OPG Western Waste Management Facility
Resin Overpacking Project

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Liners containing radioactive resins are stored in in-ground containers. Over time, degradation of the liners has occurred and there is potential for eventual leakage. The liners require overpacking in more robust packages to allow for extended storage and final placement in the Deep Geologic Repository.

This paper will discuss the equipment design for safe venting, weather protection, radiation shielding, and remote handling of the liners. Alternative considerations and reasoning for final equipment design will be addressed. It will present issues encountered and how they were overcome as well as the logistical overview of the project, including milestones and time tables.

1. Introduction

Resins from CANDU reactor Moderator and Primary Heat Transport cleanup systems, from other heavy water and light water cleanup systems and the CANDECON and CANDEREM decontamination process are currently stored at the OPG Western Waste Management Facility (WWMF). The resins are contained in approximately 585 3m^3 epoxy-coated cylindrical carbon steel containers, known as resin liners, which are stored in a total of 20 IC-12 and 89 IC-18 in-ground containers (ICs). Each of the ICs has a concrete shield-plug arrangement to provide shielding. (See Figure 1).

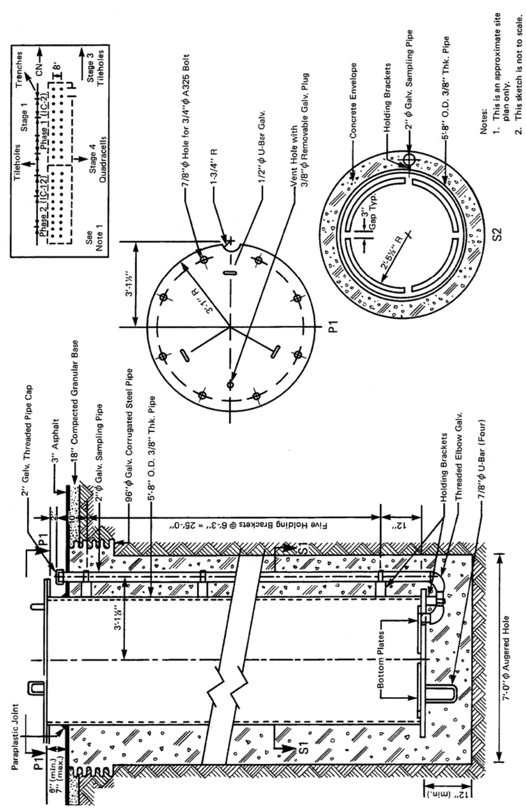


Figure 1 Shield Plug

Because of imperfections in the inner coating, degradation of the resin liners has occurred and there is a potential for eventual leakage. Preliminary inspections have confirmed the presence of corrosion.

To prevent the possibility of leakage, a resin liner remediation project has been established to re-package designated liners into stainless steel overpacks that meet long term storage and the Deep Geologic Repository (DGR disposition) requirements.

OPG evaluated doing the repacking project in-house, but determined it best to hire a contractor to perform the project on a turnkey, construction island approach. The Duratek of Canada, Inc. team, consisting on Duratek Services Inc., ES Fox Ltd, and Kinectrics North America Inc. was the selected contractor.

The project was determined to be conducted in two stages - Stage 1 for trial runs and initial overpacking of 20 liners to prove the process and Stage 2 for the recovery and overpacking of an additional 350 liners. The remaining 185 resin liners are not intended to be overpacked at this time as they are relatively new and are not expected to require overpacking until transfer operations to the proposed Deep Geologic Repository.

1.1 Preliminary Work

Engineering, design and testing of two prototype stainless-steel over-packs was successfully completed by the Nuclear Waste Management Division (NWMD).

Conceptual design and engineering work on tools, equipment and processes was completed. This work focused on the use of common construction equipment supplemented by remote-operated special tools (some equipped with video observation) and structures to protect workers from radiation dose and reduce the potential for contamination release/spillage. A conceptual operational process to over-pack the resin liner was prepared in parallel with preliminary engineering work for the required support equipment.

Subsequently, a review of reports and information on the condition of the liners, liner corrosion and gas pressure build-up prompted a stress analysis evaluation to confirm whether or not the resin liners could be lifted safely. This was taken into consideration to develop a safe lift method before the development of the final lift tools, equipment and processes.

1.2 Resin Liners

The condition of the resin liners depends upon the type of resin contained, age and effectiveness of the epoxy coating. Visual and ultrasonic inspection was performed on a limited number of resin liners to determine the wall condition. The bottom shells were not accessible and the top shells were not in contact with the resin, so these were not inspected.

