SAFETY ASSESSMENT DOCUMENT WITH ENVIRONMENTAL SYNOPSIS FOR SHIPPING HICS LOADED WITH EPICOR-II LINERS FROM INEL TO RICHLAND DISPOSAL FACILITY

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Operated by the U.S. Department of Energy

This is an informal report intended for use as a preliminary or working document

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The cleanup of Three Mile Island (TMI) Unit 2 produced SO steel prefilter liners (denoted EPICOR-II liners) containing dewatered, radioactive ion-exchange resins and zeolites. The EPICOR-II liners were shipped to the Idaho National Engineering Laboratory (INEL) for interim storage. It has been determined that the liners will be permanently buried in the commercial radioactive waste disposal facility near Richland, Washington operated by U.S. Ecology, Inc. Prior to disposal each liner will be placed in a High Integrity Container (HIC) at INEL. The liner and HIC will be transported by truck in a certified, Type 8 cask to the disposal site. This report evaluates the safety and environmental aspects of transporting the 50 liners from INEL to the disposal site near Richland.

New radioactive transportation rules, effective July 1, 1983 require any vehicle transporting Type 8 packages containing large quantities of radioactive materials is subject to specific routing criteria. So "Highway Route Controlled Quantity" has been adopted for these shipments.

Two truck routes are considered for the shipment. The southern route (650 mi, 1050 km) is west across southern Idaho, northwest through eastern Oregon and north through Washington to the disposal site. The northern route (700 mi, 1130 km) is north in southeast Idaho, northwest in western Montana, west across northern Idaho and southwest across eastern Washington to the disposal site.

Safety analyses were prepared for general transportation accidents, explosion due to radiolytic decomposition of liner contents, fires, and radiation during both normal and accident conditions. Those analyses were based upon the following conditions:

- The liner was purged with nitrogen and resultant gas sampled for residual combustible gases.
- The liner was recapped with a porous metal plug and surveyed for radiation.
The liner was loaded in HIC and the epoxy seal cured.

The HIC was loaded into the cask and the cask appropriately sealed.

Radiation and safety inspections have been conducted on the shipment to ensure compliance with all applicable DOT, NRC, and DOE regulations.

Reports of radiation surveillance, gas sampling, and compliance inspections have been submitted to the appropriate EG&G Idaho Safety, Transportation, and program offices.

Truck accidents are very unlikely: only 0.06 accident is expected for all shipments. An "extra-severe" truck accident involving impact speeds greater than 50 mi/h (80 km/h) and fires lasting more than one hour is expected at a rate of $6 \times 10^{-10}$ for all shipments. The tests required for certification show that the cask can withstand this type of accident without release of radioactivity. The cask can also withstand an intense fire for one-half hour without release of radioactivity. External radiation levels of the loaded cask are lower than maximum levels allowed by both DOT and DOE regulations for both normal and accident conditions, and they will be lower than those measured during transport of the liners from TMI to INEL due to the additional shielding provided by enclosure in the HIC.

The analysis of production of explosive gas indicates that a minimum of 74 days is required for gas concentrations to reach lower flammable limits. Eight days or less are required to load a liner into a HIC, cure the epoxy seal, load the HIC into the CNS 14-190 (USA/5026/B()), transport it to Richland (WA) and unload the cask. Since the load and transport time is much less than the time required to produce an explosive mixture, explosions are not possible during transport.
Environmental evaluations considered normal transport and accident conditions. Under either set of conditions consequences were determined to be no more severe than those associated with routine trucking conditions. Transport of the liners from INEL to the disposal site will be safer than transport of the liners from TMI to INEL due to the additional protection and shielding of the HIC. All 50 liners have now been transported to INEL without incident.

It is concluded that the EPICOR-II liners, when loaded in a HIC which in turn is loaded in the CNS 14-190 (USA/5026/B()) shipping cask, can be safely transported to the Hanford disposal site with no adverse environmental consequences.
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1. INTRODUCTION

The 28 March 1979 accident at Three Mile Island (TMI) Nuclear Station Unit 2 resulted in the accumulation of 370,000 gallons (1.4 million L) of water contaminated by fission products (primarily $^{90}\text{Sr}$, $^{134}\text{Cs}$, and $^{137}\text{Cs}$) in the basement of the Auxiliary and Fuel Handling Buildings (AFHB). Another 200,000 gallons (760,000 L) of wash water was contaminated during the decontamination of the Auxiliary Building.\(^1\)

On 16 October 1979, the Nuclear Regulatory Commission (NRC) authorized use of the EPICOR-II demineralizer system for decontamination of water in the AFHB. That work was completed in August 1980 and 50 EPICOR-II liners were stored in concrete vaults at TMI. Each liner was loaded with 2200 Ci or less of $^{90}\text{Sr}$, $^{134}\text{Cs}$, $^{137}\text{Cs}$, their daughter products, smaller amounts of $\text{Ru}$, $\text{Rh}$, $\text{Ba}$ and trace amounts of $\text{U}$ and transuranics. A summary of the curie loadings for EPICOR-II liners is given in Section 2.1.

The TMI vaults were used only as an interim storage facility for the EPICOR-II liners since the NRC concluded that TMI should not become a permanent radioactive waste disposal site. Transportation of the EPICOR-II liners to the Idaho National Engineering Laboratory for research and preparation for final disposition was determined to be the most appropriate course of action by DOE. It was decided that final disposal will be at Richland, Washington.

Two liners, PF-1b and PF-3, were first shipped to Battelle Columbus Laboratories (BCL) in Ohio for characterization. Those liners were subsequently sent to the Idaho National Engineering Laboratory (INEL), in April 1982 and January 1983 respectively, for interim storage in the TAM-607 hot shop. Shipment of the other 48 liners directly from TMI to the INEL commenced in August 1982 and is scheduled for completion in July 1983. A Safety Assessment Document\(^2\) and an Environmental Evaluation\(^3\) were prepared for the transport to INEL. An Environmental Evaluation\(^4\) and Amendments to the facility Final Safety Analysis Report (FSAR)\(^5,6\) were provided for the liner receipt, storage, and research at
This report assesses both safety and environmental aspects of transporting the EPICOR-II liners from INEL to the U.S. Ecology disposal site near Richland, Washington. Each liner will be loaded into a High Integrity Container (HIC) at INEL and the complete assembly will be shipped by truck in a shielded cask.

The EPICOR-II liners are currently property of DOE and will remain so until accepted at the disposal site. DOE is responsible for preparing the liners for shipment and for transportation to Richland, with the costs for transportation and burial to be borne by General Public Utilities Nuclear Corporation (GPUNC). The first shipment of a liner enclosed in a HIC will be in the nature of a demonstration. If no difficulties ensue, the preparation, transport and disposal of the remaining 49 liners will proceed as scheduled. Note, however, that liners continue to be researched so that only 46 are expected to be disposed in the initial campaign.

1.1 Purposes and Scope

The purpose of this document is to assess the safety aspects and evaluate potential environmental effects of transporting the 50 EPICOR-II liners individually enclosed in HICs from INEL to the commercial disposal site near Richland (WA). Separate Safety Assessment Documents and Environmental Evaluations were provided for shipping EPICOR-II liners from TMI to BCL, from BCL to INEL, and from TMI directly to INEL. An Environmental Evaluation was provided for research and storage of the liners at INEL. Safety documentation for the research and storage of the liners is contained in amendments to the FSAR for the Test Area North Building 607 (TAN-607) Hot Shop. The documentation appropriate to the disposal of the liners at Richland is contained in the license of U.S. Ecology.

1.2 Proposed Action

Plans call for transporting the EPICOR-II liners in HICs, one at a time, over a period of about 2 years, beginning September 1983 and ending September 1985. Each HIC, containing a liner, will be placed in a shipping
The shipping of liners in HICs will commence after EG&G Idaho has conducted and completed the following requirements:

- Sampled the liner, purged it with nitrogen, and determined that the combustible gas generation rate is low enough so that the time allowed for transport and disposal is less than the minimum time required to reach the lower flammable limit.
- Reinserted the porous metal plug in each liner.
- Physically loaded the liner into a HIC.
- Allowed sufficient time for the epoxy seal of the HIC to cure properly.
- Loaded the HIC into the certified shipping cask.
- Properly placed the lid on the shipping cask.
- Had a health physicist survey the shipping cask to certify that the surface radioactive contamination is within allowable limits and that surface radiation levels are within allowable limits for transporting over public highways.
- Properly labeled the shipping cask as to its content and surface emission levels according to DOT regulations.
- Properly sealed the shipping cask according to DOT regulations.
- Properly equipped the transport vehicle with placards according to DOT regulations.
- Performed vehicle and tie-down inspections.
Properly verified a safe and legal shipment.

Concluded that the shipment meets all applicable DOE Safety and Security procedures and is located outside the INEL Test Area North perimeter fence.

In order to transport large quantities of low-level radioactive material, which includes EPICOR-II liners inside HICs, the transport package must be a certified package and its user must comply with the following items:

1. Have a copy of the Certification of Compliance and all documents referenced in the certificate, and
2. Comply with the terms and condition of the Certificate of Compliance.

The transportation of radioactive materials increases the exposure risk to those persons residing near the transportation route. An estimated 230,000 people reside between 100 feet and 1/2 mile on either side of the longest of the two EPICOR-II transportation routes between INEL and the Washington disposal site. This estimate is based upon an average population density of 330 persons per square mile and a maximum transport distance of 700 mile (1130 km). The journey from INEL to Richland poses less risks than did the transport of the liners from TMI to INEL due to the additional protection and shielding provided by the enclosure of the liners in the HIC. The route from INEL to Richland is about one third the distance from TMI to INEL, and it passes through more sparsely inhabited country.

At the disposal site, a receipt inspection will be conducted. The HICs with the EPICOR-II liners will be unloaded and buried by U.S. Ecology. The shipping cask will be surveyed and decontaminated, if necessary, before being returned to INEL.
1.3 Agencies and Regulations Involved

The transportation of EPICOR-II liners involves DOE, NRC, and DOT. DOE is sponsoring the transfer, while NRC and DOT are involved via their regulations for packaging of radioactive materials. The packaging and transportation of radioactive materials within the United States is regulated by NRC, DOE, and DOT. Part 71 of Title 10 of the Code of Federal Regulations (CFR) contains applicable NRC rules and regulations concerning the packaging of radioactive materials. DOT regulations governing packaging of radioactive materials, which are consistent with NRC regulations, are found in 49 CFR, Parts 173 and 178. DOT (under the Department of Transportation Act of 1966, the Transportation of Explosives Act, the Dangerous Cargo Act, the Federal Aviation Act of 1958, and the Transportation Safety Act of 1974) has regulatory responsibility for safety in transportation. DOT regulations governing transportation of radioactive materials by rail, and by common contract or private carriers by public highway (e.g., truck) are found in 49 CFR, Parts 170-189. Additional regulations governing the transportation of radioactive materials are contained in DOE Order 5480.1, Chapter III.

There are basic safety requirements which must be met before and during transportation of radioactive materials. They are as follows:

- Adequate containment of the radioactive material;
- Adequate control of the radiation emitted by the material;
- Safe dissipation of heat generated in the process of absorbing radiation;
- Adequate control of the generation of combustible gas within waste containers; and
- Prevention of a nuclear criticality (i.e., prevention of the accumulation of enough fissile material in one location to result in a nuclear chain reaction).
EPICOR-II liners will be transported using Type B packaging as defined by 49 CFR 173.398. Type B packages are shielded heavily and designed to withstand severe accident conditions without any significant release of contents. Because vehicles transporting EPICOR-II liners are consigned for sole use, the following dose limits, as specified by DOT in 49 CFR Part 173 paragraph 173.393(j), apply:

- 200 mR/h at any point on the external surface of the car or vehicle.
- 10 mR/h at any point 6 feet (1.8 m) from the vertical planes projected beyond the outer lateral surface of the car or vehicle; or if the load is transported in an open transport vehicle, at any point 6 feet from the vertical planes projected from the outer edges of the vehicle; and
- 2 mR/h at any occupied position in the cab of the transport vehicle.

Until recently, the primary safety measures regulating transportation of radioactive materials were controls on packaging and related transportation parameters. However, DOT promulgated regulations (effective 1 February 1982) focus on routing and operational controls for highway transportation. Those regulations are revisions of 49 CFR, Parts 173 and 177. In brief, the regulations require the following:

- The motor vehicle carrying radioactive material will be placarded and operated on a route which presents exposure risk to the fewest persons.
- A more specific rule requires that the motor vehicle transporting a package containing a "Highway Route Controlled Quantity" of radioactive materials be operated on "preferred" highways in
accordance with a written route plan prepared by the carrier before departure. The driver must adhere to the prepared route plan insofar as possible. He is allowed to deviate from this route to follow detours set up by the state or local highway department or in case of unforeseen events such as flooding render the designated route impassable.

Although federal agencies principally are responsible for regulating transportation of radioactive materials, state transportation agencies regulate gross vehicle weights, dimensions, and other parameters for all commercial shipping through the issuance of permits. Indian (tribal) governments also possess some degree of control over the transportation of low-level wastes within their jurisdictions. Notification of the tribal governments is not required for these shipments since DOE shipments are exempt from this requirement.
2. DESCRIPTION

The transport cask and High Integrity Containers (HICs) have been designed for safe shipping and disposition of EPICOR-II liners. Figure 1 shows the transport cask on the tractor trailer, the HIC inside the cask, and EPICOR-II liner inside the HIC. It also shows the crushable material placed between the HIC and cask to prevent shifting of the HIC during shipping and to reduce the consequences from impact in the event of an accident. Table 1 shows the dimensions of the transport cask, HIC and EPICOR-II liners.

Section 2.1 provides a physical description of the EPICOR-II liners, their contents, and results of integrity examination of two of the liners. Section 2.2 provides a physical description of the High Integrity Container including: structural features, venting features, weight, and mechanical properties of materials used for construction. Finally, Section 2.3 describes the transport cask to be used for shipping HICs containing EPICOR-II liners from INEL to the commercial low-level radioactive waste disposal facility near Richland, Washington.

