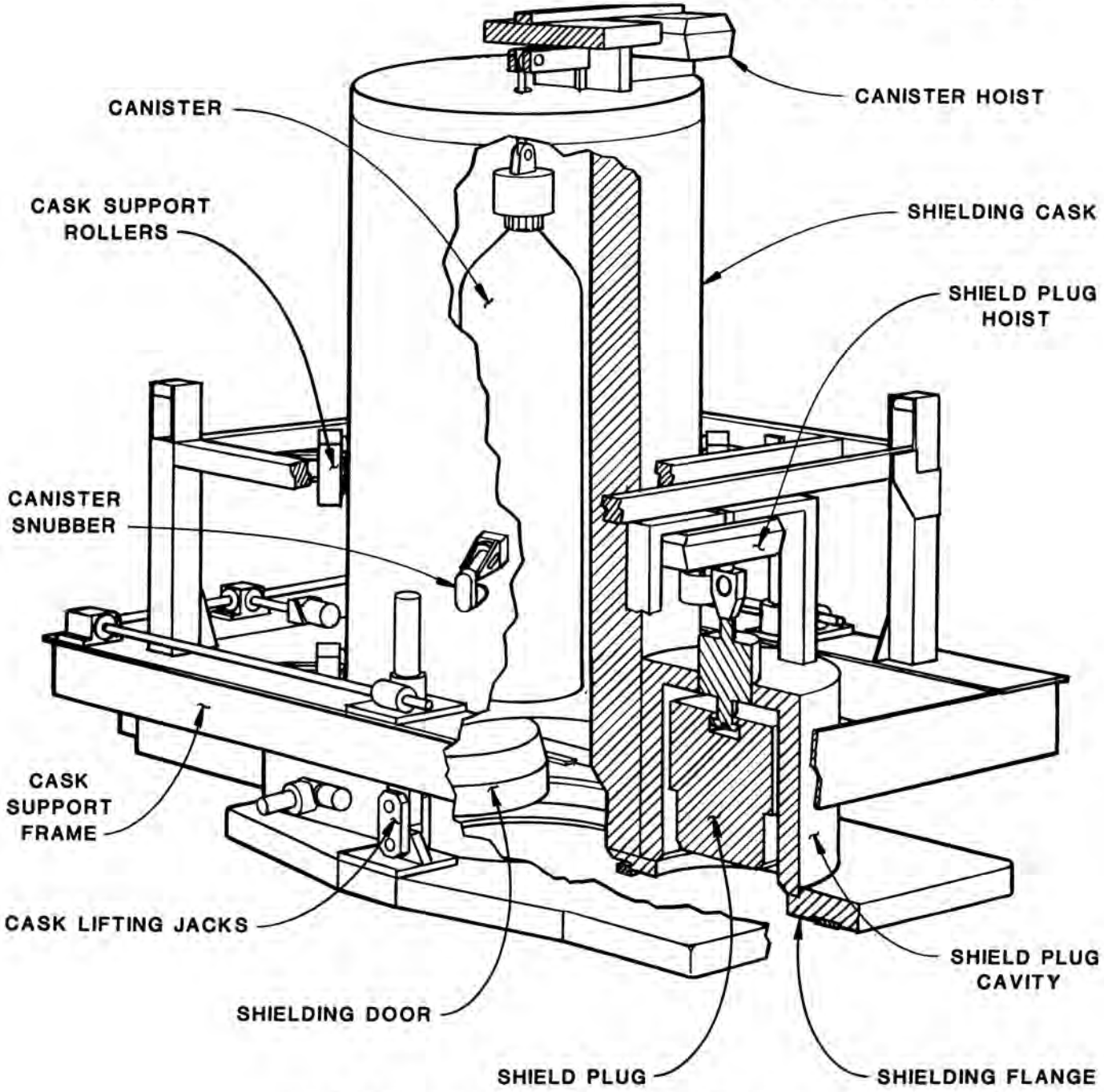

Fig. 2. Cask Assembly, Support and Positioning System

graphite impregnated plastic. After closure, the shield door is locked shut by two electric motor operated lock pins. The shield door screw drives and lock pins are equipped with position limit switches.