Visual inspection of the outside wall of the resin liners did not reveal any sign of significant damage or leakage. In addition, based on the type and age of resin contained, six liners were inspected with ultrasonics. The results indicated localized internal wall damage consisting of pits.

The structural integrity of liners was evaluated and determined that some of the liners may have a pressure build up. The impact of internal gas pressure was also investigated. It was determined the highest stress point during a lift is around the lifting lug.

During storage, the liners are subject to the effects of corrosion, microbial degradation and radiolysis. As expected, it was found that elevated hydrogen and depleted oxygen levels, by-products of corrosion were measured. Low levels of methane, indicating microbial activity and other decomposition of resin were also measured. The C-14 was predominately bound on the resin which was physically in good condition.

Figure 2 Example of shield-plug lifting insert deterioration

1.3 In-Ground Containers

There are 20 IC-12s which have two concrete shield-plugs that rest on top of the stack of 4 liners, plus a steel plate bolted to the top of the IC tube topped with a concrete weather cover.

There are 89 IC-18s which have a stepped shield plug and contain 6 liners. However, only 4 over-packed liners will be put back in the IC-18 due to the increased size of the overpacks.

Inspections also identified degradation of some of the IC-12 shield-plug lifting attachments. As a result, this required a safe lift evaluation and possible remediation of the IC-12 lifting attachments.

The need for modified (shorter) IC-12 and IC-18 shield-plugs was identified to take into account the increased stack height of over-packed resin liners. However, these modified plugs are to be installed only on the replacement IC-12 shield-plugs and the IC-18's would use their existing shield-plugs, with replacement at later date.

Figures 2 and 3 illustrate typical deterioration of IC-12 shield-plug lifting inserts.

Figure 3 Another example of shield-plug lifting insert deterioration

2. Scope of work

2.1 Project Objective

The objective of this project is to safely vent and remove designated liners and load each one into an individual over-pack; then return the over-packed liner to in an IC-12 or IC-18. This is to be done without any adverse impact.

The project includes all turnkey aspects including

- Planning
- Engineering
- Design
- Procurement
- provision and set-up of field facilities
- Staffing
- equipment set-up
- procedure preparation
- Commissioning
- Rehearsals
- Field activities
- Housekeeping
- Post-work cleanup
- Records preparation
- Assistance with licensing/regulatory issues

3. Overview of work to be performed

3.1 Stage 1

This will allow for equipment design finalization, procurement, finalization of procedures, mobilizing, establishment of a construction island, completion of a non-radioactive rehearsal, completion of a radioactive rehearsal (10 radioactive liners plus update of procedures and overpacking 40 radioactive additional liners.

To minimize cost and obtain optimal performance, Stage 1 will be conducted using only one crew.

3.2 Stage 2

This consists of overpacking the remaining 350 liners and placing them in their appropriate IC, with the delivery of a final closeout report.

To minimize the schedule and inconvenience to NWMD, Stage 2 will use of three teams versus the one in Stage 1.

Key features of the project operating procedures include the following:

1. A shielded work platform with lifting/hoisting capabilities and weather/spill protection
2. Controlled IC venting
3. Controlled liner venting in the IC
4. Spark free, hydrogen compatible vent equipment
5. A safe and simple lifting method ("reference lift") using current liner lifting lug
6. Proven optional lift methods for both "Old-Design" and "New Design" liners
7. Use of a transfer bell that provides area dose reduction and liner containment
8. Dose reduction for high activity liners through use of reinforced-concrete shields while the liner is out of the IC

At the end of the project, the site will be returned to NWMD with all the designated resin liners overpacked and re-inserted in the ICs. All necessary closeout reports will be completed and submitted to NWMD.

The following Project Flow Chart demonstrates the above project:

