RADIOACTIVE PACKAGE CONTAINER SYSTEM FOR REMOTE HANDLING OF LOW-LEVEL RADIOACTIVE WASTE

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ABSTRACT

Remotely operated handling systems are employed for safe processing and transfer of low level radioactive wastes at nuclear generating plants. These systems minimize or preclude personnel radiation exposure while expediting waste handling operations.

A remotely operated waste handling and transfer system containing several unique features has been designed, fabricated and tested for installation at Arizona Public Service's, Palo Verde Nuclear Generating Station. The system incorporates modular subcomponents such as a waste processing shield, bottom and top loading shielded cask, and remote grappling equipment, making it adaptable to multi-task waste handling operations. The system has been designed to be operationally flexible, and will contribute significantly to reducing waste processing personnel exposure.

INTRODUCTION

Increased uncertainties regarding the future availability of low level radioactive waste disposal sites has caused many commercial nuclear power utilities to investigate and implement alternatives to radwaste storage and disposal. One current methodology being explored by the nuclear power industry centers around the capability to store large quantities of low level radioactive waste on the plant site. Implementation of on site radioactive waste storage capabilities requires well defined engineering parameters, careful project cost analysis and remotely handling of the radioactive containers.

Nuclear Packaging, Inc. of Federal Way, Washington, under a contract to Arizona Public Service has developed a Radioactive Packaging Container System (RPCS), that allows shielded handling of low level radwaste at the Palo Verde Nuclear Generating Station (PVNGS). The system is designed to remotely transfer multi-configured radwaste containers into shielded storage modules or shipping casks. Its design and operation minimizes radiation exposure to site operation personnel and provides a flexible and efficient means for handling radwaste containers under various storage scenarios.

The waste handling system requirements include the capability to: (1) Process variable size radioactive waste liners in a shielded environment, (2) remotely transfer waste liners from the processing/transfer cask into storage modules or shipping casks, and (3) maintain personnel radiation exposure as low as reasonably achievable (ALARA) during transfer operations.

A modular equipment approach was adopted to meet the design requirements for the RPCS. This methodology provides maximum system operational flexibility and the ability to cost effectively modify the system subcomponents for use with future waste processing liners, storage modules or shipping casks.

SYSTEM OPERATIONAL FEATURES

System Component Description

The RPCS is comprised of the following modular components:

- Transfer cask; which provides shielding from radwaste containers during waste processing and remote transfer operations.
- Remote Liner Grapple; for remotely engaging and disengaging of radwaste liners.
- Control Console; for remotely controlling all functions of the RPCS.

Transfer Cask

The top and bottom loading transfer cask is the primary component of the RPCS (see Fig. 1). It provides shielding from radwaste containers during waste processing and subsequent transfer operations. It has as internal cavity sized to handle containers up to 2.26m^3 (80 ft^3) and is designed with a shielding equivalent of 8.8cm (3.5 in) of lead. Externally, it is 1.3m (4.5 ft) high, 2.1m (6.9 ft) in diameter, and weighs 19.7 Mg (21.8 Mgs) empty.

The cask has an integrally attached, remotely operated, 19.0cm (7.5 in) thick steel closure door assembly located at its base. The door assembly enables containers to be transferred through the cask bottom and into shipping or storage vessels. The door assembly is electrically operated from the RPCS remote control station. In the event of an electrical system failure, the door is designed to be manually operated, in order to complete or abort a container transfer operation.

Both interior and exterior surfaces of the transfer cask are designed for decontamination. The interior surface of the cask, including the doors, is clad in stainless steel. The cask exterior finish is a heavy coat of epoxy paint.

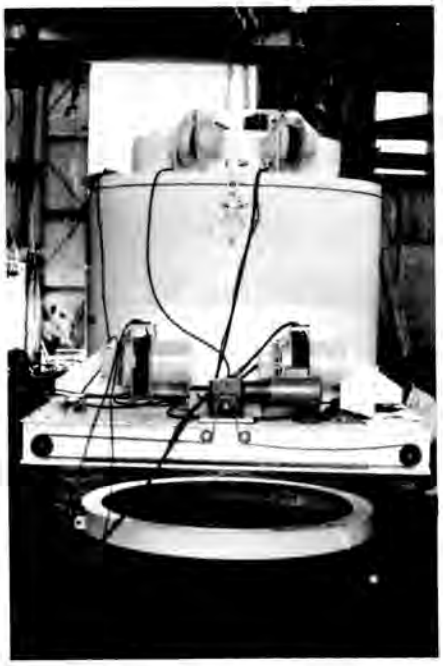

Fig. 1. Radioactive Package Container System.