2.1 EPICOR-II Liners

Each EPICOR-II liner is a cylinder 48 inches (1.2 m) in diameter and 54 inches (1.4 m) tall fabricated from 0.25-inches (0.6 cm) welded steel (Figure 2). The top surface is recessed 6 inches (15 cm) below the edge of the side wall. In the top are threaded ports for the inflow and outflow of processed liquids, attachment of instrumentation, and ventilation. The inlet and outlet ports are connected individually to header systems inside the liner. The inlet header system was used to spread unprocessed water over the demineralizer material, while the outlet header system collected filtered water from under the ion exchange medium. At the present time, the small ports are closed by threaded steel plugs. Also in the top is a large manway port made from the end of a standard 55-gallon steel drum. The entire top of the drum-end may be removed to provide an opening about 22 inches (56 cm) in diameter. That opening is sealed by a standard
Figure 1. A tractor trailer loaded with a transport cask, HIC and EPICOR-II liner ready for shipping to the commercial burial grounds.
Figure 2. Schematic design of EPIROR-I liner.
55-gallons drum top and seal. The drum top contains a 4-inch (10.2 cm) hole which is sealed with a bung. The large port was used when the liner was fitted with the header systems and was filled with ion exchange medium. The bottom is constructed of a steel plate larger in diameter than the cylinder. As a result, the bottom plate is attached to the side wall via external and internal circumferential welds. Each liner is coated inside and out with Phenol ine 368 paint to protect against corrosion. The liner weighs 1400 lbs (635 kg) empty and approximately 3400 lbs (1550 kg) when loaded with resin. Resin loadings range from 1290 lbs (585 kg) to 1940 lbs (880 kg). Each liner contains 30 ft^3 (850 l) or less of either organic resins (liners 1-11) or a combination of organic ion exchange resins and inorganic zeolite absorbers (liners 12-50).

In processing water from the AFHB, each liner became loaded with radionuclides, mostly strontium-90, cesium-134 and -137, and their daughter products: small amounts of ruthenium-106, rhodium-106 and barium-137; and trace amounts of uranium-238 and some transuranic elements. Table 2 lists the type of resins, residual effluent pH, amount of contaminated water processed, and curie loading for each liner. Table 3 lists the range of radionuclide fractions in liners. The radiation field outside the hottest liner approaches 2800 R/h on contact. In those liners with organic resins only, the radioactivity presumably declines from the top to the bottom of the resin bed. In those containing both resin and zeolite, the radioactivity appears concentrated in the zeolite, which is the top layer in most liners.
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<th>Type of Resin</th>
<th>Residual Effluent pH</th>
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<td>5.19</td>
<td>5,100</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-33</td>
<td>1/0</td>
<td>5.66</td>
<td>5,100</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-34</td>
<td>1/0</td>
<td>4.70</td>
<td>5,100</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-35</td>
<td>1/0</td>
<td>5.34</td>
<td>5,100</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-36</td>
<td>1/0</td>
<td>5.43</td>
<td>5,100</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-37</td>
<td>1/0</td>
<td>5.08</td>
<td>5,100</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-38</td>
<td>1/0</td>
<td>5.13</td>
<td>5,100</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-39</td>
<td>1/0</td>
<td>5.53</td>
<td>5,100</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-40</td>
<td>1/0</td>
<td>4.00</td>
<td>5,100</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-41</td>
<td>1/0</td>
<td>3.80</td>
<td>5,100</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-42</td>
<td>1/0</td>
<td>4.70</td>
<td>5,100</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-43</td>
<td>1/0</td>
<td>3.67</td>
<td>5,100</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-44</td>
<td>1/0</td>
<td>7.60</td>
<td>16,225</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-45</td>
<td>1/0</td>
<td>6.89</td>
<td>17,900</td>
<td>2,000</td>
</tr>
<tr>
<td>Liner Number</td>
<td>Type of Resin</td>
<td>Residual Effluent pH</td>
<td>Water Processed (gal)</td>
<td>Curie Loading</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------</td>
<td>----------------------</td>
<td>----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>PF-46</td>
<td>I/O</td>
<td>6.05</td>
<td>19,200</td>
<td>2,200</td>
</tr>
<tr>
<td>PF-47</td>
<td>I/O</td>
<td>7.82</td>
<td>28,600</td>
<td>1,900</td>
</tr>
<tr>
<td>PF-48</td>
<td>I/O</td>
<td>6.38</td>
<td>28,600</td>
<td>1,900</td>
</tr>
<tr>
<td>PF-49</td>
<td>I/O</td>
<td>3.79</td>
<td>32,731</td>
<td>1,800</td>
</tr>
<tr>
<td>PF-50</td>
<td>I/O</td>
<td>6.69</td>
<td>91,046</td>
<td>1,600</td>
</tr>
</tbody>
</table>

a. Data based upon GPUNC measurements and estimates.

b. 0 = organic  
   I/O = inorganic and organic

c. The value listed is the pH measured at the end of service of the prefiltter liner in the EPICOR-II system.

d. As of April 1, 1982.

e. Original liners were used for the Liner Integrity Examination Project. The resins from PF-3 and PF-16 transferred into new EPICOR-II liners which are designated PF-3A and PF-16A, respectively.

---

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TABLE 3. RANGE OF RADIONUCLIDE FRACTIONS IN EPICOR-II LINERS\textsuperscript{14, 15, 16}

<table>
<thead>
<tr>
<th>Isotope\textsuperscript{a}</th>
<th>Range of Values \textsuperscript{b} (Percent of Total Liner Activity)</th>
<th>Half-Life (yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{90}\text{Sr}/^{Y}$</td>
<td>1 to 23</td>
<td>28</td>
</tr>
<tr>
<td>$^{137}\text{Cs}$</td>
<td>4 to 5</td>
<td>2.0</td>
</tr>
<tr>
<td>$^{137}\text{Cs}/^{Ba}$</td>
<td>72 to 91</td>
<td>30</td>
</tr>
<tr>
<td>$^{239}\text{Pu}$</td>
<td>$1.2 \times 10^{-9}$ to $7.4 \times 10^{-6}$</td>
<td>24,000</td>
</tr>
<tr>
<td>$^{241}\text{Pu}$</td>
<td>$2.2 \times 10^{-8}$ to $1.4 \times 10^{-4}$</td>
<td>13.2</td>
</tr>
</tbody>
</table>

\textsuperscript{a} No other fission or activation products exceeded 1\% of the total activity in an EPICOR-II liner. No other TRU isotope exceeded $5 \times 10^{-5}\%$.

\textsuperscript{b} As of April 1, 1982.

INEL has conducted integrity examinations on liners, PF-16 (containing organic resins and inorganic zeolites) and PF-3 (containing only organic resins).\textsuperscript{17} The examinations showed that PF-16 has greater paint deterioration than PF-3. The calculated life of the EPICOR-II liners is estimated to be greater than 300 years based upon this examination.

2.2 High Integrity Containers (HIC)\textsuperscript{18}

The HIC is a reinforced-concrete cylindrical container designed for disposal of an EPICOR-II prefiler liner in a commercial low-level radioactive waste disposal facility. The container is designed to ensure safe, reliable, below ground disposal of the radioactive waste for a minimum period of 300 years (≈10 half-lives of predominant isotopes).

Figure 3 illustrates the design configuration of the HIC. Corrosion resistance is provided by redundant corrosion barriers (i.e., from inside to out, polyethylene abrasion liner, phenolic-coated steel liner, and concrete) supplemented by aluminum hydroxide to reduce the chemical activity of corrosives. Each corrosion barrier provides a 300-year life to
Figure 3. Design configuration of the high-integrity container without an enclosed EPICOR-II liner.
the container, so collectively those barriers give the HIC a life in excess of 1,200 years. The container lid is attached to the body by two separate materials, Concresive AEX-1513 and Concresive AEX-1512, which form permanent seals. Appendix A contains detailed drawings of the HIC.

The HIC is equipped with a vent system to allow the escape of gas produced in the EPICOR-II liner. (EPICOR-II liners will be vented during shipments.) The vent is cast into and protected by the reinforced concrete lid assembly. The HIC possesses sufficient burst strength to contain all the gas that may be generated without venting based upon a 300 year life. The concrete container attenuates radiation from the enclosed EPICOR-II liner by a factor of about nine; that is not enough shielding to permit hands-on operation but enough to simplify handling procedures and safety precautions. The center of gravity of the HIC is the geometric center of the body. Weights of the container and its ancillary paraphernalia are summarized in Table 4. The bulk specific gravity of the package is 1.84. Mechanical properties of materials for the HIC are listed in Table 5.

Each HIC will be inspected by EG&G Idaho Quality Division. The first disposal is a demonstration. The HIC will be purchased by EG&G Idaho with fabrication inspection under the control of the Quality Division. This inspection will consist of reviewing special processes such as welding, test results of the concrete, drawing configuration, and documentation. The remaining HICs will be purchased by GPUNC. GPUNC is a licensee of the NKL and will inspect HIC fabrication in accordance with the Quality provisions of that license. The Quality involvement will be equivalent to that performed by EG&G Idaho.

All HICs will be inspected by the EG&G Quality Division upon receipt at the INEL for shipping damage, parts accountability, and a verification of GPUNC data package.

Procedures are being developed for loading EPICOR-II liners into HICs. Appendix D has the procedures for loading the liner for the disposal demonstration. The procedure shows both Quality and Safety checks on the
operation. Similar procedures will be developed for disposal of the balance of the liners.

2.2.1 Structural Features

**Concrete Structure.** The cylindrical walls are 6 inches (15.2 cm) thick and the ends are 11 inches (27.9 cm) thick. The reinforced concrete is capable of withstanding an internal pressure of 250 psig and an external pressure of 150 psig. Composition of the concrete provides 6000 psi compression strength. A complex rebar cage is encapsulated in the concrete for strength. The rebar cage is constructed as follows: side--22 circumferential wraps (1/4 inches rebar) and 20 longitudinal bars (No. 5 rebar); bottom--12 crisscrossing bars (No. 4 and No. 5 rebar); and lid--24 crisscrossing bars (No. 4 rebar).

The HIC is lifted by two 1-inch forged stainless steel eyebolts connected to rods embedded in the concrete. The details of construction are found in Appendix A. The eyebolts have a safety factor of 5.5 to 1 based upon ultimate strength. The embedded rods are designed with a safety factor of 7.7 to 1 based upon pullout capacity. The assembly is tested to 150% of design load.18

**Seals.**18 A redundant seal design bonds the lid securely and permanently to the container. The interior, or primary seal, is formed from Concresive AEX-1513 which is a custom-formulated epoxy gel compatible with the phenolic coatings on the steel liner of the HIC. The primary seal is applied to the mating metal surface of the container body before the EPICOR-II prefilter liner is inserted.

The external, or secondary seal, is formed from Concresive AEX-1512 (also a custom-formulated epoxy) which fills the gap between the lid and container body. That epoxy gel or grout is a flowable material, containing rounded aggregate (sand like material) to affect self leveling.
TABLE 4. SUMMARY OF HIC WEIGHTS

<table>
<thead>
<tr>
<th>Components</th>
<th>Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Container body</td>
<td>11,096 (5,038)</td>
</tr>
<tr>
<td>Lid</td>
<td>2,531 (1,149)</td>
</tr>
<tr>
<td>Payload (EPICOR-II liner) (maximum)</td>
<td>3,400 (1,543)</td>
</tr>
<tr>
<td>Seals</td>
<td>110 (50)</td>
</tr>
<tr>
<td>Rub strips and amphoteric material</td>
<td>139 (63)</td>
</tr>
<tr>
<td></td>
<td>17,276 (7,843)</td>
</tr>
</tbody>
</table>

TABLE 5. MECHANICAL PROPERTIES OF MATERIALS USED IN THE HIC

<table>
<thead>
<tr>
<th>Material</th>
<th>Yield Stress (psi)</th>
<th>Ultimate Stress (psi)</th>
<th>Young's Modulus (10^6 psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASIM A-30</td>
<td>36,000</td>
<td>58,000</td>
<td>29</td>
</tr>
<tr>
<td>ASTM A-615 / 60 REBAR</td>
<td>60,000</td>
<td>90,000</td>
<td>29</td>
</tr>
<tr>
<td>Concrete</td>
<td>--</td>
<td>6,000</td>
<td>4.42</td>
</tr>
<tr>
<td>Studs (A-100)</td>
<td>50,000</td>
<td>60,000</td>
<td>29</td>
</tr>
</tbody>
</table>

The seals are expected to receive a maximum total accumulated radiation dose of 200 Mrads. Chemically similar compounds have been tested to 350 Mrads without significant shrinking or reductions in flexure strength. Failure of seals is not expected until doses of greater than 900 Mrads are accumulated. Therefore, the seal should maintain integrity over the life of the HIC (~1200 years).
2.2.2 Impact Resistance

Actual testing has demonstrated that the HIC will retain its structural integrity under the conditions required for Type A containers as set forth in 10 CFR 71.35.

- Corner impact on unyielding surface from a height of 3 feet (0.91 m)
- Drop of penetration pin on container sidewall from a height of 3.3 feet (1.0 m).

The State of Washington requested a test of the HIC in a corner impact on soil from a height of 25 feet (7.6 m). The HIC survived those tests with little damage and no loss of functional capabilities. A corner drop onto an unyielding surface from 9 feet (2.73 m) also was conducted even though that test exceeded the design requirements by a factor of three (based upon energy considerations). The only major damage was degradation of the upper part of the seal between the body and lid. However, the lower part of the grout seal was undamaged and the lid remained firmly fixed to the body of the HIC.

2.2.3 Venting Features

The vent system can accommodate 0.15 moles of hydrogen per day, a flow rate nearly three times greater than the design basis. It consists of the following components:

1. A stainless steel, inline filter element with a 5-micron pore size. The filter ensures that solid (resin) particles will not escape from the container to the external environment.

2. A PVC water trap that self-purges any water by means of gases generated within the container.
3. A 70-micron polyethylene external filter, with large surface area. That filter, located in a recessed PVC pocket at the lid edge, functions as a screen against the entry of mud and debris.

2.3 Cask

A certified Type B transport cask, CNS 14-190 (USA/5026/B(1)), will be used to contain the HIC with its liner during transport by truck from INEL to Richland. The cask will be purchased by DOE specifically for this project. DOE ownership will persist until all 50 liners have been shipped. The tie-down systems are designed to comply with the Nuclear Regulatory Commission Regulation 10 CFR 71.31(d) governing tie-down devices.