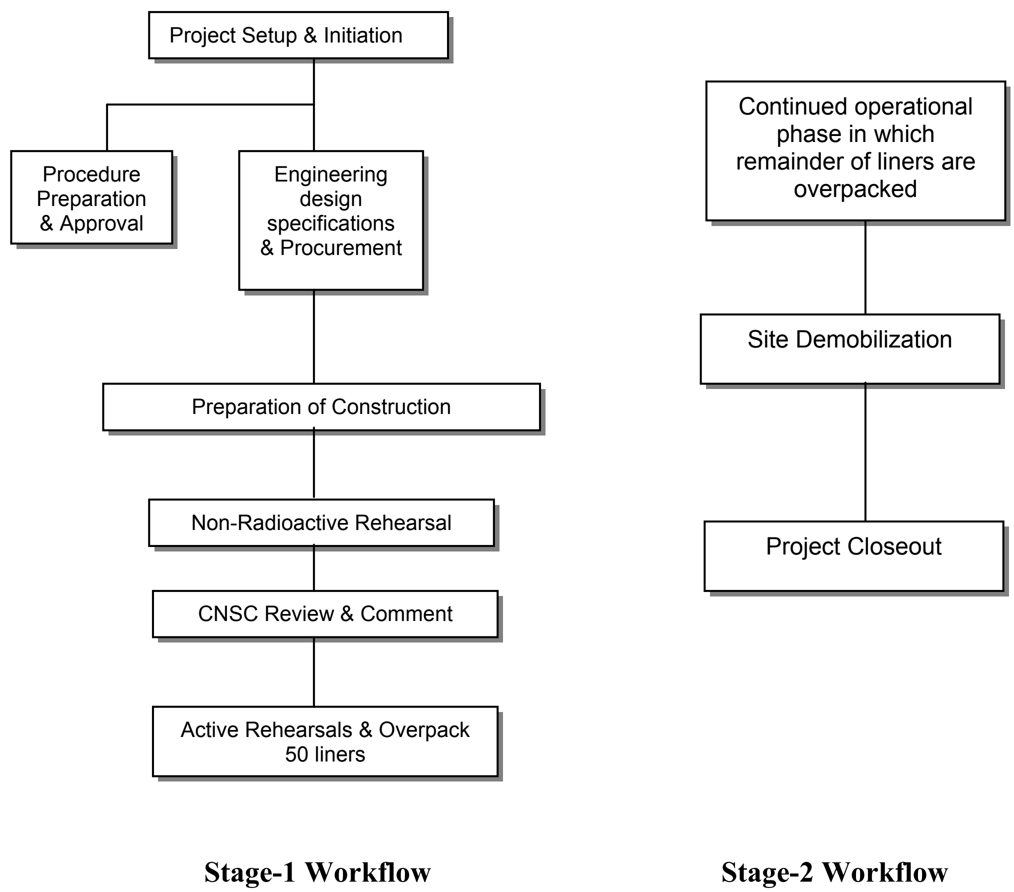


Figure 4 Work Flow Chart

4. Project details

Key Features of the project include the following

4.1 Construction Island (CI)

The project will be conducted under a CI approach where all work activity will be conducted in an area controlled by the contractor. All responsibilities for a work area will be under the control and implementation of the contractor and includes radiation protection, safety, ingress and egress control, etc.

Pictured here is the WWMF work area and the general construction design.

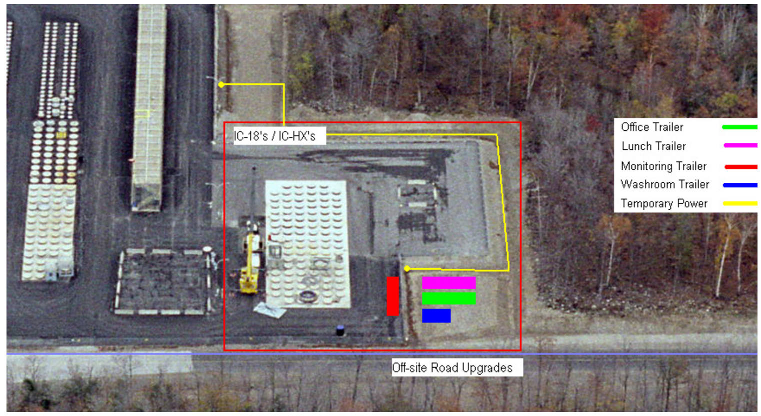


Figure 5 The construction island

Entrance to the CI will be through the current fence access. A clean controlled pathway will be established for entrance to the work zone entrance trailer (Zone 1).

Table 1 Work Zone Description

Zone 1	Zone 2
• An office area with lunch room, and desks for the Radiation Safety Officer, Radiation Safety Technician and Radiation Protection Assistants. • A dose control desk with badge racks and an Electronic Personnel Dosimeter (EPD) reader • Wash rooms • A radiation safety instrument storage area • A controlled, one-way entrance to Zone-2 area towards the rear of the trailer	• An uncontrolled doorway to the work zone, most of which is Zone 2 • A change room trailer • An emergency shower unit • A storage area for emergency equipment and radiation safety supplies • A controlled, one-way exit from Zone 2 to Zone 1 with a personnel contamination monitoring station.

The CI will house a posted, roped-off radioactive work area, designated as Zone 3, consisting of a controlled, one-way entrance to a change room.