Remote Liner Grapple

The remote liner grapple (RLG) and transfer shield lift lid, when used together, provide for remote grappling and handling of the radwaste containers and transfer shield (see Fig. 2). The RLG is equipped with the grapple, load cell, rotator, and viewing system. The transfer shield lift lid is designed for quick installation and removal from the transfer cask. Location guide ways, quick disconnect electrical connectors, and ball-lock pins enable the transfer shield lift lid to be installed or removed without personnel exposure during waste container handling operations (see Fig. 3).

The container grapple contains two grappling fingers, which engage specially designed pockets on the waste container. Installation of bolt on attachments enables the grapple to engage radwaste containers of different handling designs (see Fig. 4). The grapple is equipped with guides to insure alignment with the container during remote grappling operations. The guides enable positive grapple engagement with as much as a 44mm (1.75 in) misalignment between the vertical axes of the container and grapple.

The grapple fingers are engaged and disengaged by a linear actuator positioned in the grapple body. Limit switches are used to indicate when the grapple is seated on the container and provide position status of the grapple fingers (i.e., extended or retracted).

A load cell is used on the grapple to accurately weigh the waste container. The load cell also provides the operator with an accurate indication as to whether container transfer operation is proceeding smoothly. Sudden fluctuations in the load indicator during container transferring would indicate an operational anomaly which may require further operator attention.

The remote liner grapple is equipped with rotation capabilities enabling the grapple to be remotely rotated through 180° (+ /- 90°). This feature provides a means of accurately aligning the grappling fingers with the specially designed container grapple pockets.

A black and white closed circuit television (CCTV) camera is mounted on the grapple, and provides the operator with a clear view of the grapple finger as it engages the grapple pocket on the radwaste container. A motorized zoom lens is mounted on the CCTV camera providing the operator with an alternate method of surveying a radioactive work area prior to the initiation of a radwaste liner transfer operation.

The modularity of the remote liner grapple, together with the transfer shield lift lid, enables it to be operated as a remotely controlled component, completely separate from the transfer cask (see Fig. 5). In this mode it can be used for placing empty containers in the transfer cask or as a remote handling device in hazardous environments within the plant's radwaste facilities.

System Control Station

The RPCS control station provides remote operation of the transfer cask and remote liner grapple during waste container handling operations (see Fig. 6). It is designed to operate all of the modular subcomponents of the radioactive packaging container system. The control station