The CNS 14-190 (USA/5026/B(1)) shipping cask (Figure 4) is a steel-encased, concrete shielded shipping cask. The cask is 94.25 inches (239 cm) in diameter by 103.75 inches (264 cm) in length. Reinforced concrete occupies the 7 inches (17.8 cm) annular space between the shells and the two base plates. The lid is a 4.75 inch (12.1 cm) thick laminated steel cover held in place by thirty-two, high strength 1.25 inches (3.18 cm) diameter bolts. A silicone O-ring is used to seal the joint between the lid and the cask body. The outer shell and base plate are 1/4 inches (0.6 cm) thick, while inner shell and base plate are 2 inches (5.1 cm) thick. The cask is reinforced at the top and bottom with steel rings and is equipped with lifting lugs. The lid is provided with two access ports. Empty weight of the cask is about 54,000 pounds (24,500 kg), and it has a maximum load of 23,000 lbs (10,400 kg).

A semitrailer is dedicated exclusively for use with the cask. The cask is held to the trailer by sixteen 1.25 inches (13.17 cm) bolts, see Figure 4. The empty weight of the cask, trailer and tractor is ~87,000 lbs (39,500 kg); the maximum loaded weight is ~103,000 lbs (46,700 kg) which requires highway overweight permits.
Figure 4. CNS-14-190 Type B transport cask.
A copy of the certificate of compliance for the CNS 14-190 (USA/5026/B()) cask is included as Appendix B. Shipments will only be made in a cask that has a current, valid certificate of compliance. The U.S. Nuclear Regulatory Commission certification of compliance states that the DOT requirements dealing with radiation shielding leak tightness, heat transfer characteristics, tie-downs, and response to hypothetical accident conditions have been met or exceeded by the transport cask.

The cask is being provided under similar procedure to that used to ship the SDS Zeolite Adsorbers from TMI to the Hanford Facility of DOE. The cask will be an EG&G-owned, NRC licensed cask. The cask is being fabricated under the quality standards of the license of the fabricator. Critical inspections such as weld testing and gamma scanning of the shielding were witnessed by EG&G Idaho Quality Division inspectors. Configuration conformance and documentations were also reviewed by the Quality Division. Routine inspections during service will be performed by the Quality Division. Routine maintenance will be performed by EG&G personnel. A receiving inspection will be performed by EG&G Operations personnel prior to loading a HIC. The Quality Division will assist in the resolution of any unused conditions found.
TRANSPORTATION

3.1 Documentation

Transportation documentation will include Form-ID 5480.1A (US DOE Idaho National Engineering Laboratory Off-Site Radioactive Material Shipment Record) with the following supporting documentation: radioactive material shipment checklist, radioactive waste shipment and disposal form, isotopic percent worksheet, curie content work sheet, vehicle survey, vehicle inspection checklist, low level radioactive waste shipment certification, radioactive waste shipment and disposal form, and a bill of lading. Those forms are attached in Appendix C.

3.2 Description of Routes

Two routes are proposed for transporting High Integrity Containers loaded with EPICOR-II liners from INEL to the commercial low-level waste burial grounds Richland, Washington. Both routes are DOT approved for this type of shipment. The Southern Route passes through the states of Idaho, Oregon, and Washington, passes through two Indian Reservations (Fort Hall Reservation in Idaho, and Umatilla Reservation in Oregon), and has a length of about 650 miles. The Northern Route passes through the states of Idaho, Montana, and Washington, does not pass through Indian Reservations, and is about 700 miles in length. The Southern Route does not utilize any of the routes described in the TMI FPEIS with the exception of the last few miles from Kennewick (WA) to the disposal area. The northern route makes use of the approved route for transporting the liners directly from TMI to Richland from the junction of I-15 and I-90 (a few miles west of Butte, MT) to the disposal area. A detailed description of the two routes follows.

3.2.1 Southern Route

The Southern Route (Figures 5 and 6) travels south from TAN-607 within the INEL to the junction of US-26 and US-20 near the Central Facility Area. From that junction, it proceeds southeast on US-26 to its junction
Figure 5. Idaho National Engineering Laboratory vicinity map.
Figure 6. Map showing the two routes for shipping HIC's from INEL to the Washington State commercial burial ground at Richland.

3.2.2 Northern Route

The Northern Route (Figures 5 and 6) leaves TAN-607 by the same route as does Route 1 through the Central Facility Area. From there it proceeds east on US-20 to its junction with I-15 near Idaho Falls, ID. From that junction, it proceeds north on I-15 to its junction with I-90 a few miles west of Butte, Montana. From that junction, it proceeds northwest on I-90 to its junction with US-395 just west of Ritzville, Washington. It proceeds southwest on US-395 to its junction with US-12 (at Pasco, WA). At that point, it proceeds west on US-12 to its junction with Washington State Highway 240 where it follows Washington State Highway 240 northwest to the burial grounds.
4. SAFETY ANALYSIS

This chapter considers safety aspects of the shipment of EPICOR-II liners from INEL to Richland for disposal. Each liner will be placed in an HIC and transported individually to Hanford in a shielded cask. The cask is sealed and has been analyzed for severe accident conditions. Any radioactivity that might be released during transit is extremely remote.

As discussed in Section 1.1, safety assessments were prepared for shipment of the liners from TMI to INEL. A total of 50 of the liners have been transported to INEL without incident. The transport of liners from INEL to Richland is expected to pose even lesser risk because of additional protection and shielding being provided by the HIC and the route being both one third as long as that from TMI to INEL and situated in mostly rural areas.

Section 4.1 presents criteria which must be fulfilled before shipment can commence. Section 4.2 contains an accident analysis, comprising a consideration of accident occurrence and analyses of possible accidents—transportation, explosion, and fire. Section 4.3 presents maximum radiation levels expected outside the cask under normal and accident conditions.

4.1 Criteria Required for a Safe Shipment

The EPICOR-II liners differ from other common demineralizer radwaste in that quantities of radioactivity have been contained within the ion exchange media for over three years. Radiolysis produced hydrogen during the time liners were in storage. Therefore, certain criteria were developed to control combustible gas mixtures while the liners are in transit. Criteria for transport of liners from INEL to Hanford are much the same as those used to ensure safe transport of liners from TMI to INEL. The criteria, when implemented, will ensure that concentrations of combustible gas mixtures greater than the lower limits of flammability will not exist within the liner or during shipment from the INEL to the...
Washington disposal site. The liner will be in compliance with the applicable DOE, NRC, and DOT regulations. The EG&G Safety Division approved procedures required to satisfy the criteria are as follows:

- After removing the liner vent plug, purge liner with commercial grade argon.
- Recap the liner with a porous metal plug and make radiation surveys.
- Load the liner into a HIC and allow time for the epoxy seal to cure.
- Load the HIC into the cask and seal in the approved manner.
- Conduct radiation and safety inspections of the cask shipment for compliance to all applicable DOT, NRC, and DOE regulations.
- Submit results of radiation survey, gase sampling, and safety inspection to EG&G Idaho, Inc.

Upon determination of the combustible gas generation rates, an appropriate time window for shipment of the liner will be specified by EG&G Idaho, Inc. The shipping window will be the same as was used to ship the liners to the INEL from TMI.

4.2 Accident Considerations

4.2.1 Transportation Accidents

As in transport of any material, there is a certain amount of risk. The EPICOR-II liners are classified as a low-level waste (Class C) and, because of their activity levels, they must be shipped in a certified Type B container, having adequate shielding and a maximum volume of 212 ft³ (6.0 m³). Shipments of the type planned are common in the United States.
"Past incident and accident experience in low-level waste transportation is documented in the Radioactive Materials Transportation Incident Data Base maintained by the Transportation Technology Center at Sandia National Laboratories, Albuquerque, New Mexico. That data base incorporates information from the Hazardous Materials Incident Reporting System (HMIR) instituted by DOT in 1971, from NRC short form and preliminary notification reports dating from 1976, and from supplementary data sources including the Emergency Operations Center of DOE and State radioactive materials control or radiation protection departments."  

The incident and accident experience for the period 1971 to 1981 reflects the following statistics in low-level waste transportation safety:

- Of an estimated 50,000 low-level waste shipments (all types) in the past nine years, there were 312 incidents (including accidents). That number of incidents leads to an approximate incident probability of 0.6% per shipment.  

- Of those 312 incidents, 27% (83) involved suspected releases of radioactivity which did not occur, 63% (199) involved trace surface contaminations, 10% (30) involved the release of limited quantities of radioactive materials, and 7% (22) were transportation accidents, none of which resulted in release of material. The probability of a transportation accident based on past experience is 0.042% per shipment.  

The accident rate for all shipments by truck is $1.7 \times 10^{-6}$ accidents/mile. Using a distance of 700 miles (1130 km) from INEL to Hanford and 50 shipments of individual liner, the probability of an accident occurring is approximately 0.06 during the transfer of all 50 liners. That is, any sort of transportation incident is very unlikely.

An "extra-severe" truck accident involving a collision at 50 mph or greater and resulting in a fire lasting more than one hour is expected every $6 \times 10^{13}$ truck miles. That frequency in an accident probability of $6 \times 10^{-10}$ for all 50 shipments. Severe accident scenarios are considered as part of the Certificate of Compliance approval process.
for the CNS 14-190 (USA/5026/B()) cask. Granting of the certificate ensures that the cask and its contents will survive these accidents with minimal significant consequences. The configuration of the HIC enclosed in the CNS 14-190 (USA/5026/B()) cask has been evaluated and shown to meet all the applicable requirements of 10 CFR 71.21 The HIC itself has been subjected to severe drop tests (see Section 2.2.1) and shown to maintain its integrity.21 Therefore, environmental concerns associated with a transportation incident are limited to nonradioactive effects (oil and fuel spillage, fire, etc.).

The probability of the safe shipment of all 50 liners is enhanced by a sound Program Plan28 for all stages of the project with appropriate equipment and trained, experienced personnel to implement the plan. EG&G Idaho, Inc., the cask manufacturer, and the transportation firm are all experienced and trained to safely handle and transport radioactive materials. EG&G Idaho is a prime contractor at the INEL and has years of experience in the design, testing, and day to day operation of radioactive material handling systems. The cask manufacturer, and the transportation firm, have been involved in the packaging, transporting, and handling radioactive materials associated with commercial power production for many years. The firm selected to transport the liners to Washington will be selected using the same criteria. That experience, coupled with regulations governing the packaging and transportation of radioactive materials, provide a sound basis for the safe transportation of EPICOR-II liners from INEL to Richland.

Emergency preparedness is an important mitigative measure in case of accidents or hazardous incidents during transportation. If an accident occurred during transportation, the emergency plan developed by the appropriate state would be implemented. Also the Radiological Assistance Plan and the Federal Interagency Radiological Monitoring and Assessment Plan would be available to support the state plan. Moreover, each driver will receive detailed descriptions of the routes, instructions for drivers involved in accidents, emergency procedures for radioactive waste accidents, and emergency telephone numbers.
4.2.2 Possibility of Hydrogen Ignition

As indicated above (Section 4.1), the long storage times for the EPICOR-II liners have allowed hydrogen to be generated. Although no ignition source will be present inside the liner, HIC, or cask, the procedures listed in Section 4.1 preclude the occurrence of a combustible mixture during transit.

4.2.2.1 General Background. The first liner to leave TMI was PF-16 which was believed at that time to contain more radioactivity than any of the other 49 liners. Before being shipped to Battelle Columbus Laboratory (BCL) in May 1981, PF-16 first was moved from the staging facility to the Chemical Cleanup Building at TMI for examination. After the ventilation plug had been unscrewed four turns, combustible gas alarms in the building sounded, indicating that hydrogen may have been present. No gas sample was collected. The ventilation plug was removed and replaced the next day, and the liner packaged and readied for transportation to Columbus, Ohio. Two weeks later, when BCL opened the liner, no gas was detected; but an analysis of the atmosphere within the liner indicated about 12% hydrogen and minute amounts of oxygen (<1%). Examination of the resin in PF-16 suggested that the resin had not been altered physically.29

A 25-day gas generation experiment was performed at BCL using liner PF-16. At the start the vapor space was filled with air (20.9% O₂ and negligible H₂). After 25 days the O₂ concentration had dropped to 16.7% and the H₂ concentration was 0.40%.30

These developments indicated that combustible gas ignition should be considered in a complete Safety Assessment for the shipment of demineralizer resins which have accumulated a loading of about 1000 Ci or more and which have been in storage for periods on the order of a year.

For an explosion of gaseous fuels to occur, four general conditions must be met. They are as follows:
A combustible gas within a flammable or detonable concentration must be present within the liner.

An oxidizer such as air (oxygen) must be in admixture.

An ignition source must be present.

Chain carrier radicals (ions) must be produced within the flame front which propagate the combustion reaction.

The reduction to a safe level or elimination of any one of those four conditions prevents a gas phase explosion.

4.2.2.2 Research Results. Brookhaven National Laboratory (BNL) conducted a literature search of the state-of-the-art of knowledge on radiation effects on organic ion exchange resins in 1977.31 Two laboratory studies and two updated reviews were reported in 1980.32,33,34,35 The experimental results reported through 1980 have been for either organic resins or inorganic (zeolite) materials, but not for mixtures of the two types. Generally, the laboratory studies found that organic resins in radiolytic environments produce combustible gases, such as hydrogen and methane, and also of carbon dioxide and, in lesser amounts, carbon monoxide. The inorganic resins in radiolytic environments produce hydrogen and oxygen via radiolysis of water present in the resin bed.

Two studies published in 1981 find effects on ion exchange media in radiolytic environments not previously reported or addressed.36,37 The first study reported that, although elevated $H_2$, $CO_2$, and $CO$ concentrations were measured in an EPICOR liner, the oxygen concentration measured was two orders of magnitude lower than the concentration present in ambient air. The concentration of oxygen present in the liner was below that necessary to form a combustible mixture with hydrogen. The latter study found that resins in stainless steel containers irradiated by gamma and electron sources showed depletion of oxygen and that container
pressures first decreased below initial values before increasing with increased dose. Since stainless steel containers were used, the oxygen could not have been depleted via corrosion.

The most recent resin irradiation studies at INEL indicate that, for integrated doses of 0.75 to 1.5 megarad using a fuel element irradiation source, oxygen concentrations are depleted in excess of 90% in an organic resin environment while oxygen concentrations are depleted between 10 and 20% in an inorganic resin environment. Therefore, removal of all the oxygen in the gas space of the liner before sealing will preclude combustion since no oxidizing agent will be available to react with the hydrogen.

