# THE INDUSTRY-WIDE EFFECTS OF NEW TRANSPORTATION REGULATIONS ON THE SHIPMENT OF LSA MATERIAL FROM NUCLEAR UTILITIES

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## ABSTRACT

The Nuclear Regulatory Commission (NRC) has issued for comment proposed regulatory changes to 10 CFR Part 71 to bring the United States more in line with the international regulations issued by the International Atomic Energy Agency (IAEA) dealing with the shipment of radioactive material. Although not yet published, the Department of Transportation (DOT) is expected to issue proposed changes to 49 CFR to essentially adopt the IAEA standards.

Under these new regulations, LSA is still defined in terms of specific activity; however, an upper limit has also been established based on an external radiation level of 1 R/Hr at three meters without intervening shielding. Adoption of IAEA standards will increase packaging requirements for LSA material. As a result of these increased packaging requirements, the NRC has raised their lower limit of control to 2XA1 per package. Below this level only DOT requirements need be met. Once this threshold is reached, however, the NRC will now require the use of an NRC licensed container that meets the TYPE B package standards (with a few exceptions) contained in the proposed 10 CFR Part 71.

Assuming that DOT essentially adopts the IAEA standards as published in Safety Series 6, 1985 Edition, ARI evaluated the industry-wide effects of the NRC's raising their lower limit of control and increasing package requirements for packages greater than 2XA1. In conducting the evaluation, ARI ran numerous shipment configurations. Variables considered included such things as plant type (BWR/PWR), resin type (bead/powder), resin grade (primary/ non primary), waste form (dewatered in HIC/solidified in liner) and shipping container (6-80/8-120/14-195). Based on these variables, the effects of these new regulatory changes were examined relative to increased (or decreased) costs, as well as the total number of shipments required. This paper documents the results of this evaluation.

## INTRODUCTION

In 1959, the International Atomic Energy Agency (IAEA) undertook the development of international regulations for the safe transportation of radioactive materials. The U.S. Nuclear Regulatory Commission (NRC) and the Department of Transportation (DOT) have issued regulations which were, for the most part, in conformance with IAEA's "Regulations for Safe Transport of Radioactive Materials, Safety Series No. 6," published in 1973 and revised in 1979. Since this publication, IAEA has updated the regulations, the most current version being the 1985 edition of Safety Series No. 6(1).

As part of the update, IAEA published a new set of guidelines for determining the transportation classification, and corresponding package requirements, for the transport of radioactive materials. These revisions include a new set of A1 and A2 values (used for establishing Type A package contents limits), and a new definition of Low Specific Activity (LSA) material.

The NRC is currently proposing to essentially adopt the most recent IAEA Safety Series No.6 regulations for determining transportation classification (2). In addition, NRC is proposing to increase its threshold of control from greater than Type A to 2xA1 for LSA material. At the same time, the NRC is proposing to increase packaging requirements for LSA material under its control.

Assuming adoption of IAEA standards, DOT will establish an upper limit for LSA material. Under current regulations, LSA material is defined solely in terms of specific activity with no upper limit on the total activity per package. Under new regulations, LSA is still defined in terms of specific activity; however, an upper limit has also been established based on an external radiation level of 1 R/Hr at three meters without intervening shielding. Material that exceeds this 1 R/hr at 3 meters may no longer be shipped as LSA. Adoption of IAEA standards will increase packaging requirements for LSA material by requiring the use of Industrial Packages (IP-1, 2 and 3). Each of these Industrial Packages have specific performance objectives and design and construction criteria stated within the regulations.

At the request of the Electric Power Research Institute (EPRI) in support of the Nuclear Management and Resource Council (NUMARC), the Nuclear Transportation Group (NTG) and the Utility Nuclear Waste Management Group (UNWMG), Analytical Resources evaluated the effects of these new regulations on the utility industry. The evaluation was based on EPRI's extensive utility radwaste data base which provides detailed information on

radwaste generation rates, sources and characteristics from approximately 96% of operating U.S. nuclear reactors.