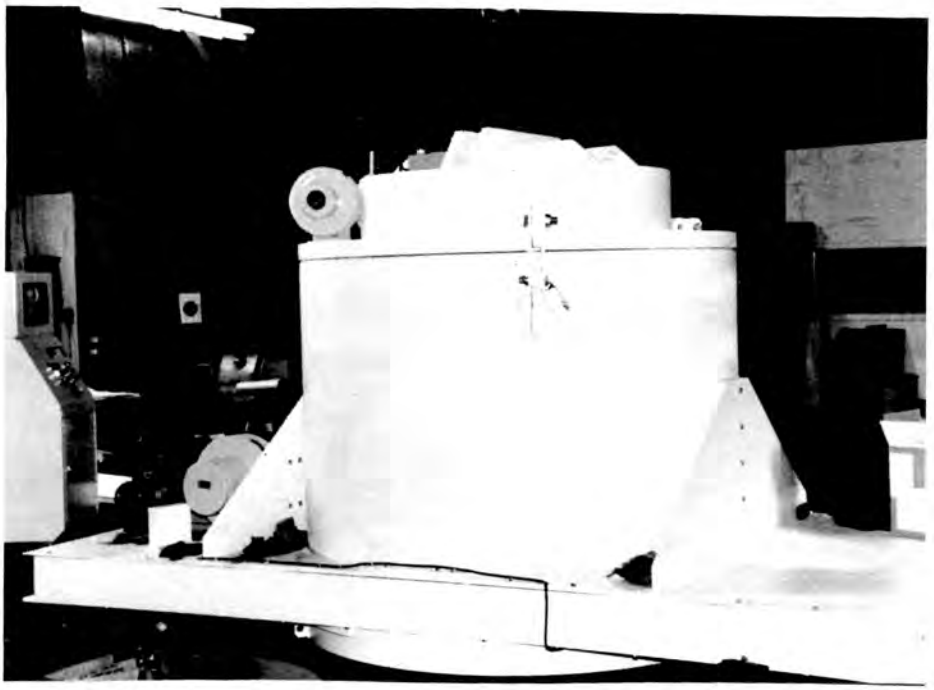

Fig. 2. Transfer Shield.

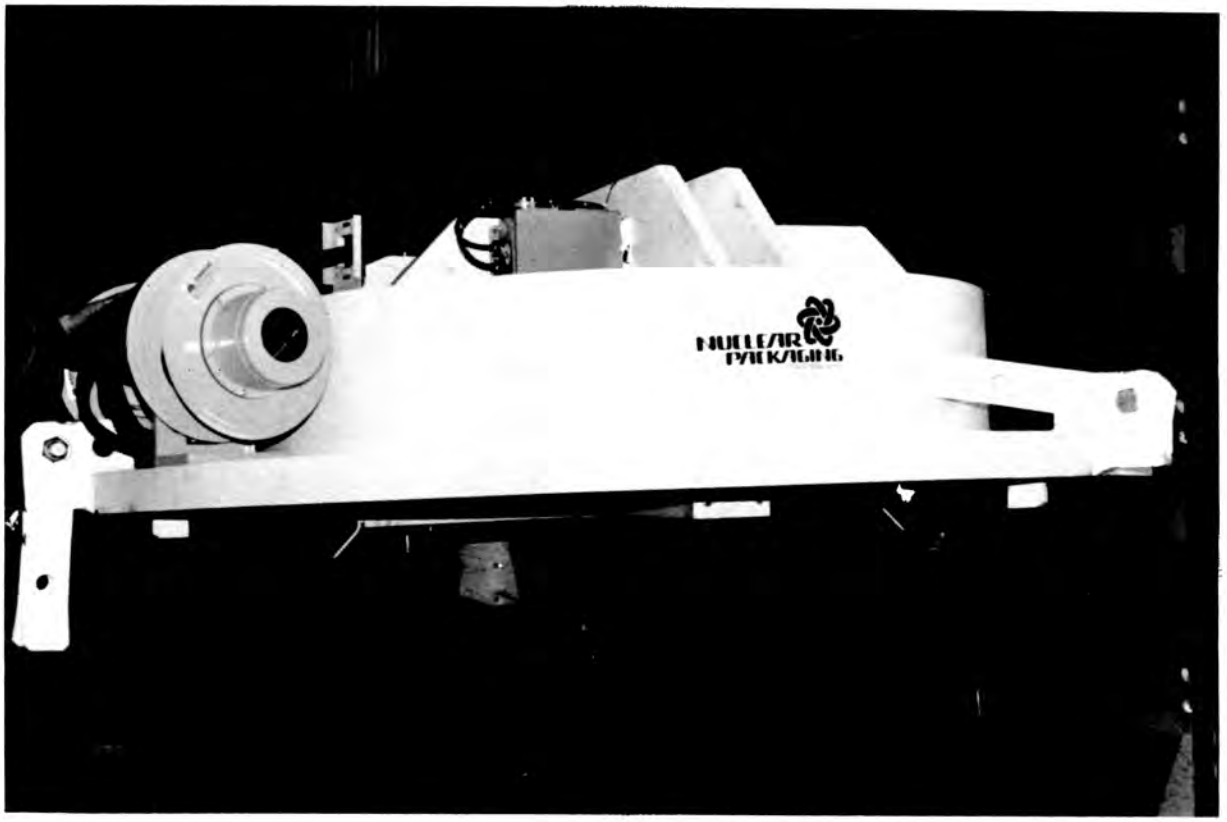

Fig. 3. Lift Lid.