4.2 A shielded work platform with lifting/hoisting capabilities

Each liner recovery team will have a shielded work platform that will be equipped with lift/hoist equipment to handle the liner venting tool, video equipment, lighting, liner condition probes, contamination smear sample tool and cutting tool (if necessary). It allows for safe operation of the listed equipment while maintaining an ALARA compliant work atmosphere.

In addition, each work platform will have a weather/spill protection barrier permanently installed to allow for wind protection and containment of radioactive material should the unlikely event of a dropped liner and spill.

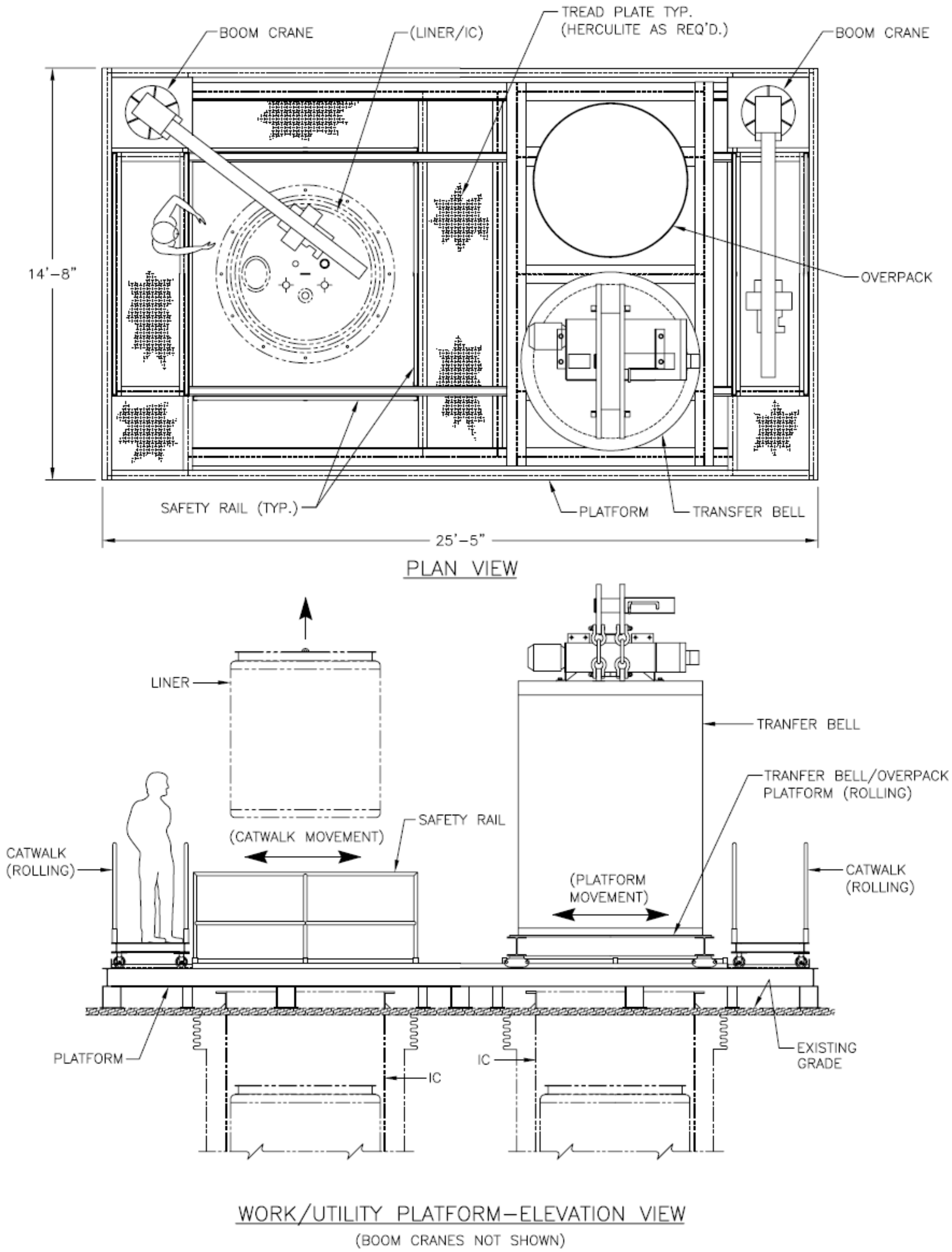


Figure 6 Work Platform Enclosure

4.3 Ventilation

ICs will be vented before lifting through a controlled process when the shield plug or metal plate is lifted sufficiently to create a flow path for air. All water will be removed prior to venting. This will be done via the IC sample liner, which is the same line used to vent the IC.