## OBJECTIVE

The objectives of this evaluation were to utilize EPRI's extensive data base of radwaste volumes, sources and characteristics to evaluate the impact to the industry of NRC's proposed rule changes with respect to:

- The potential to increase the total number of Type A shipments
- The potential to increase the total number of Type B shipments
- Costs associated with increased or decreased number of Type A and/or Type B shipments

## PROPOSED METHODS (NRC ADOPTION OF IAEA STANDARDS)

Depending on the new grouping for LSA materials (LSA-II or LSA-III), the average specific activities for LSA quantities may not exceed 10E-04 A2 per gram or 2x10E-03 A2 per gram, respectively. In addition, IAEA has established an upper limit for LSA packages based on an external unshielded radiation level of 1 R/hr @ 3 meters.

The NRC is proposing to use 2 times the revised A1 value as its threshold of control for LSA material. LSA material that exceeds this level now requires a modified Type B package.

The results of the proposed NRC and DOT regulatory changes are illustrated in Fig. 1. The comparison of current versus proposed regulations is based on the average PWR isotopic distribution for dewatered bead resin shipped in a 14-195 liner (at approx 9,800 lbs). The figure shows that under current regulations, the NRC assumes regulatory control at around 12 curies of activity; at which point, an NRC certified container is required. Below that level, DOT requires shipment in a strong tight container. At approximately 1,200 curies, a Type B package would be required. Under proposed regulations, NRC control would not begin until approximately 40 curies. At this threshold, however, a package meeting Type B requirements is required for shipment.

## EVALUATION ASSUMPTIONS AND PARAMETERS

### Waste and Container Parameters

In order to thoroughly evaluate the impact of proposed low level radioactive waste transportation regulation changes, a variety of waste parameters typical of the commercial nuclear power industry were selected. The source of all data used in the following evaluations was actual power reactor information obtained directly from plant operators for publication by the Electric Power Research Institute (EPRI) in report " Radwaste Generation Survey Update", NP-5526, Volumes 1 and 2 (January 1988). This report, and its predecessor, "Identification of Radwaste Sources and Reduction Techniques", NP-3370 (January 1984), represent the most comprehensive utility developed data base of LLW volumes, sources, and characteristics currently available.

For this evaluation, waste volumes and characteristics for the period 1985-86 were averaged to obtain a composite waste source for each plant or multi-unit station. In those instances where specific data was not available for a particular plant in the EPRI data base, industry wide averages were used for the missing data. In all cases, the evaluation considered wastes from Boiling Water Reactors (BWR) separately from Pressurized Water Reactors (PWR).

For these evaluations, specific waste streams, waste types, waste forms, and shipping container configurations were considered separately in all of the various combinations possible. The following parameters were used:

| | |
|---|---|
| Plant Type: | Boiling Water Reactor (BWR)<br>Pressurized Water Reactor (PWR) |
| Resin Type: | Bead<br>Powder (BWRs Only) |
| Resin Grade: | Primary<br>Non-primary |
| Waste Form: | Dewatered in High Integrity Container<br>Solidified in Steel Liner |
| Container: | 6-80<br>8-120<br>14-195 (Non-primary Resins Only) |

This evaluation concentrated exclusively on ion exchange material generated from liquid waste stream processing, which represents the majority of wet waste shipped for disposal.

### Dose Rate Correlations

To assess the economic impact of the various radwaste shipping regulation options discussed earlier, the disposal cost program developed and published by EPRI in Report NP-4757 was used. The basic spreadsheet program published in NP-4757 was modified to incorporate the specific transportation and cask lease parameters identified below.

In order to evaluate the impact of the proposed NRC change on LSA shipping requirements, an analysis was performed for various typical radwaste packages to determine dose rates as a function of container size and isotopic mix. The analysis was performed utilizing MICROSHIELDtm Version 3.02 by Grove Engineering Inc. For ease of calculation during the evaluation of multiple scenarios, the dose-to-curie and curie-to-dose methodologies presented in EPRI Report NP-4757 were used. Results of the MICROSHIELDtm analysis were utilized to develop a correlation equation between the results obtained utilizing the EPRI program and MICROSHIELDtm.

### Cask Lease Rates

Several Type A and Type B casks were identified for use in this evaluation. Fig. 2 shows the various containers and cask configurations assumed.