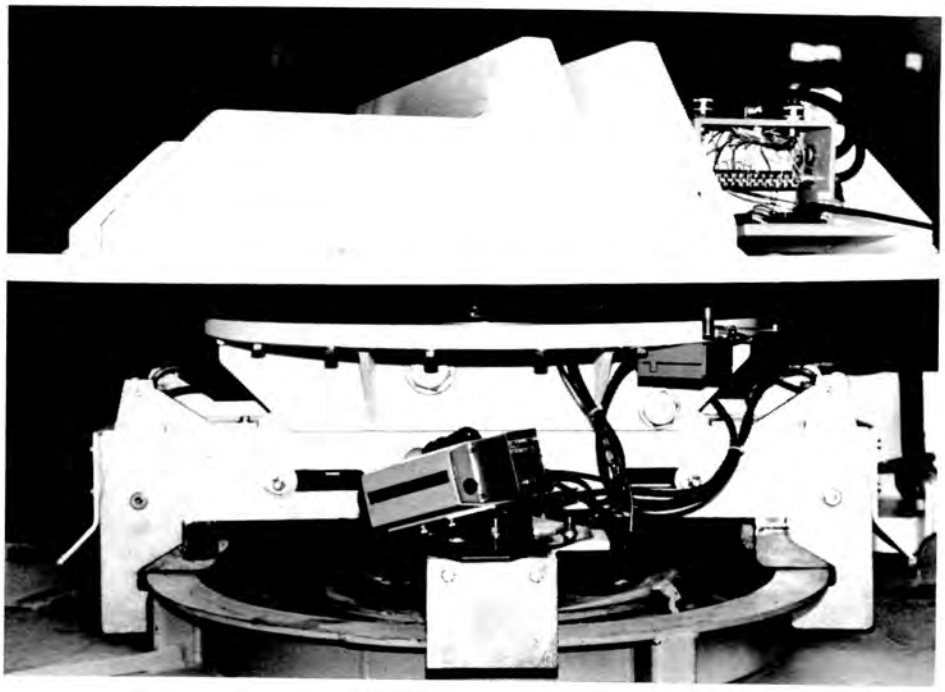

Fig. 4. Grapple System.

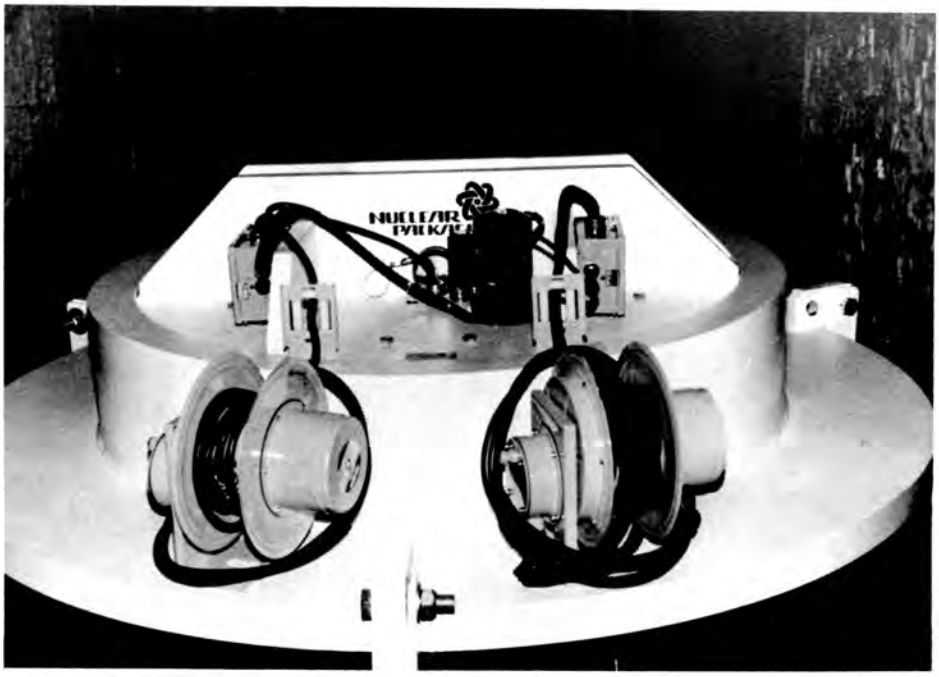

Fig. 5. Lift Lid.

portability enables the operator to minimize his radiation exposure while simultaneously maximizing the system's operational flexibility.