The vent system consists of two beds of specialty media:

- A bed of Carbolyme for removal of C-14
- A Ducal Drierite bed (calcium sulphate with calcium chloride as a catalyst) for removal of tritiated moisture

The contaminated gas enters at the bottom of the Carbolyme bed while the scrubbed gas leaves at \the top of the Drierite bed and is routed through a filter trap and a gas flow meter before being exhausted. CO_2 will also be removed.

Figure 8 Scrubber

4.4 Liner venting in the IC through a controlled process before lifting.

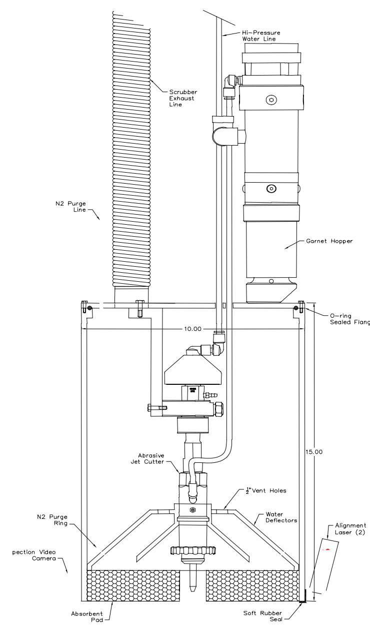
Liners containing certain resins may be under significant positive pressure arising from corrosion generated hydrogen gas in some levels exceeding the flammability limit in air. Other resin liners may actually be either under a partial vacuum. All liners will be vented before overpacking. To avoid ignition, all activities will be spark free.

The design for the liner vent tool uses an abrasive water jet technology. The design requirements include

- Cuts hole 1/8 in. on 3/8 inch carbon steel
- Lowering of vent tool/cap plus cutting of hole less than 12 minutes
- Any contaminants/materials (water, abrasive) introduced have to be contained so as not to impact integrity of IC
- Vent tool/cap must be able to reach depths of 40 ft
- All power for remote monitoring required to be <= 24V
- Connection ports for coupling to scrubber
- Nitrogen purging to minimize scrubber bed consumption

Other attributes of the vent tool include

- A tool supported by a hoist frame and lowered into the IC using an electric winch.
- A camera and associated lighting will be utilized to guide the placement of the socket head on top of the selected plug.



Figures 9(a) and 9(b) Venting tool and diagram of venting procedure

Once engaged on the liner, the vent tool will be operated for a 45 seconds to penetrate the liner.

4.5 Liner Inspection for Material, Debris, and Contamination

Each liner top will be visually inspected for any loose material prior to lifting. Should any lifting cables be found attached to the liner, remote cutting tools will be used for removal. In addition, smear samples will be taken of the liners with remote smear handling tools to check for loose contamination. While lifting the liner from the IC, a funnel-shaped tool will be placed at the top of the IC as a go/no-go indication of the maximum liner diameter.

4.6 Use of boom cranes

It was found that the use of tried and proven boom cranes would be the safest and most efficient means of expediting the project.

4.7 Use of the existing liner lifting lug, or reference lift method.

If this method challenges a safe liner lift, alternate lift methods and liner-handling procedures will be available.

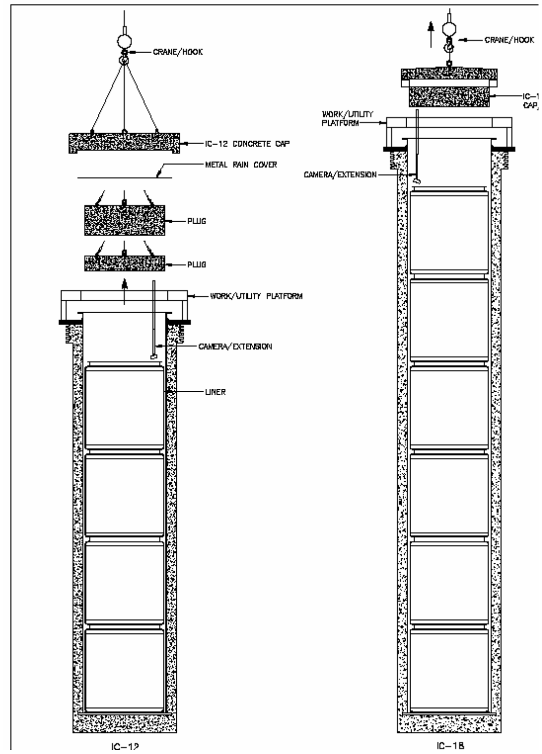


Figure 10 Removal of liner using existing lifting lug

4.8 Proven alternate lifting methods

These include a top grappling tool for the "New Design" liners and a bottom grappling tool and liner basket for the "Old Design" Liners.