Hydrogen generation tests were performed at TMI by GPUNC on some of the liners before the shipment to INEL. The tests were made over periods of several weeks. The available data are summarized in Table 6. The hydrogen generation-rate was proportional to the curie loading. The average rate is approximately 1.64 x 10^-6 cm^3/Ci-s. In addition to the hydrogen generation-rate study, studies at BCL and TMI have verified that oxygen is almost entirely absent in the liners because of an oxygen depletion mechanism. Subsequent to the gas generation studies, each liner sent to the INEL had the initial atmosphere sampled, was purged with nitrogen, and then had the hydrogen generation-rate measured, over a period of 2-4 days. That was done to demonstrate that the liner atmosphere would have hydrogen and oxygen concentrations less than the lower limits of flammability during the maximum shipping period. The lower limits of flammability are a hydrogen concentration of 0.052 g-moles/ft^3 and an oxygen concentration of 0.063 g-moles/ft^3.

4.2.2.3 Analysis for Shipment. Before shipment, each liner is purged with nitrogen and then closed with a porous plug. The porous portion of this plug is a sintered metallic material containing passages on a microscale which allow gases to escape but precludes the escape of particulate material. Such a flow path does not promote the mixing of the air from the free volume of the HIC with the nitrogen, and any hydrogen
### TABLE 6. HYDROGEN GENERATION IN THE TMI-2 EPICOR-II PREFILTER LINERS

<table>
<thead>
<tr>
<th>Liner Number</th>
<th>Activity (Curies)</th>
<th>$\frac{3}{(\text{cm}^2/\text{Ci})\cdot\text{s}}$</th>
<th>(g/h)</th>
<th>Calculated&lt;sup&gt;a&lt;/sup&gt; (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1498</td>
<td>1.558 E-6</td>
<td>0.00844</td>
<td>89.8</td>
</tr>
<tr>
<td>2</td>
<td>1052</td>
<td>2.197 E-6</td>
<td>0.00832</td>
<td>91.4</td>
</tr>
<tr>
<td>3</td>
<td>1878</td>
<td>1.464 E-6</td>
<td>0.00990</td>
<td>90.1</td>
</tr>
<tr>
<td>6</td>
<td>166</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>&gt;150</td>
</tr>
<tr>
<td>7</td>
<td>1402</td>
<td>1.337 E-6</td>
<td>0.00675</td>
<td>132</td>
</tr>
<tr>
<td>32</td>
<td>1767</td>
<td>1.651 E-6</td>
<td>0.0105</td>
<td>85</td>
</tr>
<tr>
<td>35</td>
<td>1767</td>
<td>1.651 E-6</td>
<td>0.0105</td>
<td>85</td>
</tr>
<tr>
<td>36</td>
<td>1767</td>
<td>1.651 E-6</td>
<td>0.0105</td>
<td>85</td>
</tr>
<tr>
<td>39</td>
<td>1767</td>
<td>1.651 E-6</td>
<td>0.0105</td>
<td>85</td>
</tr>
<tr>
<td>40</td>
<td>1767</td>
<td>1.651 E-6</td>
<td>0.0105</td>
<td>85</td>
</tr>
<tr>
<td>42</td>
<td>1767</td>
<td>1.651 E-6</td>
<td>0.0105</td>
<td>85</td>
</tr>
<tr>
<td>46</td>
<td>2184</td>
<td>1.526 E-6</td>
<td>0.012</td>
<td>74</td>
</tr>
</tbody>
</table>

<sup>a</sup> Time to reach lower flammability limit.

that is generated in transit, in the liner. Nonetheless, since a gaseous flow path exists from the liner to the HIC (through the porous plug) and from the HIC to the cask (through the vent system of the HIC), the possibility of an air-hydrogen mixture forming must be considered. The most conservative assumption is that the nitrogen in the liner is somehow replaced with air, while the hydrogen remains in the liner. That allows the hydrogen to mix into the smallest volume of air.
The minimum free volume in any of the liners is 714 l. This is for the liner with the most resin and includes void space. Using this volume and a hydrogen generation rate of $1.64 \times 10^{-6} \text{cm}^3/\text{Ci-s}$ as given above, the flammability limit would be reached in 74 days in the liner. Thus there is well over two months to transport each liner to Hanford and dispose it before hydrogen ignition is possible. In actuality, placement in the HIC, transport, and disposal is only expected to take about one week.

Note that this analysis conservatively assumed that the hydrogen remained in the liner and air passed through the porous plug to replace the nitrogen which passed out through the same plug. In reality, the increased pressure in the liner due to the hydrogen generation is likely to force some of the $\text{H}_2$ and $\text{N}_2$ out of the liner and very little mixing of air into the liner will occur. In this case, with the larger HIC free volume and only part of the hydrogen available, the time to obtain a combustible mixture will probably be one or two years.

4.2.3 Fire

One severe accident considered feasible is collision of the truck carrying the liner with a truck containing a flammable liquid such as gasoline. Conceivably, following an accident the trailer and cask could end up near the center of the fire due to the ignition of vapors from the pool of spilled liquid fuel. The cask is completely constructed of non-combustible material, and the 7 inches (17.8 cm) of concrete in the wall provide a substantial thermal barrier for periods approaching an hour. Tests on actual type B casks have shown that they can withstand fires of this type without leakage. For the CNS 14-190 (USA/5026/B()), this type of accident is considered in more detail in the SAR.22

49 CFk 173 specifies a radiant heat source at 1475°F (802°C) for 30 minutes, after which an environmental temperature of 130°F (54.4°C) holds. The maximum temperature attained on the inside surface of the cask was less than 200°F (93.3°C).
4.3 Radiation

This subsection consists of three parts. First, the radiation field outside the shielded cask is considered to demonstrate that there is no risk to the general public. Secondly, the radiation exposure of the drivers is computed to show that their dose is well below specified limits. Finally, radiation levels following a postulated accident are shown below appropriate limits.

Radiation levels outside a shipping cask containing a HIC and liner will be below those measured during transport of liners from TMI to INEL. That is due to the additional shielding, about a factor of 9, provided by the HIC. Actual tests have shown that the HIC is structurally sound and retains its integrity in any credible accident.

4.3.1 General Radiation

A radiological analysis was done for the EPICOR-II liner in transit configuration, i.e., with the liner inside the HIC which in turn is within the sealed CMS 14-190 (USA/5026/B()) cask. The analysis was done using liner PF-46, the liner with the highest remaining inventory corrected for decay to September 19, 1983. The inventory is shown in Table 7. The geometry used is as shown in Figure 7. The calculations were done using the computer code ISUHLID-II.

The maximum field at the side of the cask was calculated to be 50 mR/hr at contact, falling off to 10 mR/hr at 3 feet. Maximum fields from the cask top were calculated to be 10 mR/hr at contact and 5 mR/hr at 3 feet respectively. These are well within the 10 CFR 49 Section 173.393 (1,j) limits of 200 mR/hr at contact, and 10 mR/hr at 6 feet from the vertical planes projected from the edge of the vehicle. The fields are also within EG&G Safety Manual limits for radioactive shipments. Since those radiation levels are well below the appropriate limits, the hazard to the general public, who will neither be in contact with the cask nor in its general vicinity for any appreciable period of time, is minimal.
### TABLE 7. RADIOISOTOPIC INVENTORIES USED FOR SHIELDING CALCULATIONS

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Inventory (Ci)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cs-137</td>
<td>934</td>
</tr>
<tr>
<td>Ba-137b</td>
<td>934</td>
</tr>
<tr>
<td>Cs-134</td>
<td>57</td>
</tr>
<tr>
<td>Sr-90</td>
<td>94</td>
</tr>
<tr>
<td>Y-90</td>
<td>94</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2113</strong></td>
</tr>
</tbody>
</table>

---

a. Other radioisotopes present in the liner add an insignificant external radiation dose.

b. Ba-137 is a decay product of Cs-137. Since it has a much shorter half-life than Cs-137, it is in equilibrium with Cs-137.

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The final Programmatic Environmental Impact Statement (PEIS) for the TMI accident indicated that the population dose to people (estimated 700,000) living along a 2,750 mile (4,427 km) route from TMI to the disposal site would range from 17 to 50 person-rem for all TMI waste and fuel shipments. Thus, the average dose to an individual living along this route would range from 0.02 mrem to 0.1 mrem. The population dose and average individual dose rates would be lower for the shipments of liners from INEL to Richland because: (1) the route is much shorter; (2) the radiation fields around the casks are greatly attenuated due to the HICs; (3) less waste is being shipped than was considered in the PEIS; and (4) the population along the route is much lower than that used in the PEIS calculations. Thus, normal transport of EPICOR-II liners should not pose a radiological health hazard.
**NOTE** - The HIC is assumed to have shifted directly against cask side for conservatism.
The radioactivity decay heat generation rate in any shipment will be less than 8 watts, and external radiation readings will be a small fraction of the design shielding limit of the cask. The dose rates for each shipment will be verified by measurement after the liner is loaded in the shipping cask.

4.3.2 Exposure of the Drivers

Unlike the general public along the transit route, the drivers will be relatively close to the cask for extended periods of time. By utilizing two drivers the shipment will go straight through to Richland with only food and fuel stops. Maximum truck travel time is estimated to be 20 hours, which allows for an average of 35 mph via the longer route. [Driving time could be as short as 12 hours, if a 55 mph average is maintained for the shorter route.] Only the truck travel time is used in computing the dose to the drivers, because the drivers are expected to be away from the truck during stops. If severe winter weather or other road closures cause the trip to be interrupted, one driver is required to remain with the shipment at all times. This contingent dose has not been assessed due to the unknown duration of the interruption; it, however, may approach an equivalent to the dose of one additional trip that is shown below as a small fraction of the allowable annual dose.

As shown in Figure 8, the driver closest to the cask will be the one resting in the sleeper portion of the truck cab. For simplicity it is assumed that both drivers are only 20 feet (6.1 m) from the front of the cask although the minimum distance (depending on the tractor used) will be at least 22 feet (6.7 m). A shielding analysis done for 20 feet showed the radiation level to be 0.54 mR/hr for the highest inventory cask. This is significantly below the DOT limit (10 CFR 49 173.393j) of 2 mR/hr at any occupied cab location. Therefore, the maximum dose per shipment is 11 mR. Two teams of drivers will be used to transport the 50 casks, so the maximum dose received by any one driver (25 trips) is 270 mR. That is well below the maximum occupational dose (whole body) of 5000 mR/yr set by DOE.
Figure 8. Complete vehicle as loaded for transport of EPICOR-II liner and HIC in CNS-14-190 cask from INEL to Richland.
4.3.3 Radiation Levels Following an Accident

The CNS 14-190 (USA/5026/B()) cask which will be used to ship the EPICOR-II PF liners from INEL to Richland is a licensed type B cask meeting all applicable DOT, NRC, and DOT requirements. Figure 4 illustrates the cask. A copy of the certificate of compliance (SAR) is contained in Appendix B. Details are contained in the Safety Analysis Report for the cask.22

Analysis for the CNS 14-190 (USA/5026/B()) cask, described in the SAR, demonstrates that the reduction of shielding caused by imposing the hypothetical accident condition loads as specified in Appendix B of 10 CFR 71 will not increase the external dose rate to more than 1000 mR/hr at 3 feet from the external surface of the package and that none of the contents would be released from the package. The hypothetical accident conditions specified in Appendix B of 10 CFR 71 were applied sequentially to determine their cumulative effect on the cask package.

As discussed above, the cask will retain its integrity and its contents under severe accident conditions. The worst case accident condition is that both the liner and HIC have ruptured (although highly unlikely) and the resin has escaped and flowed to the bottom of the cask which is lying on its side. The lower surface of the resin will conform to the curved cask wall and the top surface may be irregular. This resin distribution has been modeled for ISOSHLD-II as a rectangular block 7.35 feet by 3.46 feet by 1.26 feet high. The source material is assumed to be homogeneously distributed through this block. Considering only the shielding provided by the cask, the maximum field outside the cask was found to be 630 mR/hr at the cask surface and 400 mR/hr 3 feet from the cask. These are well below the 1000 mR/hr at 3 feet specified by 10 CFR 71.36(a). Note that this assumes that the person is located directly below the cask and that the HIC has lost its structural integrity, both of which are highly unlikely. For more probable occurrences, the dose rate would be much lower than the calculated values.
Recent estimates indicate that current shipments involve approximately 2,500,000 packages of radioactive materials per year in the U.S. There have been no known deaths or serious injuries to the public or transportation industry personnel as a result of any radioactive material shipment. Therefore, considering the designed curie limit of the cask, the low curie content of the liners, the history of radioactive shipments, and the minimal risk of contamination or release, it is concluded that these shipments will not compromise the safety of people living along the proposed routes.

4.4 Safety Assessment Summary

Criteria have been prepared to ensure that each shipment will meet all applicable requirements and that each shipment will be adequately prepared to reach Richland safely. An analysis of an estimated 50,000 shipments of radioactive material over a nine year period shows that only 312 incidents of any sort happened. Only about 10% of transport incidents resulted in more than minor surface contamination, and there has been no case in which a major release of radioactivity occurred. Based on the historic accident rate, the occurrence of an accident in the transport of all 50 liners to Hanford is very unlikely. All of the 50 liners have been shipped from TMI to INEL without incident.

In the unlikely event that a serious accident should occur, the construction of the cask is such that leakage of radioactive material from the cask is extremely remote. Tests have shown that the HIC did not lose its structural integrity due to impact loadings typical of a severe accident.10

The possibility that enough hydrogen may be generated by radiolysis within the liner to create the required conditions for ignition has been carefully considered. Under the worst possible assumptions, the measured rates of hydrogen production will not cause the $H_2$ concentration to reach the lower flammable limit in less than 74 days. Under the most time-consuming scenario, only two weeks will elapse between installation of the
porous plug in the liner at INEL and burial at Richland. Therefore, the hydrogen concentration will be below the lower flammable limit for the entire shipment.

The radiation fields in the vicinity of the cask have been computed and shown to be well below the applicable limits, under both normal and accident conditions. The dose received by the drivers is only a small fraction of the allowable occupational dose.