To prevent swinging motion of the canister inside the cask, electric actuated snubbers engage the canister during vehicle motion. The snubbers penetrate the cask wall at three locations and are equipped with exterior actuators and limit switches.

The cask interior is lined with stainless steel to prevent carbon steel contamination of the canisters and to facilitate cask decontamination. The cask exterior is coated with epoxy paint for high pressure water cleaning.

The shield plug cavity is a vertical cylinder mounted adjacent to the canister cask and is used for shielding of the hatch shield plug during insertion and removal. The shield plug cavity is carbon steel construction, 1.3m outside diameter, 1.4m high, with 10cm thick walls.

Both the canister cask and shield plug cavity have top mounted chain hoist systems for lifting and lowering of the canister and shield plug. The hoists are standard manufacture packaged, electric power chain hoists mounted at the top of the cask and shield plug cavity. The canister hoist is 356kn capacity and the shield plug hoist is 267kn capacity. Mechanical operation grapples are used on each hoist. The canister grapple engages the canister neck and the shield plug grapple engages a pocket at the top of the shield plug. The canister hoisting system controls include a load cell, position encoder and limit switches and the shield plug hoist uses limit switches for hoist position indication.

Cask Support And Positioning System

The cask support and positioning system is used to move the cask assembly into position for canister transfer after the SCT vehicle is roughly positioned over a canister hatch. The cask assembly is located inside an exterior structural steel frame which is attached to the trolley. Two 6,672kn capacity hydraulic motor drive screw jacks lift and lower the cask assembly and eight guide rollers on the side of the cask are used for support during this motion. The bridge is a standard crane type design with a steel frame and flanged steel wheels and is driven by two electric motor drive screw jacks. The bridge rails are mounted on the vehicle structure and retaining clamps are used to prevent the bridge wheels from lifting off the rail in an accident condition. The trolley is a steel frame which uses rollers that rest on the bridge structure and the frame design retains the trolley to prevent trolley lifting. The trolley drive is also an electric motor drive screw jack system.

Crane Vehicle

The crane vehicle transports the cask during canister transfer and serves as the support frame for the cask during canister loading. The crane is a "straddle" type crane to allow positioning of the cask over canister hatch locations. The crane has a 7,562 kn load capacity and is equipped with a hydrostatic drive system which allows precision positioning of the cask over the canister hatch. The vehicle power unit is drive by a 164kw diesel engine which provides hydraulic and electric power to the vehicle and cask system drives. Electric power is obtained from a belt driven 10KW generator mounted on the engine and hydraulic power is supplied by a 95 l/m hydraulic pump mounted on the engine drive gear box. The vehicle also has a full size auxiliary power unit in the event of a primary unit failure.

The Vehicle Specifications include:

- o Treadwidth 5.5m
- o Wheelbase 5.8m
- o Maximum turning radius 12.8m
- o Gradeability 3%
- o Maximum speed 4.8kph

The vehicle operator cab (Fig. 3) is mounted high on the frame structure for adequate viewing during transport and cask positioning during canister transfer. A standard operator panel is used while driving the vehicle and an adjacent control panel is used for monitoring and controlling the cask operating systems.

Operation Description

In both loading and unloading, the positioning sequence (Fig. 4) is identical and the canister is either loaded into the vehicle or unloaded into a storage location as required. During road travel the cask bottom is positioned 15cm above the road surface and the bridge is in the rear position and the trolley is centered in the vehicle. To load a canister, the SCT operator drives the vehicle forward into the process building loadout area. The position of the transfer hatch is observed on the CCTV monitor via shield plug cavity camera no. 1 and the vehicle is positioned to within 15cm of the hatch center. The vehicle is stopped and parking brakes are set.