A diagram of the liner lift approach process is provided below which demonstrate the method for assurance of a safe lift.

The attachment for lifting the resin liner will then be made. This approach (the "reference lift") will be to use the central lifting lug.

In each lift case, the liner will be lifted just enough to transfer full weight to the liner and held under video inspection for five (5) minutes. The liner will be studied for any abnormal deformation. If any abnormal deformation noted, the liner will be lowered to take its own weight again. Alternate lift methods were evaluated to account for potential liner lift failure and it was concluded that the lift and wait procedure with visual examination is sufficient to assure a safe lift.

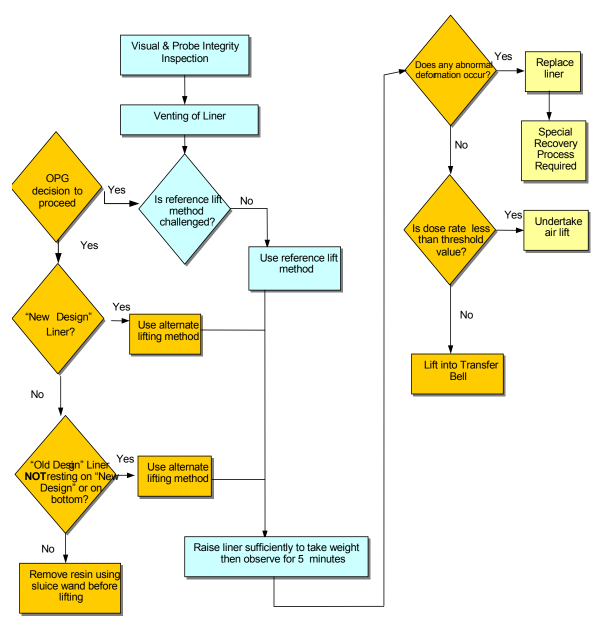


Figure 11 Decision Tree

This is different from the 10-minute lift requirement for the IC shield plugs, as the shield plugs have different failure mechanisms. The shield plug failure would be a shear-out of the insert, which would be

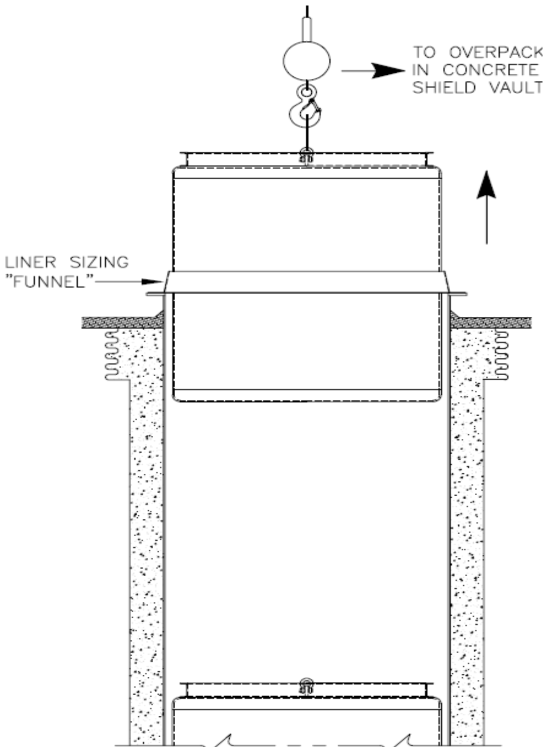


Figure 12 Use of liner-sizing funnel

considered a catastrophic failure.

The liners below a designated threshold (for example 10 mSv/hr) will be air transferred. For greater dose rates, the liner will be transferred using a transfer bell. The transfer bell also provides contamination control and containment for a potential liner failure by having an installed bottom enclosure.

This transfer bell, as illustrated, is designed such that the internal cavity can contain a resin liner or an overpack loaded with a resin liner.

The optional alternate lift methods will be different for the "New" and "Old" design resin liners. The "New design" liners will be lifted using a grapple tool to engage the rolled channel located on the top head of the container. This will allow the liner weight and stress to be distributed to the sides and removes the stress from the liner top. "Old" design liners resting on other "Old-design" liners will be lifted using a specially designed bottom lift tool. This again will allow the weight and stress to be transfer to the sides removing the stress from the liner top.