The requirements for a safe shipment have been met and 50 EPICOR-II liners can be transported from INEL to Richland without undue risk to either the general public or the personnel involved.
5. ENVIRONMENTAL SYNOPSIS

The purpose of this section is to evaluate potential environmental effects associated with the transport of EPICOR-II liners from the INEL to a commercial radioactive waste disposal facility at Richland, Washington for final disposal. The overall environmental concerns associated with the TMI accident were addressed by the final Programmatic Environmental Impact Statement (PEIS) that was prepared by the NRC. Furthermore, an Environmental Synopsis was prepared in 1982 for transport of EPICOR-II liners from TMI to the INEL. Thus, this is the final phase of program to evaluate and then dispose of EPICOR-II liners.

5.1 Description of Environment

5.1.1 Route 1

Route 1 is 650 miles (1,000 km) long and passes through southern Idaho, northeastern Oregon and then goes north from Hermiston, Oregon to the disposal site at Richland, Washington. Approximately 70% of the route occurs in agricultural or sagebrush/grassland areas and the remainder (30%) passes through the forested mountains of northeastern Oregon. Most of the areas along the route are used for farming and ranching. Approximately 210,000 people live within 0.5 miles (0.8 km) of this proposed route. This estimate is based upon an average population density of 330 people/mile$^2$ (127 people/km$^2$).

This route does not bisect any major cities but does skirt the edge of Pocatello and Boise, Idaho and Baker, LaGrande, and Pendleton, Oregon before reaching Richland, Washington. The route does not pass through any major recreational areas but does occasionally follow the Snake River in southern Idaho.
5.1.2 Route 2

Route 2 is about 700 miles (1,100 km) long and passes through southeastern Idaho, western Montana, and eastern Washington. Approximately 65% of the route traverses forested, mountainous areas in all 3 states. The remainder of the route passes through farmland and areas dominated by sagebrush and grassland. The areas along the route are primarily used for agriculture, ranching and timber harvesting. Based on an average of 330 people/mile$^2$ (127 people/km$^2$) approximately 230,000 people live within 0.5 miles (0.8 km) of this proposed route.


5.3 Potential Environmental Impacts

5.3.1 Transportation

The transportation of EPICOR-II liners from the INEL to the Richland Site is not expected to have noticeable environmental effects. Vehicle emissions, engine noise, and heat will be produced as part of normal trucking operations. These effects will be temporary and not cause a significant changes in the existing air quality along the highway. Under normal transportation and storage conditions, no routine effluents or releases from the casks or transport vehicles are expected. "Normal" transportation is the situation when transportation occurs without unusual delay, loss, or damage to the package, or an accident involving the transport vehicle. The impact on the environment is considered negligible under this condition.

As previously stated, EPICOR-II liners will be transported from the INEL to Richland in HICs. This is the only transport condition that differs from those described in the previous Environmental Evaluation prepared for transport of EPICOR-II liners from TMI to the INEL. The
use of HICs should further decrease the chance of accidently releasing radionuclides to the environment. Thus, another safety feature has been adopted.

5.3.2 Transportation (Incident Conditions)

Incident frequency is discussed in Section 4. An incident involving the release of radionuclides was considered highly unlikely in the previous Environmental Evaluation for EPICOR-II liners and is even less likely now because of the use of HICs. Therefore, environmental concerns associated with a transportation incident are limited to nonradioactive effects (oil and fuel spillage, fire, etc). These effects would be similar to those from any large truck accident and should have little effect on the environment.

5.3.3 Radiation Exposure

The principal environmental impacts from normal transport and disposal conditions are radiological. These impacts include direct radiation exposure to workers, truck drivers, and bystanders along the route. Radiation exposures have been discussed in Section 4.

5.3.4 Mitigative Measures

The use of HICs also provide an important mitigative measure and have been discussed previously in this report. These conditions are discussed in Section 4.

The most effective mitigative measure is developing a sound project plan for all stages of the project with appropriate equipment and trained, experienced personnel to implement the plan.
5.4 Anticipated Benefits and Alternatives

5.4.1 Benefits

Using HICs to transport waste may be the most important benefit of this action. The successful use of HICs should demonstrate a safe, environmentally sound method of transporting radioactive waste.

Furthermore, the proposed action will remove radioactive waste from the INEL. Transportation of the liners to Richland will also result in the disposal of TMI waste.

5.4.2 Alternatives

The U.S. Ecology disposal site at Richland is the only facility that will currently accept TMI waste. The radioactive waste management sites at the INEL and Nevada Test Site will only accept defense related waste. The waste disposal site at the Savannah River plant will not accept TMI waste because of public sentiment. Therefore, transportation of EPICOR-II liners to another facility is not possible at this time.

5.4.2.1 Mode of Transportation. Shipments by truck or intermodal rail/truck are alternatives for the transport of EPICOR-II liners to Richland. Trucks can depart from the INEL and go directly to the disposal location at the Richland Site. Availability of shielded rail casks is limited; there are constraints imposed on rail shipments that create logistics problems and increase shipment duration; and intermodal shipments may involve higher exposure levels to handlers than do single mode shipments because of the transfers required. Therefore, truck transportation from the INEL to the disposal location at Richland is considered the most acceptable mode of transport for EPICOR-II liners.

5.4.2.2 Routes. Only two routes available for shipping EPICOR-II liners from the INEL to Richland have been described. Other routes could be used but they are much longer and/or not suitable for a heavy or radioactive shipment.
5.4.2.3 No Action. The no action alternative would result in the liners being retained at the INEL. Although the INEL has a waste disposal complex, this facility is not presently authorized to accept commercial waste. Therefore, this alternative is unavailable at this time.
6. CONCLUSIONS

6.1 General Conclusion

It is proposed to ship 50 EPICOR-II liners, each loaded and sealed in a HIC, to a commercial disposal site near Richland, Washington. Each liner and HIC will be shipped as a certified truck shipment in a CNS 14-190 (USA/5026/B()) shielded cask. Specific conclusions for the Safety Analysis and the Environmental Synopsis are listed below. Based upon those conclusions it is concluded that the liners can be safely shipped as proposed with no adverse environmental effect.

6.2 Safety Analysis Conclusions

Based upon the safety analysis of Section 4 it is concluded that:

1. The probability of a traffic accident while shipping the liners is very low. Fifty EPICOR-II liners already have been transported from TMI to INEL without incident. The distance from TMI to INEL is about three times as great as that from INEL to Richland.

2. The cask would contain the radioactive contents of the liner, if an accident were to occur. It is also highly unlikely that the HIC would rupture.

3. The combustible gases will not reach the lower flammable limit during shipment of the liner.

4. There are minimal consequences of a fire following an accident.

5. Radiation fields are below prescribed standards for both normal and accident conditions. The HIC reduces the radiation levels to a fraction of those measured during shipment of the liners from TMI to INEL.
Therefore it is concluded that the liners can be safely shipped.

6.3 Environmental Synopsis Conclusions

Based upon the environmental synopsis of Section 5 it is concluded that:

1. If no accident occurs, the environmental effects are limited to routine highway trucking. No adverse impacts have been observed in the transport of all 50 liners from TMI to INEL, a journey about three times that from INEL to Richland.

2. Should an accident occur during transport environmental effects are limited to those common to routine trucking. The HIC and the cask will prevent the escape of any radioactive materials and provide adequate radiation shielding even under accident conditions.

3. Measures exist to mitigate the environmental impacts in the unlikely event of a radiological release.

4. The benefits of trucking the liners to Hanford exceed those of the other alternatives.

Therefore it is concluded shipping the liners as proposed has no adverse environmental effects.
7. REFERENCES


12. TMI FPEIS (Reference 1), p. 9-5.


17. Reference(s) for PF-3 and PF-16 exam. reports and estimate of liner life. (May-TMI Monthly Report.)


23. TMI FPEIS (Reference 1), Chapter 9.


27. Wash-1238 (Reference 25), p. for 1 "extra severe" accident every 6E13 truck-miles.


30. J. D. Yesso, Battelle Columbus Lab, BCL Monthly Progress Letter to R. E. Holzworth, EG&G Idaho.


40. R. E. Ogle EG&G Idaho, letters to T. C. Runion, EG&G Idaho; REQ 23 and 32, 1982, and 1, 5, 6, 7, 7, 9, and 11, 1983. Subject was SAD compliance of EPICORK prefilter liners for shipment to INEL.


43. M. E. Wilk to R. L. Chapman, Addition to Radiation Analysis of Shipping Cask - CNS 14-190, EG&G Idaho Internal Memo MEW-8-83 from May 10, 1983.


46. Radiation Field at Drivers Position During Shipping of Cask CNS-14-190, EG&G Idaho Internal Memo MEW-13-83 from M. E. Wilk to A. L. Ayers, Jr., May 31, 1983.


APPENDIX A

HIGH-INTEGRITY CONTAINER DESIGN
ALL SURFACES OF PART NO. TP-1014 ARE TO BE GRIND AND CLEANED.

A. FACE: PREPARE THE GRIND, ROLLER AND FILE THROUGH A ROLLER.

B. SCREW COAT: PREPARE THE SCREW, ROLLER AND FILE THROUGH A ROLLER.

C. DRILL HOLE:

LINES OF SUPPLY: LANDING CRE.

THE BUNKER INDUSTRIAL CENTER

ST. LUCES, NY.

REFERENCES:

EP-20W1

STEEL CORROSION BARRIER

NUCLEAR PACKAGING, INC.

FAB DETAILS.

STL. ASSEMBLY

LID DETAILS.

EP-20W1

NUCLEAR PACKAGING, INC.

FAB DETAILS.
DETAIL ITEM 1

- All holes shall be drilled with standard straight pipe flares unless otherwise specified.
- Tolerances shall be ±0.005 inches unless otherwise specified.
- All dimensions shown are in inches.
- All materials shall be compatible with radiation and fluids.
- All parts shall be welded using the specified welding process.
- All parts shall be inspected using the specified inspection methods.
- All parts shall be painted with the specified paint type.
- All parts shall be assembled per the specified assembly instructions.
- All parts shall be labeled with the specified label information.
- All parts shall be packaged per the specified packaging instructions.
- All parts shall be stored in a controlled environment.

DETAIL ITEM 2

- All dimensions shown are in inches.
- All parts shall be machined with the specified tolerances.
- All parts shall be inspected using the specified inspection methods.
- All parts shall be painted with the specified paint type.
- All parts shall be assembled per the specified assembly instructions.
- All parts shall be labeled with the specified label information.
- All parts shall be packaged per the specified packaging instructions.
- All parts shall be stored in a controlled environment.

DETAIL ITEM 3

- All dimensions shown are in inches.
- All parts shall be machined with the specified tolerances.
- All parts shall be inspected using the specified inspection methods.
- All parts shall be painted with the specified paint type.
- All parts shall be assembled per the specified assembly instructions.
- All parts shall be labeled with the specified label information.
- All parts shall be packaged per the specified packaging instructions.
- All parts shall be stored in a controlled environment.
CERTIFICATE OF COMPLIANCE FOR THE CNS 14-190 SHIPING CASK

APPENDIX B

CERTIFICATE OF COMPLIANCE FOR THE CNS 14-190 SHIPING CASK

(a) Packaging

(1) Model No.: CNS 14-190

(2) Description

The packaging is a steel-encased, concrete shielded shipping cask. The cask is 94-1/4 inches in diameter by 103-3/4 inches in length. Reinforced concrete occupies the 7-inch annular space between the shells and the two base plates. The lid is a 4-3/4 inch thick laminated steel cover held in place by 32 high strength 3-1/4-inch diameter bolts. A silicone O-ring is used to seal the joints between the lid and the tank body. The outer shell and base plate are 1/4 inch thick, while inner shell and base plate are 2 inches thick. The cask is reinforced at the top and bottom with steel rings and is equipped with lifting lugs. The lid is provided with two access ports. Gross weight is about 71,000 pounds.

(3) Drawings

The package is constructed in accordance with the following ATSDR, Inc. Drawing Nos.: 1000-D-0049; 0146-B-0004, Rev. E; 0146-B-0009; 0146-D-0025, Rev. A; 0146-D-0020-1, Rev. A; and 0146-C-0010, Rev. E.
CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIALS PACKAGES

5026
8
USA/5026/B( )
1
3

PREAMBLE

The certificate is issued to certify that the packaging and contents described in item 5 below meet the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71 "Packaging of Radioactive Materials for Transport and Transportation of Radioactive Materials Under Certain Conditions."

The certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

This CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

Chem-Nuclear Systems, Inc.
240 Stoneridge Drive
Columbia, SC 29210

Chem-Nuclear Systems, Inc.
Application dated November 19, 1979, as supplemented.

O Docket Number
71-5026

CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71 as applicable and the conditions specified below.

(a) Packaging

(1) Model No.: CNS 14-190

(2) Description

The packaging is a steel-encased, concrete shielded shipping cask. The cask is 94-1/4 inches in diameter by 103-3/4 inches in length. Reinforced concrete occupies the 7-inch annular space between the shells and the two base plates. The lid is a 4-3/4 inches thick laminated steel cover held in place by 32, high strength 1-1/4-inch diameter bolts. A silicone O-ring is used to seal the joint between the lid and the cask body. The outer shell and base plate are 1/4 inch thick, while inner shell and base plate are 2 inches thick. The cask is reinforced at the top and bottom with steel rings and is equipped with lifting lugs. The lid is provided with two access ports. Gross weight is about 71,000 pounds.

(3) Drawings

The package is constructed in accordance with the following ATCOR, Inc. Drawing Nos.: 1000-D-0049; 0146-B-0004, Rev. E; 0146-B-0009; 0146-D-0025, Rev. A; 0146-D-0020-1, Rev. A; and 0146-C-0010, Rev. E.
(b) Contents

(1) Type and form of material

(i) Byproduct material in the form of solids and solidified waste contained within secondary container(s).

(ii) Radioactive material in the form of activated reactor components packaged in secondary containers.

(2) Maximum quantity of material per package

Greater than Type A quantity of radioactive material, not to exceed 20 thermal watts and 23,000 pounds including weight of the contents, secondary container(s) and shoring. The contents may include fissile materials provided the mass limits of 10 CFR §71.7 are not exceeded.

6. The dose rate from the loaded cask shall not exceed 10 mrem/hr at six feet from the surface of the cask.

7. The access plugs shall be appropriately plugged and sealed prior to transport.

8. Shoring shall be placed between the secondary container(s) and the cask cavity to prevent movement during accident conditions of transport.