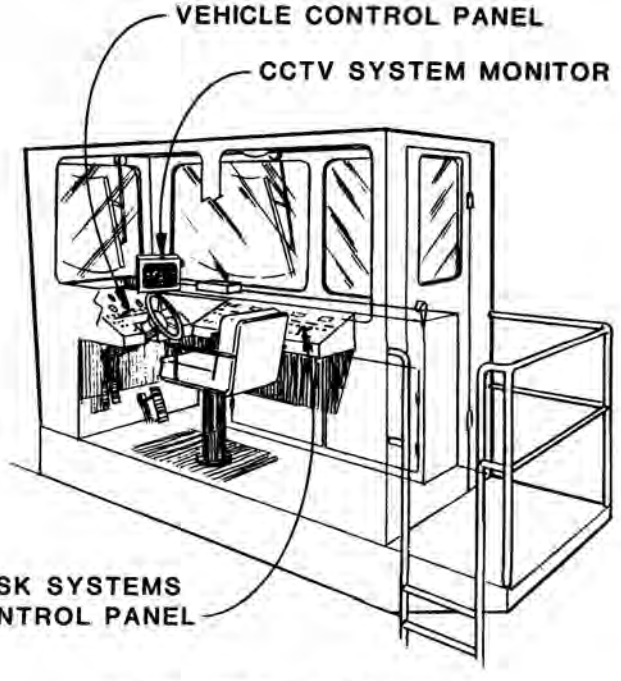

Fig. 3. SCT Operator Cab

The cask assembly is lowered to within 2.5cm of the floor surface by the cask jack system to provide shielding during plug removal. Via observation through camera no. 1 and a positioning grid on the CCTV monitor, the operator adjusts the bridge and trolley position to within ± 1.3cm of the transfer hatch center. The operator then starts the control system in the automatic mode. The shield plug hoist lowers the grapple which engages the plug pocket and then lifts the plug into the shield plug cavity.

The bridge moves forward 0.6m and CCTV camera no. 2 mounted in the bottom flange views the canister in the storage location to establish the canister is properly positioned for loading and the canister serial number is recorded. The bridge then moves forward 0.7m which centers the cask over the open hatch. The cask is lowered 2.5cm onto the building floor and the cask shield door is opened.

The canister hoisting system lowers the grapple into the hatch and the canister neck is engaged. The canister is lifted into the cask and the cask shield door is closed. Hoisting of the canister is observed via CCTV camera no. 3 at the top of the cask to verify proper grappling and hoisting. Canister snubbers engage the canister to prevent swinging motion during the vehicle movement.

The cask is raised 2.5cm and the bridge moves back 1.3m which centers the shield plug cavity over the open hatch. The shield plug hoist lowers the plug into place and ungrapples from the plug. This installation is viewed from the CCTV camera no. 1 to verify proper operation. The cask is then raised 13cm and the automatic control sequence is complete. The vehicle is then ready for travel to the storage building to deposit the canister.

SCT Control Systems

The SCT is equipped with two control systems, one for vehicle operation while moving during canister transport and the second for cask positioning and canister loading while the vehicle is parked.

The vehicle control system is a standard crane hydraulic and electric control system for operator driving control of the vehicle. The operator drives the vehicle via a hydraulically controlled steering wheel and accelerator and standard tandem brake systems stop the vehicle.

The cask control system is operated by a programmable logic controller (PLC) with the necessary associated indication and monitoring components. The system operates in three modes, fully automatic, stepped automatic and manual.

During automatic operation, after the SCT vehicle is positioned over the hatch shield plug, the operator starts the system and the PLC carries out the entire sequence including shield plug and canister hoisting. The operator can monitor the system operation and adjust if required. During stepped operation, the operator uses PLC control of distinct operations in a sequence fashion. Manual control allows full operator control of each function thus bypassing PLC control.

A CCTV system is used to monitor the process of shield plug and canister hoisting by using TV cameras mounted on the cask and shield plug cavity. The operator observes the operations on a monitor located in the operator cab.