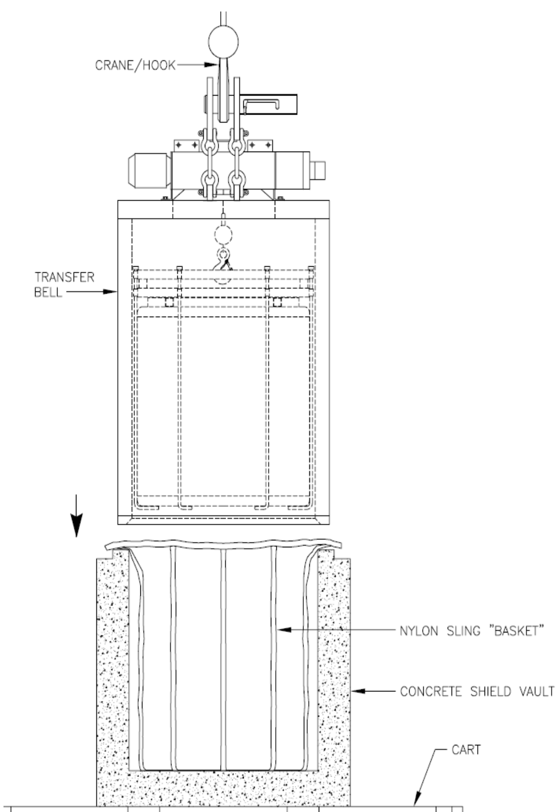


Figure 13 The nylon sling basket

When the bottom lift is required, the liner will be removed and placed into a nylon lifting basket (see illustration) and the bottom grapple will be removed.

In the case where a liner lift would challenge liner integrity, a proposed retrieval method is resin removal through the liner top head using sluice wands by cutting into the head of liner.

Standard Duratek on-site reinforced concrete shields will be used to stage the overpack to receive a resin liner. The shield will then provide dose minimization both while bolting the overpack lid in place and transferring on site.

4.9 The Transfer Bell

As conditions require, a Transfer Bell will be used to lift liners and transfer them into over-packs located in shields. This provides additional personnel shielding, adheres to ALARA principles, provides an additional contamination control boundary, and provides liner containment for spill protection.

Key features of the transfer bell design include

- The capability of containing a resin liner, or an overpack loaded with a resin liner
- A motorized hoist mounted on the top side to permit lifting of the resin liners or overpacks
- A crane-mounting attachment fixed on the top side above the hoist assembly
- Shielding for dose control

4.10 Concrete shields

Concrete shields will be used while liners are out of the ICs to minimize personnel radiation exposure. The shield will be manufactured to allow for the overpack top to be slightly above the top of the shield for ease of installing the lid bolts. Overpacks will be transferred on-site via this shield.

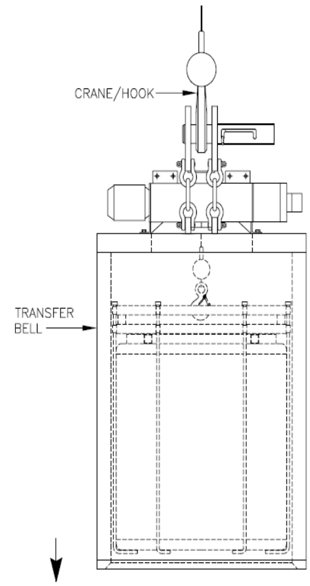


Figure 14 Liner inserted into transfer bell

4.11 Historical records

Historical records will be generated by recording unshielded dose rates and a gamma scan of 10% of the liners.

4.12 Emergency Response

Response to emergencies has been anticipated, including spill response and clean-up for spills of resin liner contents outside an IC structure.

5. Potential Field Conditions

While not all potential adverse conditions have been identified, many were evaluated and are described below. This includes a detailed list of postulated malfunctions and accidents, and proposed contingency plans.

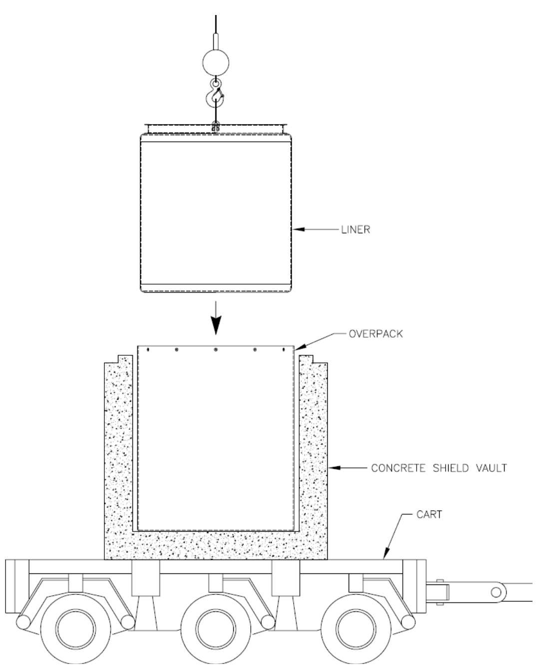


Figure 15 Liner prior to lowering into shielded overpack mounted on transfer cart