9. Prior to each shipment, the packaging lid silicone O-ring shall be inspected. The O-ring shall be replaced with a new silicone O-ring if inspection shows any defects or every six (6) months, whichever occurs first.


11. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR §71.12.

REFERENCES

Supplements dated: April 14 and June 17, 1983.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Charles E. MacDonald, Chief
Transportation Certification Branch
Division of Fuel Cycle and
Material Safety, NMSS

Date: JUL 1: 1983
By application dated June 17, 1983, Chem-Nuclear Systems, Inc. requested that the certificate be amended to allow the fabrication of future packages from A-516, Grade 70 carbon steel rather than the currently authorized A-36 and A-516, Grade 60 carbon steels. The applicant has shown that A-516, Grade 70 carbon steel has better mechanical properties for use in shipping packagings.

The staff is in agreement with the applicant that the proposed material of construction will improve the overall quality of future packagings.

Charles E. MacDonald, Chief
Transportation Certification Branch
Division of Fuel Cycle and
Material Safety, NMSS

Date: Jul 18 1983
APPENDIX C

TRANSPORTATION DOCUMENTATION
# US DOE Off-Site Radioactive Material Shipment Record

**Shipment From:**

**Log No.:**

**References:**

DOE 5480 IA Chap III.

49 CFR 100-109

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(DIRECTIONS ON REVERSE SIDE)
RADIOACTIVE MATERIAL SHIPMENT CHECKLIST

DATE SHIPPED

MATERIAL BEING SHIPPED: ____________________________________________

SHIPPING CONTAINER TYPE: _________________________________________

NUMBER OF CONTAINERS: ___________________________________________

CASK MODEL: ________________________________________ D.O.T.# __________

CASK CERTIFICATION CHECKED BY: _______________________________ DATE: __________

CURIE CONTENT CALCULATION PERFORMED BY: ______________________ DATE: __________

(ATTACH WORK SHEETS)

RECEIVING FACILITY: ____________________________ LICENSE # __________

FACILITY LICENSE CHECKED BY __________________________ DATE: __________

SHIPMENT ACCEPTABILITY VERIFIED WITH RECEIVING FACILITY:

PERSON CONTACTED __________________________ DATE: __________

CONTAMINATION SURVEY PERFORMED BY: ______________________ DATE: __________

BETA/GAMMA SURVEY PERFORMED BY: ______________________ DATE: __________

VEHICLE SURVEY PERFORMED BY: __________________________ DATE: __________

SHIPPING FORMS PREPARED BY: __________________________ DATE: __________

RECEIVING AGENT: __________________________________________

CARRIER: __________________________

SCHEDULED TO ARRIVE AT RECEIVING SITE: ________________________ (date)

ACTUAL ARRIVAL DATE: __________________________

D.O.T. NOTIFIED -- NAME: __________________________ DATE: __________
COVER SHEET TO ACCOMPANY CNSI'S RADIOACTIVE WASTE SHIPMENT AND DISPOSAL FORM

1. Cosignee's State License Number ________________________________

2. Consignee is authorized to receive this radioactive material ________________________________________________

Waste Management

3. Shipment Number ________________________________

4. Vehicle Type ________________________________

5. Placard ________________________________
Operator ________________________________

6. Proper Shipping Name ________________________________

7. Vehicle Radiation Survey
   Highest Contact ________________________________ mr/hr
   6FT Reading ________________________________ mr/hr
   Occupied Area ________________________________ mr/hr
   Technician ________________________________

Signature

8. Total Contents of Shipment ________________________________ Curies

   This vehicle shall not be used to carry packages from another consignee. The packages on this vehicle shall be unloaded by the consignee designated on the shipping forms or his designated agent only.

   Signature of Vehicle Driver ________________________________ Date

10. Sealed ________________________________

11. The recorded package contents and radiation and contamination data have been reviewed.

   HP Foreman/Supervisor ________________________________

12. Consignee Acknowledgement of Receipt

   Consignee, please sign and return a copy of the cover sheet to the consignor, as indicated on the Radioactive Shipment Record Form, to indicate receipt of this shipment.

   Consignee Signature and Title ________________________________ Date
## CALCULATION WORKSHEET
### FOR ISOTOPE PERCENT

1. Calculations for

2. Shipment number

3. Reference document used for calculations

4. Calculations

#### 4.1 Total Activity

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**Total Activity**

#### 4.2 Percent calculations

a. Activity of isotope (__________

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CURIE CONTENT WORKSHEET
FOR SAMPLE SHIPMENTS

1. Shipment number

2. Reference document used for calculations

3. Calculations:

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TOTAL(________) X (________) Sample volumes

Calculated by ________________ Date __________

Verified by ________________ Date __________
LOW-LEVEL RADIOACTIVE WASTE SHIPMENT
CERTIFICATION FOR THE FEDERAL GOVERNMENT AS A
GENERATOR/PACKAGER, AND ITS BROKERS AND CARRIERS

The following certification, completed as applicable, is made to the State of Washington:

Certification is hereby made to the State of Washington that Radiation Shipment Record No. _________ of low-level radioactive waste has been inspected in accordance with requirements of the Governor of Washington's Executive Order dated November 19, 1979, prior to its shipment. Further certification is made that the inspection has revealed no items of non-compliance with all applicable laws, rules and regulations.

As determined under the provisions of the Federal Tort Claims Act (28 USC § 2671-2680), the undersigned shall be liable for and hold harmless the State of Washington from any and all claims, suits, losses, damages or expenses on account of injuries to any and all persons whatsoever, and any and all property damage, arising or growing out of or in any manner connected with any activities performed under this order.

Except for any violation of applicable existing state or federal statute or regulation respecting packaging and shipment, inspection and acceptance of any item or container or material covered by this certification by the State of Washington or a duly authorized contractor shall release the party who executed the certificate from any and all requirement c. indemnification from injury or loss.

SECTION A:
FOR THE GENERATOR/PACKAGER: ____________________________
(Company Name)

PERMIT NUMBER: ____________________________

VOLUME OF WASTE IN THIS SHIPMENT:

DATE ____________________________ BY: ____________________________
TITLE ____________________________

Certification is hereby made to the State of Washington that Radiation Shipment Record No. _________ of low-level radioactive waste has been inspected in accordance with requirements of the Governor of Washington's Executive Order dated November 19, 1979, prior to its shipment. Further certification is made that the inspection have revealed no items of non-compliance with all applicable laws, rules and regulations.

The undersigned shall indemnify and hold harmless the State of Washington, in an amount not to exceed $1,000,000.00 per individual who may be injured, provided that indemnification shall not exceed $5,000,000.00 in total, for each occurrence, from any and all claims, suits, losses, damage, injury and expenses to any person whatsoever or to property arising or growing out of or in any manner connected with the activities performed under this order.

Except for any violation of applicable existing state or federal statute or regulation respecting packaging and shipment, inspection and acceptance of any item, or container or material covered by this certification by the State of Washington or a duly authorized contractor shall release the party who executed the certificate from any and all requirement of indemnification from injury or loss.

SECTION B:
FOR THE BROKER: ____________________________
(Company Name)

PERMIT NUMBER: ____________________________

VOLUME OF WASTE IN THIS SHIPMENT:

DATE ____________________________ BY: ____________________________
TITLE ____________________________

SECTION C:
FOR THE CARRIER: ____________________________
(Company Name)

VOLUME OF WASTE IN THIS SHIPMENT:

DATE ____________________________ BY: ____________________________
TITLE ____________________________
LOW-LEVEL RADIOACTIVE WASTE SHIPMENT
CERTIFICATION FOR COMMERCIAL GENERATOR/PACKAGERS,
AND BROKERS AND CARRIERS

The following certification, completed as applicable, is made to the State of Washington:

Certification is hereby made to the State of Washington that Radiation Shipment Record No. __________ of low-level radioactive waste has been inspected in accordance with requirements of the Governor of Washington's Executive Order dated November 19, 1979, prior to its shipment. Further certification is made that the inspection has revealed no items of non-compliance with all applicable laws, rules and regulations.

The undersigned shall indemnify and hold harmless the State of Washington, in an amount not to exceed $1,000,000.00 per individual who may be injured, provided that indemnification shall not exceed $5,000,000.00 in total, for each occurrence, from any and all claims, suits, losses, damage, injury and expenses to any person whomsoever or to property arising or growing out of or in any manner connected with the activities performed under this order.

Except for any violation of applicable existing state or federal statute or regulation respecting packaging and shipment, inspection and acceptance of any item, or container or material covered by this certification by the State of Washington or a duly authorized contractor shall release the party who executed this certificate from any and all requirement of indemnification from injury or loss.

SECTION A:
FOR THE GENERATOR/PACKAGER: _____________________________ (Company Name)

PERMIT NUMBER: _____________________________

VOLUME OF WASTE IN THIS SHIPMENT: _____________________________

DATE: _____________________________ BY: _____________________________

TITLE: _____________________________

SECTION B:
FOR THE BROKER: _____________________________ (Company Name)

PERMIT NUMBER: _____________________________

VOLUME OF WASTE IN THIS SHIPMENT: _____________________________

DATE: _____________________________ BY: _____________________________

TITLE: _____________________________

SECTION C:
FOR THE CARRIER: _____________________________ (Company Name)

VOLUME OF WASTE IN THIS SHIPMENT: _____________________________

DATE: _____________________________ BY: _____________________________

TITLE: _____________________________

OSHS RHF-31A
DSHS IS-1/4
O4/80
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<th>SHIPPER'S RADIATION CONTROLLER</th>
<th>SHIPPER'S NAME &amp; ADDRESS</th>
<th>TOTAL QTY</th>
<th>TOTAL SHIPPED</th>
<th>TOTAL WEIGHT</th>
<th>TOTAL IN POUNDS</th>
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**STRAIGHT BILL OF LADING - SHORT FORM - Original - Not Negotiable**

This instrument is not a bill of lading when the property described below is moved in a vehicle (other than that of a common carrier) furnished and/or operated by shipper or owner of the property, but is merely a receipt for said property on behalf of shipper or owner.

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading, to be delivered to the consignee and destination shown herein, subject to the terms and conditions of the special contract between the carrier and the consignor or consignee in effect on the date of the issue of this Bill of Lading. In the absence of a special contract, transportation will be subject to all the terms and conditions of the carrier's tariffs legally on file. It is further agreed by the carrier that the transportation of this shipment will be performed in compliance with all applicable rules, regulations and laws.

(Mail or street address of consignee — for purposes of notification only.)

Consignment to:  

Destination:  

State:  

County:  

Shipping Address:  

Route:  

Delivering Carrier:  

Car or Vehicle Initials:  

Collect On Delivery:  

C.O.D. charge:  

Shipper:  

Consignee:  

NO PACKAGES KGM KIND OF PACKAGE DESCRIPTION OF ARTICLES SPECIAL MARKS AND EXCEPTIONS

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<th>DESCRIPTION</th>
<th>SPECIAL MARKS AND EXCEPTIONS</th>
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(To be filled in only when shipped direct and governing tariffs provide for delivery direct)

$ to be paid by:  

Signatures of Consignor:

Agent or Carrier:  

Per:

Charges Advanced:  

This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.

"If the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is carried or shipped weight.

"NOTE: Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property. The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding.

Per:  

Agent:  

Permanent address of shipper:  

EG&G Idaho, Inc.

Shipper:  

Per:  

Agent:  

P.O. Box 1625, Idaho Falls, Idaho 83415
APPENDIX D

DISPOSAL DEMONSTRATION PROCEDURES
TITLE: EPICOR II LINER DISPOSAL DEMONSTRATION
Work Package No.: HCN-83-16
Test Engineer G. A. Williams

REVIEW AND APPROVAL REQUIREMENTS

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ISSUED BY:
| Document Control |          | 9/26/83 |

PROCEDURE FIELD CHANGES

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<td>1</td>
<td>Preparation of PF-18</td>
<td>TAN607</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*Work Package General Instructions</td>
</tr>
<tr>
<td>2</td>
<td>HIC Loading &amp; Shipping</td>
<td>Demonstration</td>
<td>TAN 607</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Final Closure:
- HCB Facility Supervisor
  - Signature
  - Date
- HCB Test Engineer Supervisor
  - Signature
  - Date
- Quality Representative
  - Signature
  - Date
CNS I-4-190

Demolition of ion exchange media to HIC + PF-18

<table>
<thead>
<tr>
<th>Isope</th>
<th>Activity</th>
<th>Gaseous (Check)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sr-90</td>
<td>35.01 Ci</td>
<td></td>
</tr>
<tr>
<td>Ru-106</td>
<td>29.8 Ci</td>
<td></td>
</tr>
<tr>
<td>Cs-137</td>
<td>875.2</td>
<td></td>
</tr>
<tr>
<td>925.9</td>
<td>91.6 Ci</td>
<td></td>
</tr>
<tr>
<td>29.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Describe items checked above (quantity, composition, pressure) if not listed.

Date: 5/16/83

HOT CELL SAFETY QUESTIONNAIRE

Ship to Hot Cells

C2: Cask or container identification
C: Package ID
D: Description of materials
E: Special handling precautions
F: Special disposal
G: Description of materials
H: Commercial burial at Hanford, Washington

<table>
<thead>
<tr>
<th>Radioactivity</th>
<th>Total Curies</th>
<th>Total Dpm</th>
<th>90% Rad.</th>
<th>80% Rad.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cs-137</td>
<td>875.2</td>
<td>925.9</td>
<td>80%</td>
<td>90%</td>
</tr>
<tr>
<td>Ru-106</td>
<td>29.8</td>
<td>29.8</td>
<td>80%</td>
<td>90%</td>
</tr>
</tbody>
</table>

C. Construction of HIC + PF-18 in a HIC, seal the lid in place.

1.5 g dm³

Experiment Description

10/10

[Diagram of the experiment]
HOT CELL SAFETY ANALYSIS SUMMARY

Work Package No. HCN-83-16  Task(s) 1  Date 9/13/83  By G. A. Williams

Experiment number or other designation  EPICOR-II Liner Disposal (Demonstration)

Job Description(1)  Remove PF-18 from TSC-2, dewater, vent, purge, place in HIC, cure HIC & ship.