The control station includes the following RPCS controls and features:

- Emergency system shut-down switch.
- Rotation "cw/ccw" control and status indicators.
- Grapple "seated" indicator.
- Grapple "extend/retract" control and status indicators.
- Grapple load indicator.
- Transfer shield "seated" indicator.
- Transfer shield "open/close" control and status indicators.
- Keyed over-ride switch.
- Black and white CCTV monitor.
- Motorized zoom lens control.

A programmable logic controller (PLC) located inside the control station provides the control interlock logic for the RPCS operation. It aids in assuring that waste container grappling and transfer operations are properly sequenced so that operator and equipment safety is not compromised.

The following provides a representative example of the interlock functions controlled by the PLC:

- Cask doors will not open or close if the transfer shield is not fully seated on a storage cask or a shipping cask.
- Grapple fingers will not operate if the grapple is not fully seated on a waste container.
- Grapple rotation will not operate if the grapple is fully seated on a waste container.

All control system wiring is interconnected via quick disconnect electrical connectors. This enables continued system modularity and ease in start up and maintenance under adverse field conditions.

Fig. 6. Remote Control Station.

System Operation

The radioactive packaging container system was designed to provide a shielded means of processing and transferring containers within the radwaste facilities of Arizona Public Service's, Palo Verde Nuclear generating station. The lift operations of the RPCS are accomplished with the overhead crane in the radwaste facility. A typical container processing and transferring operation would be performed as described in the following sequence of events.

The remote liner grapple is interfaced to the facility's overhead crane hook. The remote liner grapple is then made ready for remote operation by electrically connecting the lift lid and remote liner grapple to the control station. The remote liner grapple and lift lid are then raised by the overhead crane and moved about the radwaste storage/processing bay for remote surveillance of the work area prior to initiating a transfer operation. The remote liner grapple is then seated on the selected empty radwaste container. The grapple fingers are extended, thus engaging the container. The empty container is then placed within the transfer shield through the top opening, and disengaged from the grapple by retracting the grapple fingers. The container is now ready for processing in a shielded environment.

Upon completion of radwaste processing, the remote liner grapple and lift lid are lowered onto the transfer shield, and the lift lid is attached to the transfer shield. The remote liner grapple is then lowered onto the container and the container is engaged. The transfer shield is made ready for a transfer operation by electrically connecting it to the control station. The container and remote liner grapple are raised such that the remote liner grapple interfaces with the lift lid. The transfer shield is lifted and positioned over a storage container (or shipping cask). The transfer shield is lowered onto the storage container such that the transfer shield is fully seated. The transfer shield doors are opened and the remote liner grapple with engaged radwaste container are lowered into the storage container. The radwaste container is disengaged from the grapple, and the transfer shield is removed from atop the storage container. The remote liner grapple and lift lid are disconnected from the transfer shield, and are used to remotely position the storage container lid onto the storage container.

ALARA Benefits

The ALARA benefits are realized by recognizing how the above typical handling operation affects personnel radiation exposure. Note that the entire transfer evolution is performed without touching or exposing the container.

- The transfer shield fully protects operation personnel against radiation streaming.
- The complete remote control of all functions enables personnel to maintain a safe working distance from the radioactive source.
- Without the need for temporary processing shields and manual connection of rigging devices, a transfer operation can be performed more quickly and efficiently, thereby decreasing personnel radiation exposure.

SUMMARY

The radioactive packaging container system will enable operation's personnel at PVNGS to process and transfer radioactive waste containers in a quick, safe, and cost efficient method. The modular system design approach will prove to be flexible and adaptable to changing operational parameters and interfaces. The modular system design lends makes it readily adaptable to reconfiguration to meet future demands in radioactive waste processing, handling, and storage requirements.

Also, PVNGS will realize cost savings due to an overall reduction in equipment lease time, contract personnel time, and utility labor time spent transferring and handling radwaste. The reduced exposure will result in fewer Health Physics controls, fewer support personnel, and less time to accomplish handling operations.

In summary, the radioactive packaging container system will prove to be a great asset to Palo Verde Nuclear Generating Station by:

- reducing personnel exposure resulting from waste handling.
- reducing overall costs resulting from routine waste handling.
- providing new methods of handling waste at PVNGS by meeting plant-specific design considerations.