Table 2

Potential Adverse Condition	Situation / Origin	Preventative Measures or Remedy
1. Potentially active waste or hardhat on top of resin liner interfering with the manipulator operation or covering the shackle.	WWMF Operations verified a small number of occurrences where hardhats and other personal items have dropped into open IC structures during unloading operations. They have also verified that small quantities of radioactive waste (gloves, plastic bags, paper towels) have been dropped into IC structures as part of resin liner unloading activities.	Use resin liner grapple tool manipulator arm to shift items to the side (on top of resin liner) and then proceed with lifting shackle to centre hook; OR Use manipulator arm to grasp items and lift them to the surface for retrieval as potentially active waste, then lower grapple back to resin liner for regular process sequence.
2. Sling left on shackle (4' slings used for approx one (1) yr, other cases of long slings getting stuck and being dropped into the IC)	WWMF Operations has verified a 2 sling combination was used for storage of $3m^3$ resin liners for approximately one (1) year. This practice was initiated after they were unable to pull the 80 foot sling out of the shackle after the resin liner was stored. A 4 foot long sling was looped through the resin liner shackle then an 80-foot long sling was looped through the ends of the 4 foot shackle. This practice was initiated after they were unable to pull the 80 foot sling out of the shackle after the resin liner was stored.	If short sling– use manipulator arm to pull sling thru shackle and move to side. If long sling – (1) use manipulator arm equipped with cutting tool to cut sling close to shackle, then pull thru – continue with regular process sequence. If long sling - (2) use manipulator to grasp one free end and lift to surface or attach hook on free end to rope the free end to the surface (may require a hole in the top of the grapple frame).
3. Leaky liner	Non-Destructive Examinations of resin liners in storage have identified local corrosion of vertical sections of the carbon steel resin liners. Based on the data gathered resin liners with localized thru-wall corrosion may exist. In this condition, residual liquids and/or resin beads may leak out of the resin liner during handling operations. No data is available for the bottom of resin liners, but similar risks apply for a leak in the side and bottom of a resin liner.	Use audio/video equipment to inspect resin liner prior to and during the lift. Use a crane load cell to assure the full weight of the liner is being lifted. In the event of a leak abandon the lift, close the IC and develop a case specific recovery plan.
4. Contamination spread or released in Weather Enclosure or on Work Platform	Dose rates coming from resin liners may prevent workers from approaching the resin liner as it is lifted from the IC. The risk of spreading loose contamination off the resin liner to surrounding area while suspended between the IC structure and the over-pack needs to be managed. Spill response procedures and equipment are required	Radiation Protection supplies and equipment already in place within Weather Enclosure. Weather enclosure becomes the Rad Work Area. Crane practices should minimize the time the resin liner is suspended above ground before installation in the over-pack. Weather/wind restrictions may be required. A full enclosure could eliminate potential contamination spread.

Potential Adverse Condition	Situation / Origin	Preventative Measures or Remedy
5. Resin liner has higher dose rate than expected.	Unshielded dose rates for all resin liners were recorded at the time of placement in the IC structure. Additional dose rates information has been obtained but the accuracy of the both measurements is not assured.	Based on ALARA evaluation, backout limits may be assigned. If dose rate is above limits – workers regroup. Access to the weather enclosure should be rigorously controlled.
6. Lifting points on IC Shield-plugs are degraded to the point of being unsuitable for lifting.	Embedded anchors on IC-12 shield-plugs are known to have accumulations of water, sediment and corrosion products. Some adjacent concrete is cracked or chipped. Experience with IC-12 inspections forced crews to abandon attempts to inspect 2 of 5 IC's because the embedded anchors were corroded to the point the lifting eye could not adequately engage.	All embedded anchors will require cleaning and inspection. Damaged embedded anchors will be remediated or alternate attachment devices attached. All lifts of IC-12 Shield-plugs ("pucks") that sit directly on resin liners will be lifted less than 3" and held for 5 minutes as a means of verifying the integrity of rigging and attachment to the shield-plugs.

6. Conclusion

Mobilization to the project site commenced in March, 2007. The Construction Island was established, equipment delivered and set up and cold rehearsals were conducted between March and April 2007. Recovery and overpacking of resin liners commenced thereafter. Stage 1 recovery operations are projected to complete in June 2007. Stage 2 recovery operations will commence upon receipt of a notice to proceed from OPG with a target completion date for Stage 2 of February 2008.