---

Facility the analysis was made for  TAN 607

Fissile Material(2)

- Quantity 235U 4.5 x 10^-7 g, Pu 1.0 x 10^-3 g
- Enrichment 235U 2.5 %, Pu 3165
- Est. Burnup %, 3165

MWd/MT. Chemical Form ion exchange media

Radioactivity(1)

- Total Curies 2025
- Reactor Discharge Date 3/23/79
- Decay Heat 8 x 10^-3

Est. Direct Radiation (@ 1 ft in air); 100 Rm/β-γ; Est. Surface contamination 0 dpm / ft. γ, 0 dpm α

Facility Hazards(3)  Radiation and contamination exposure.

Personnel Hazards(4)  Radiation and contamination exposure.

---

Experiment Damage Hazards(1)  Maintain identity of liner

Shipping Cask, Hazards & Precautions(1)  Care must be exercised while handling the cask on the transporter.

Special Controls:

---

Additional comments:

---

NOTES:

(1) See Safety Questionnaire for details necessary to complete this Analysis and attach for reference.
(2) State total fissile material, attach itemized list for multiple fuel rods or other units.
(3) Evaluate for potential hazards to facility including fire, explosion, excessive gamma heat or radiation, structural, contamination spread, effluent releases, and general plant safety.
(4) Evaluate for potential hazards to personnel including radiation exposure, airborne contamination, tank materials, chemical reactions, and general personnel safety.
SUMMARY

This task provides instructions for bringing the TSC-2 (Temporary Storage Container) into the Hot Shop and unloading PF-18. Instructions are also provided to de-water and purge PF-18 before loading it into a High Integrity Container (HIC). The cured HIC will then be loaded in the CNS 14-190 Transport Cask and shipped to Hanford for disposal.
WORK PACKAGE GENERAL INSTRUCTIONS

Title: EPICOR II Liner Disposal Demonstration

Work Package: HCN-83-16
Task Number: 1

Date: 9-23-83

I. REFERENCES

Materials Technology Division SPs

1. 1.3.11, Detailed Operating Procedures

2. 1.3.1, Document Revision Requests

Hot Cell Branch Directives

1. HCN-100, TAN 607 Hot Shop Hoisting and Rigging Requirements

2. HCN-108, Access Control for TAN Hot Shop

Miscellaneous

1. Section 5000, EG&G Idaho Safety Manual, Radiation Safety (all sections except 5050, 5060, 5070, and 5110)

2. EG&G Hoisting and Rigging Manual
3. TAN HCN Operational Safety Requirements Document (OSRD) Sections 8 (except 8.2), Sections 9.1 and 10 (except 10.5, 10.6, 10.7, 10.9, 10.10, 10.13, 10.14, 10.16, and 10.17).


Drawings

Nuclear Packaging, Inc., Drawings

<table>
<thead>
<tr>
<th>TITLE</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Integrity Container System</td>
<td>EP-20-100 D</td>
</tr>
<tr>
<td>Container assembly</td>
<td>200-101</td>
</tr>
<tr>
<td>Spreader bar fabrication details</td>
<td>EP-70-01 D</td>
</tr>
<tr>
<td>Lift links fabrication details</td>
<td>DP-70-02 D</td>
</tr>
<tr>
<td>Interface collar fabrication details</td>
<td>EP-70-03 D</td>
</tr>
<tr>
<td>Lift and hoist equipment assembly</td>
<td>EP-70-100 D</td>
</tr>
</tbody>
</table>

B. Forms (attached)

Comment Sheet
Briefing Log
LIFT EQUIPMENT RECORD SHEET

II. General

This work package provides instructions for bringing the TSC-2 into the Hot Shop for the HIC demonstration. Instructions are provided for removing PF-18 from the TSC-2, the de-watering and purging of PF-18 and for loading PF-18 into a HIC. The HIC will be allowed to cure, then loaded and shipped in the CNS 14-190 cask as directed in Task 2.
The following provisions apply to this procedure:

1. The Operation Supervisor or test engineer may each assign
alternates and note this on the Comment Sheet.

2. Nonapplicable steps will be marked "N/A", initialed and dated,
and the reason recorded on the Comment Sheet by: (a) the
originator prior to issue, or (b) the Operations Supervisor
during execution of the procedure.

3. All changes to this procedure will be made by DRR in accordance
with SP 1.3.1, Document Revision Requests.

4. Procedure steps or sections may be performed out of sequence as
follows:

Operations Supervisor marks the steps/sections to be performed
out of sequence "OOS", and records the reason on the Comment
Sheet. At the exit point of the original procedure mark "EXIT
TO _____", and enter in the blank the first step number of the
OOS series. After the last OOS step, mark "EXIT TO _____", and
enter in the blank the number of the step being returned to in
the original sequence (the original exit point to the OOS series).

Technician dates and initials (a) the last step performed before
starting the OOS series, (b) each OOS step as performed, and (c)
the first step performed after returning to the original sequence.

5. Asterisked (*) blanks are to be filled in by the Test Engineer
prior to starting work. If spaces are not applicable, mark
"N/A", initial and date (the reason need not be recorded on
Comment Sheet).
6. Designated steps will be initialed and dated when completed.

7. Verification and inspection steps will be performed by Technicians unless otherwise noted.

III Materials and Equipment

1. Liner Lifting Fixture
2. Slings and Lifting Fixtures.
3. Venting Assembly.
4. Plastic and/or Blotting Paper
5. Argon Purge Gas
6. Modified LINER Integrity Examination (LIE) Equipment (see Figure 1)
7. Resin Catch Pan
8. TV Camera and Monitor
9. Electrical Grounds for Liner and Venting Assembly
10. T-Bar Assembly for Lifting Spent Resin Liner
11. High Integrity Container (HIC)
12. HIC Spreader Bar
13. HIC Lid Lifting Links
14. Interface Collar
15. 'Primary Sealent (3)
16. Epoxy A/B and Aggregate
17. Pouring Assembly
18. Mixing Pails (2)
19. Drill
20. Mixing Blade
21. Grout Pouring Container
22. Ramps for Hot Shop Rails
23. Adapter for Lower Distribution Port
24. Adapter for Vent Port
25. Water Sample Container
IV. SPECIFIC PRECAUTIONS AND LIMITATIONS

1. All lifting, rigging, and handling of components requiring lifting equipment shall be done per EG&G Hoisting & Rigging Manual, Branch Directive HCN-100, and attached rigging diagrams. The cranes and lifting equipment will be inspected and certified in current load test status.

2. For the duration of each crane lift involving the loaded EPICOR liner, and all critical lifts, a duly briefed person will be stationed at the main crane breaker, in radio contact with crane operator in case of unexpected crane movement. At completion of each lift, notify and remove the person from breaker.

3. Use plastic sheet to prevent contamination spread of equipment and materials during this procedure.

4. Do not open Hot Shop doors if wind is in excess of 15 mph.

V. PREREQUISITES

NOTE: Prerequisites may be performed in any sequence.

Init Date

1. All necessary lift equipment and rigging gear is available and certified in current load test status by Quality Division (QQ), on the LIFT EQUIPMENT RECORD SHEET.

NOTE: A crane and slings as needed (see Figures 6 and 10) will be available for any lifts conducted outside the Hot Shop.
2. All necessary tooling and supplies as listed in Section III are available where needed in Hot Shop. Tools and supplies for operations outside the Hot Shop will also be in place where needed.

3. Crane emergency release service pedestal pig-tail is in position.

4. SES shielding doors are open, SES personnel doors are closed, and Hot Cell door is closed.

5. Operability of locomotive and rail car to transport concrete storage container has been verified, if transfer to temporary storage is required.

6. The O-MAN and any other necessary remote tools are in position.

7. Blanks in asterisked procedure steps have been filled in.

8. Forms EG&G-2612 and 2612A, Radiation Hazards analysis and Radiological Control, have been prepared and included in the work package, and the requirements have been met.

9. Hot Shop personnel have been briefed on this procedure, applicable sections of the Hot Cells North facilities OSRD, and the radiological controls specified in item 8, above, and have signed the Briefing Log. The Hot Shop entry team is ready.
10. Hot Waste box is in the Hot Shop.

11. Configuration of liner to be vented (see Figure 2) has been determined during loading operation and is recorded in work package (Comment Sheet). If configuration A, spacers (see Drawing 415928-22) must be removed from venting assembly legs. For configurations B and C, spacers must be in place.

12. Vent port location has been identified during loading operation and is recorded in work package. Guide brackets (see Drawing 415928-16) on venting assembly have been positioned for the appropriate port as shown in Figure 3.

Configuration

Figure 3, Sheet ______ of ______

13. De-watering equipment has been set up per Figure 1.

14. Work areas have been covered with plastic and/or absorbent paper.

15. A video record of the HIC demonstration will be made with the color system, if available. If color system is not available, use the black and white system.

16. Assure rail stops are in place.

17. Position portable radiation measuring instrument for use in determining liner radiation level.
The HIC is in the Hot Shop and the lid vent plug is open.

**IV  PROCEDURE**

1.0 Verify that all prerequisites have been met.

Procedure started: Technician ______________________________ Date __________

2.0 Receive TSC-2 and unload PF-18.

2.1 Enter Hot Shop to perform the following:

2.1.1 Cover working areas with plastic or absorbent paper.

2.1.2 Plug in and check out the light used with the TV camera for viewing the venting operation.

2.1.3 Clean window of vent tool.

2.1.4 Check and remove any foreign material on the vent tool drive system. Remove old plug if necessary.

2.1.5 Perform the preventive maintenance on the vent tool, oiling if necessary. Check housing gasket and replace if necessary.

2.1.6 Verify the vent tool is directly connected to Hot Shop exhaust system.
Verify the vent tool argon supply is connected to the Hot Shop system.

Verify no-load operability of all controls and corresponding assembly functions for the vent tool.

2.2 Remove plastic rain cover from TSC-2

2.3 Open Hot Shop Doors.

2.4 Using spacer car between locomotive and flat car, move flat car with TSC-2 into Hot Shop.

2.5 Survey spacer car; if necessary, decontaminate to acceptable limits.

2.6 Uncouple spacer car from carrier and remove from Hot Shop.

2.7 Close Hot Shop doors.

2.8 Clear Hot Shop of personnel for subsequent remote operation.

2.9 Rig to lid of TSC-2 per Figure 5, observing Precaution #2, remove lid and place as directed by the Operations Supervisor. "Uncouple the crane hook.

2.10 Raise alarm points on RAMs in the Hot Shop to level predetermined by TAN Safety.
2.11 Remove liner from TSC-2 as follows:

2.11.1 Rig T-bar to 10-ton crane hook. Figure 6 and, using 0-MAN, rotate T-bar as needed to engage the lifting lugs. Visually verify engagement.

2.11.2 Observing Precaution #2, raise liner from TSC-2, and move to the east side of the south silo. Disengage from liner and place T-bar in designated area.

2.12 Rig to TSC-2 lid per Figure 5. Observing Precaution #2, replace lid on TSC-2. Uncouple crane hook from lid.

2.13 Health Physics (HP) enter the Hot Shop and perform a preliminary radiological survey of Hot Shop work area. Survey and smear carrier, TSC-2, and lid for external contamination and general radiation levels; decontaminate as required by HP.

2.14 Open Hot Shop doors.

2.15 Using shielded locomotive with spacer car attached, remove carrier with TSC-2 from Hot Shop.

2.16 Install and secure weather cover (plastic) on TSC-2.

2.17 Move TSC-2 to an outside storage area, as determined by the HP based on radiation reading. Chock wheels of rail car.
2.18 Cover area with plastic and place ramps over Hot Shop door rails.

2.19 Attach snorkel to tractor exhaust.

2.20 Back transporter into Hot Shop.

2.21 Rig the HIC spreader bar to the 100-ton crane.

2.22 Attach spreader bar lifting hooks to the HIC lifting slings.

2.23 Observing Precaution #2, lift HIC, move laterally and place it on the plastic sheet as directed by the Operations Supervisor.

2.24 Remove spreader bar lifting hooks from HIC lifting slings and place spreader bar on clean plastic on Hot Shop floor.

2.25 Survey and remove transporter with cask from Hot Shop. Remove snorkel from tractor exhaust.

2.26 Remove ramps from Hot Shop door rails and store. Close Hot Shop doors.

3.0 PF-18 Distribution Port Plug Removal

3.1 Rig T-bar to 10-ton crane hook, Figure 6 and hook to PF-18 lifting lugs. Verify engagement.
3.2 Observing Precaution #°, raise liner from behind silo and move laterally to floor adjacent to C window. Disengage T-bar from liner.

3.3 Lift venting assembly using O-MAN, Figure 7.

3.4 Install venting assembly on liner and remove plug to lower distribution port (effluent) as follows:

3.4.1 Using separate leads with magnetic ends, ground both the liner and the assembly to a convenient location of railroad rail in floor. Move assembly into position above liner, observing Prerequisites 11 and 12 and lower until the two guide brackets engage the liner lifting lugs. Continue to lower, observing directly or by TV camera, until lower end of toolhousing is about 5 in. above the liner.

3.4.2 Position the tool tip and engage it in the recess of the 2-in. pipe plug in the liner by performing the following actions as required:

<table>
<thead>
<tr>
<th>Desired Movement</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower tool tip toward plug.</td>
<td>Move valve V10 to &quot;TORQUING&quot; position. To stop downward travel, return valve to central (unlabeled) position.</td>
</tr>
</tbody>
</table>
**Desired Movement** | **Procedure**
--- | ---
Raise tool tip up off the plug. | With air pressure adjusted to 90 psi, slowly move valve V10 to the RAISE position. When the tool tip is at the desired elevation, return valve to the unlabeled position. To lower tool tip, slowly move valve to the TORQUING position and return it to the unlabeled position when desired elevation is obtained.

Rotate tool tip. | Place valve V9 in the LOOSEN position. Slowly turn valve V15 toward ON position. Return V15 to the OFF position when desired tool tip orientation is obtained. Tool rotation can be reversed by placing valve V9 in the TIGHTEN position.