Failure Recovery Design

The SCT is an integral piece of equipment for the DWPF plant and is needed to maintain the

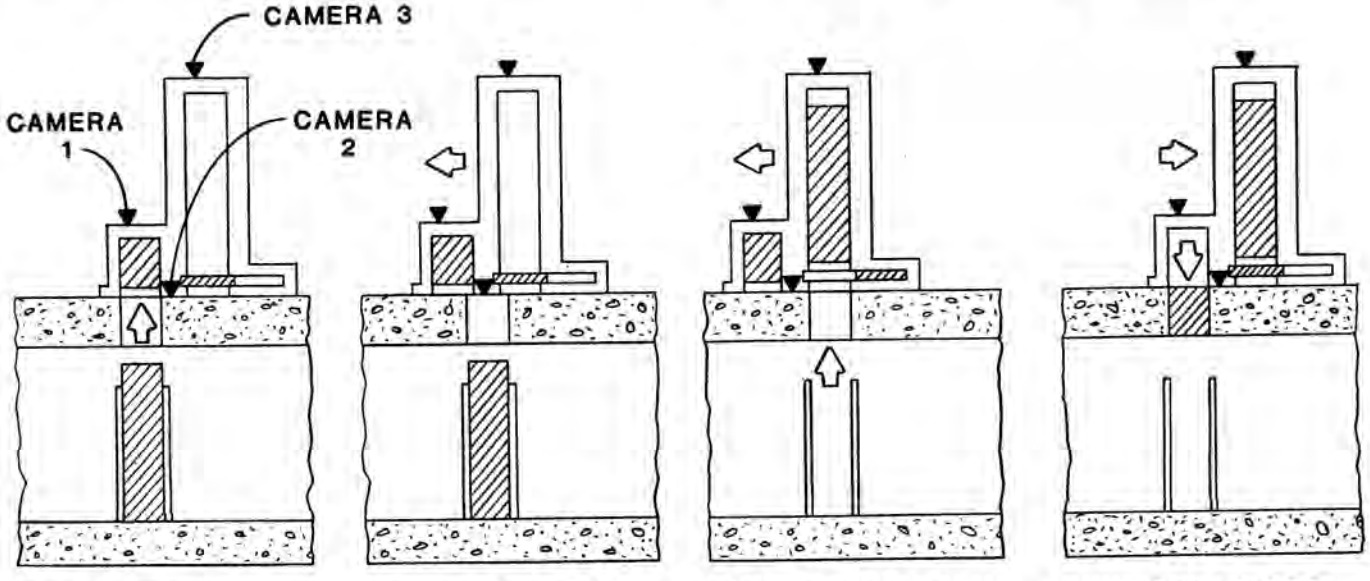

Fig. 4. SCT Canister Loading Sequence

production schedule by moving canisters to the storage area. Lost time due to an SCT failure could have significant impact on the plant if the vehicle is not promptly placed back into service.

As a result, all system mechanical components are designed for reliability and ease of replacement if a failure occurs. For components affecting shielding, replacement of systems are accomplished without compromising system shielding. The cask jack system drives are equipped with mechanical clutches which can be uncoupled by hand in the event of a jack failure. The system design and capacity is such that the cask can then be hoisted with one jack and can be operated in this mode until a repair is made.

Similarly, the canister hoisting system is equipped with two full capacity packaged electric chain hoists, with one hoist operating in normal conditions. The hoists are connected via a continuous chain and in the event of a primary hoist failure, the second hoist is started via the control system and hoisting operation is continued. In addition, drive systems important to handling of the canisters are equipped with drive shaft extensions which allow manual drive of the system in the event of a power or motor failure. The SCT vehicle is equipped with a primary power unit and a full size auxiliary power unit. In the event of a primary unit failure, the vehicle controls are switched to the auxiliary unit and full operation continues including full hydraulic and electric system supply.

The control system is also designed to allow manual operation in the event of a computer failure or malfunction.

SUMMARY

The shielded canister transporter design has met the project needs for a reliable and flexible system required for transfer of waste canisters at the DWPF. The design uses proven components and systems to assure reliable operation which meets the owner's requirements.