Move tool tip to the X direction. | Place valve V12 in either the + or - DIRECTION position as desired. Slowly turn valve V16 toward the ON position and observe the movement of tool tip. Return valve to OFF position when desired position is obtained. Tool movement direction can be reversed by placing V12 in the other DIRECTION position.
<table>
<thead>
<tr>
<th>Desired Movement</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Move tool tip in the Y direction.</td>
<td>Place valve V13 in either the + or the - DIRECTION position as desired. Slowly turn valve V17 toward the ON position and observe the movement of the tool tip. Return valve to OFF position when desired position is obtained. Tool movement direction can be reversed by placing V13 in the other DIRECTION position.</td>
</tr>
<tr>
<td>Forcing tool tip into square hole of plug.</td>
<td>If rust or other foreign material prevents the tool tip from entering the square hole of the plug and the tool tip is correctly positioned, a downward force can be applied by slowly moving valve V11 to the LOWER position. Return V11 to the TORQUING position.</td>
</tr>
</tbody>
</table>

3.4.3 Verify complete engagement of the tool tip in the plug. This is indicated by the seating of the tool tip holder's shoulder and magnets on the plug.
3.4.4 Place or verify that the control panel valves are in the position listed below:

<table>
<thead>
<tr>
<th>Valve</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>V15</td>
<td>OFF</td>
</tr>
<tr>
<td>V9</td>
<td>LOOSEN</td>
</tr>
<tr>
<td>V16</td>
<td>OFF</td>
</tr>
<tr>
<td>V17</td>
<td>OFF</td>
</tr>
<tr>
<td>V11</td>
<td>TORQUING</td>
</tr>
<tr>
<td>V10</td>
<td>TORQUING</td>
</tr>
</tbody>
</table>

3.4.5 Lower venting assembly until housing is seated against the liner.

3.4.6 Adjust air pressure down to 25 ± 5 psi.

3.4.7 Record rotational position of the tool drive shaft. ________ (Indexing marks are visible through window in assembly).

3.4.8 Open valve on argon purge gas line to permit flow through venting assembly into exhaust line.
3.4.9 Slowly turn valve V15 toward ON position while observing tool shaft rotation. At first indication of shaft rotation, leave V15 in its existing position and monitor shaft rotation until at least 2 revolutions are made or the plug drops slightly as it rides up the last thread and plug is fully unscrewed from the port. Return V15 of OFF position.

NOTE: If plug does not move when valve V15 is fully open, valve must be returned to OFF position, air pressure increased by 10 psi, and the plug removal operation performed again. This sequence may be repeated, if necessary, at 10 psi air pressure increments up to a maximum 70 psi pressure.

3.4.10 Raise plug out of liner port by adjusting air pressure to 70 ± 6 psi and placing valve V10 in RAISE position. When plug is clear of liner port, return V10 to central (unlabeled) position.

3.5 Remove plug and venting tool from liner per the following sequence:

3.5.1 Remove electrical ground leads from liner and venting tool assembly.

3.5.2 Lift and remove venting tool from liner.

3.5.6 Remove plug from liner, if necessary. Relocate venting tool on floor adjacent to C window, disengage 0-MAN.
4.0 DE-WATER AND PURGE PF-18

4.1 Use prerigged T-bar, Figure 6 and, using O-MAN and/or wallmount, engage T-bar to the liner lifting lugs. Visually verify engagement.

4.2 Observing Precaution #3, move liner laterally and lower onto resin catch pan for de-watering, (see Figure 1). Disengage T-bar from liner.

4.3 Place T-bar as directed by the Operation Supervisor and remove T-bar from crane hook.

NOTE: All remote handling will be performed using either the wallmount or O-MAN, or both, as appropriate, except as otherwise noted.

4.4 Place adapter on lower distribution port and connect plug to vacuum system, as shown in Figure 1.

4.5 Remove water from liner as follows:

NOTE: De-water for 1 h. Stop process for 1 h. Repeat 3 times for a total of 6 h de-watering time.

4.5.1 Close Valves V-1 and V-3, (see Figure 1). Position Valve V-2 so that the vacuum pump is connected to the 55-gal drum.

4.5.2 Turn on vacuum pump and establish an 8 in. vacuum in drum. Use vacuum gauge on drum lid.
4.5.3 Open valve V-1 to establish water and air flow from liner.

4.5.4 When 55-gal drum is full, Valve V-4, (see Figure 1) will open.

4.5.5 Drain the tank as follows:

4.5.5.1 Shut off the vacuum pump.

4.5.5.2 Close Valve V-1 and reposition Valve V-2 to vent drain to atmosphere.

CAUTION: Allow approximately 500 ml of water to remain in the water sample collection device for pH analysis.

4.5.5.3 Open Valve V-3 to drain the tank.

4.5.5.4 Close Valves V-3 and V-4 to reposition Valve V-2 to connect vacuum pump to drum.

4.5.5.5 Turn on vacuum pump to establish vacuum in drum.

4.5.5.6 Open Valve V-1 to continue vacuuming liner.

4.5.5.7 After 1 hr of de-watering, shut off the vacuum pump for 1 hr.
4.5.5.8 Repeat steps 4.5.1 through 4.5.5.7 a minimum of three times.

NOTE: It may be necessary to perform additional de-watering cycles. Consult with the Test Engineer and/or Operation Supervisor.

4.6 Open 4-way valve on vacuum system, (see Figure 1).

4.7 Place adapter on vent port and connect to purge line.

CAUTION: Watch gage closely, and do not exceed 5 psi during liner purging.

4.8 Purge liner for approximately 6 hr., as directed by the Operations Supervisor. (Minimum flow 1 cfm.) Turn off system.

4.9 Disconnect purge and vacuum lines and remove adapter from distribution port and adapter from vent port.

4.10 Place porous plug on vent port.

4.11 Place 2-in. solid plug on lower distribution port.

4.12 Rig T-bar to 10-ton crane hook (see Figure 6) and hook to PF-18 lifting lugs. Verify engagement.
Init Date

4.13 Observing Precaution #2, raise liner and move laterally to the east side of the south silo. Disengage T-bar from liner.

4.14 Place T-bar as directed by the Operation Supervisor and disengage from crane hook.

4.15 HP enter Hot Shop and perform radiological survey of work area for HIC loading preparations.

4.16 Perform pH analysis as follows:

4.16.1 Remove water sample from collection device and move sample to labyrinth door.

NOTE: If reading on the sample container exceeds 500 mR/h at contact, consult HP Supervisor.

4.16.2 HP survey the sample and with HP concurrence remove the sample from the Hot Shop.

4.16.3 Determine pH and record results QD.

5.0 HIC LOADING AND CURING

NOTE: Steps in this section may be performed simultaneously to perform work in time allowed.

5.1 Set up scaffolding for HIC loading.
5.2 Rig the HIC spreader bar to 100-ton crane and attach the spreader bar lifting hook to the HIC lifting slings, as shown in Figure 8.

5.3 Observing Precaution #2, lift HIC and place it on the plastic sheet in the scaffolding.

5.4 Remove spreader bar lifting hooks from HIC lifting slings and place spreader bar on plastic sheet in Hot Shop floor.

5.5 Attach HIC lid lifting links to 10-ton crane, as shown in Figure 9.

5.6 Attach lifting links to HIC lid.

5.7 Verify that the vent plug on bottom of HIC lid is open.

5.8 Remove HIC lid and place on Hot Shop floor.

5.9 Verify installation of polyethylene sleeve and base disk.

5.10 Verify presence of aluminum hydroxide paste in base disk cutouts.

5.11 Remove lift links from 10-ton crane.

5.12 Rig insertion collar to O-MAN, Figure 10.
Init Date

5.13 Mix three batches of primary sealant per the following instructions:

NOTE: Mixing instructions are also provided with kit.

5.13.1 Remove tri-seal cap.

5.13.2 Screw dasher rod clockwise into barrier.

5.13.3 Remove tape band and pull rod to top of cartridge, squeeze side of cartridge at barrier to release barrier, then push rod to bottom to displace barrier.

5.13.4 Mix material (50 strokes minimum by hand) by turning dasher rod clockwise while making full stroke from top to bottom of cartridge.

5.13.5 Pull rod to top of cartridge and remove by turning counterclockwise.

5.13.6 Remove F-Cap from bottom of cartridge, screw nozzle into top and insert into retainer.

5.14 Record time and date ______.

CAUTION: Steps 5.15 through 5.26 are to be performed in approximately 1 h.

5.15 Apply 1/2-in. bead of primary sealant to the top of the I.D. of the HIC lid step.
5.16 Lift insertion collar and place it on the HIC.

5.17 Remove rigging from O-MAN, leaving it attached to the insertion collar.

5.18 Evacuate Hot Shop for subsequent remote operation.

5.19 Rig 10-ton crane hook to T-bar.

5.20 Engage T-bar to PF-18 lifting lugs verify engagement.

5.21 Observing Precaution #2, lift the liner from the east side of the South silo and move it laterally until it is over the HIC insertion collar.

5.22 Insert the liner into the HIC and disengage T-bar from liner.

5.23 Place the T-bar on the Hot Shop floor and disengage from crane hook.

5.24 Rig the HIC lid lifting links and the HIC lid to the 10-ton crane.

5.25 Using the O-MAN remove the insertion collar and place it on clear plastic.

5.26 Observing Precaution #3, lift the HIC lid and place it on the HIC.
NOTE: Prepare surfaces of lid and HIC for grouting by removing dirt, grease, and any material that would adversely affect the bond.

5.27 Record the time of day.

5.28 Remove lifting links from the HIC lid and 10-ton crane and place on clear plastic.

5.29 Outside the Hot Shop, in the change room, mix two batches of EPOXY A/B and aggregate grout with the drill and mixing blade, per the following instructions:

NOTE: Mix binder per manufacturers instructions to achieve a free-flowing consistency.

5.29.1 Mix the A and B component thoroughly with a paint stirrer attached to a drill. Carefully scrape sides and bottom of container.

5.29.2 Mix for at least 3 minutes and/or until the mixture is free of streaks.

5.29.3 Add mortor (from Step 5.29.3) to sand and mix for at least 3 minutes until a free-flowing consistency is achieved.

5.30 Record the time of day and date.
5.31 Pass the two mixing pails into the labyrinth.

5.32 Pour the grout into the grout pouring container.

CAUTION: Steps 5.33 through 5.37 are to be performed in approximately 1 hr.

5.33 Using the O-MAN place the grouting assembly onto the HIC.

5.34 Pass the grout pouring container to the O-MAN at the labyrinth/Hot Shop door.

5.35 Alternately, pour the grout into the grouting assembly funnels and change funnel position as desired. Also fill lid lift recesses with grout.

5.36 Bring the grout pouring container back to the labyrinth/Hot Shop door.

5.37 Repeat steps 5.29 to 5.36 until the HIC/lid void is full of grout. Verify level of grout as specified in Item 5 of Figure 11.

5.38 Record time and date ____.

5.39 Remove the grouting assembly from the HIC, and place it on clean plastic.
Init Date

5.40 Rig the HIC spreader bar to the 100-ton QD crane and attach the spreader bar lifting hooks to the HIC lifting lugs.

5.41 Observing Precaution #9, lift HIC, move laterally and place behind South silo on plastic sheet. HIC will cure for two days.

5.42 Remove spreader bar lifting lugs and place on clean plastic on Hot Shop floor.

NOTE: HIC will cure for two days. If HIC is to be cured in TSC-2, proceed to Section 6. If it is not, NA steps in Section 6.

6.0 TRANSFER OF HIC TO TSC-2

6.1 HP enter and survey Hot Shop. Have work area decontaminated, if necessary.

6.2 Remove plastic rain cover from TSC-2.

6.3 Open Hot Shop doors.

6.4 Using spacer car between locomotive and flat car, move flat car with TSC-2 into Hot Shop.

6.5 Survey spacer car; if necessary, decontaminate to acceptable limits.

6.6 Uncouple spacer car from carrier and remove from Hot Shop.
6.7 Close Hot Shop doors.

6.8 Clear Hot Shop of personnel for subsequent remote operation.

6.9 Rig to lid of TSC-2 per Figure 5. Remove lid and place as directed by the operation supervisor. Uncouple the crane hook.

6.10 Rig the HIC spreader bar to the 100-ton crane and attach the spreader bar lifting hooks to the HIC lifting slings.

6.11 Observing precaution #2, lift HIC, move laterally and lower into TSC-2.

6.12 Remove spreader bar lifting lugs and place on clean plastic on Hot Shop floor leaving slings attached to HIC.

6.13 Rig to TSC-2 lid per Figures 5, and observing Precaution #2, replace lid on TSC-2. Uncouple from crane hook.

6.14 HP enter the Hot Shop and perform a preliminary radiological survey of Hot Shop Work area. Survey and smear carrier, TSC-2, and lid for external contamination and general radiation levels; decontaminate as required by Health Physics.

6.15 Open Hot Shop doors.
Using shielded locomotive with spacer car attached, remove carrier with TSC-2 from Hot Shop.

Install and secure weather cover (plastic) on TSC-2.

Move TSC-2 to an outside storage area, as determined by the HP based on radiation readings, Chock wheels on rail car.

Procedures ended: Technician ________________ Date ________________
1. BASED UPON DW#6 E-417240 (ITEM NO. CIRCLED)
   "EPICOR LINER EXAMINATION EQUIPMENT
   INSTALLATION AND DETAILS."

2. GAS WILL DISCHARGE UNFILTERED THROUGH
   THIS PORT DURING THE INERT GAS PURGE.

Figure 1. Modified Liner Integrity
Examination Equipment

SKETCH #1
DEWATERING
EQUIPMENT
Figure 2.
Figure 3.
Sheet 2 of 3
Figure 3.
Sheet 3 of 3
Figure 4.
10-Ton Crane Hoist:

Direct hitch connection. No other rigging used.

Figure 5. Rigging for Temporary Storage Container Lid

Shielding cover:
Steel plus 8-1/4 in. lead shot. Diameter to suit cask, 10 ft max.
Height: 12,000 lb. max
Figure 6. Rigging for T-Bar Lifting Device
Single Point Lift

Weight: Under
1500 lb.

To venting assembly attachment point
(3 places)

Figure 7. Rigging for Venting Assembly Fixture
100 TON CRANE HOOK

3" X 16' NYLON ENDLESS SLING DOUBLED

SPREADER BAR A

1/4" X 5' WIRE ROPE 2 PLACES

HIC CONTAINER

APPROX WEIGHT 17,500 LBS
10 TON CRANE HOOK

SHACKLE - 1/8 MIN.

RIGGING ASSY
DWG EP-70-02D

CASK LID

APPROX WEIGHT 2650 LBS

HIC CONTAINER LID RIGGING

FIG. 9
O-MAN

4 SLING RIGGING ASSY

INTERFACE COLLAR

APPROX WEIGHT - 160 LBS

INTERFACE COLLAR RIGGING

FIG. 10