In order to permit a reasonably valid cost comparison for this effort, a standard daily cask lease rate for both Type

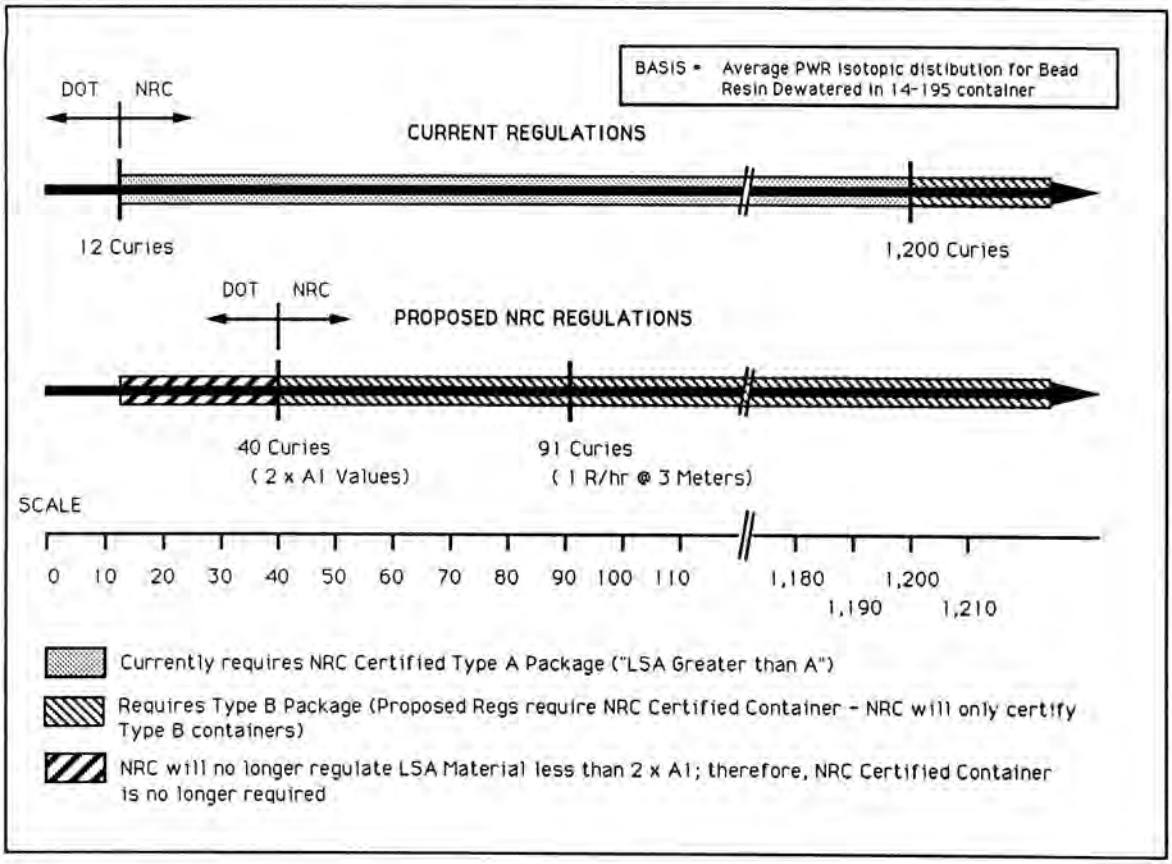


**Fig. 1.Current Regulations vs. NRC's Proposed Regulations.**

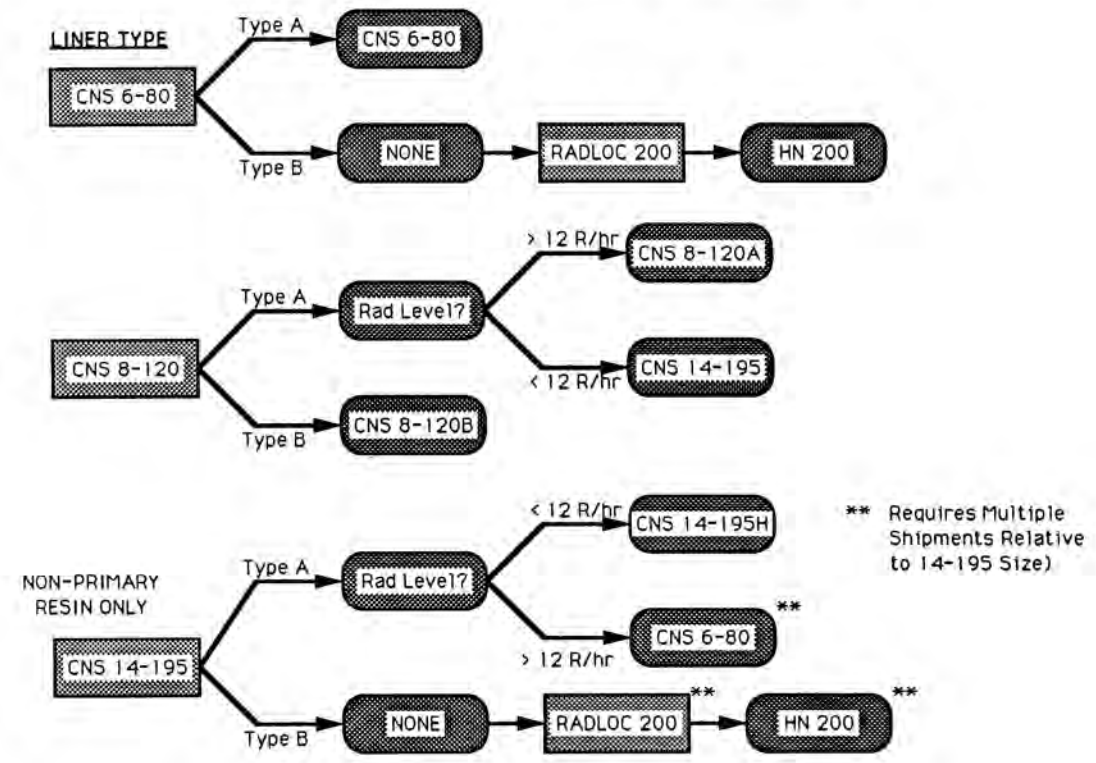


**Fig. 2. Waste Container and Cask Configurations.**

**TABLE I**
Cask Lease Rates and Transportation Assumptions

| Cask Type | Daily Rate | Weight | Miles Per Day |
|---|---|---|---|
| HN 100 | $330 | Legal | 600 Miles (12hrs x 50 MPH) |
| HN 200 | $1,000 | Overweight | 400 Miles (8hrs x 50 MPH) |
| CNS 6-80 | $545 | Legal | 600 Miles (12hrs x 50 MPH) |
| CNS 14-195H | $510 | Legal | 600 Miles (12hrs x 50 MPH) |
| CNS 8-120A | $1,700 | Legal | 600 Miles (12hrs x 50 MPH) |
| CNS 8-120B | $1,925 | Overweight | 400 Miles (8hrs x 50 MPH) |

A and Type B casks was required. Table I shows the daily cask lease rates assumed, based upon actual utility contracts (6).

In addition, Type B casks were assumed to remain at the plant site for an extra day to account for leak testing, installation of impact limitors, torqueing lid bolts, etc.

**Transportation Charges**

Actual distances from each plant to the Hanford and Barnwell disposal sites were obtained from Tri State Motor Transit (TSMT), and were used in the economic evaluation. The standard transportation charge per mile from TSMT (7) was used.

**Disposal Rates**

Actual radioactive waste disposal rates in effect as of 11/1/87 for Hanford and 1/15/88 for Barnwell were used. The economic evaluations included base disposal charges, radiation surcharges at Hanford, cask handling fees, weight surcharges, curie surcharges, out-of-region surcharges (if appropriate), and applicable local taxes. The contact radiation level on each container used to estimate the radiation surcharge at Hanford was estimated using a multiplier of four (4) over the dose rate at 1 foot.

**Potential Cost Savings For Shipments Less Than 2 X A1**

The NRC's proposed rule changes essentially established a lower limit of control (2 x A1), below which the NRC will no longer regulate. Therefore, NRC certified containers will no longer be required for shipments below this lower limit, resulting in a potential cost reduction from the use of non-certified containers.

To estimate the potential cost saving of non-certified versus certified containers, the CNSI 14-195H was compared to the CNSI 14-195L. The 14-195H is an NRC certified container, while the 14-195L is a non-certified container of comparable size. Actual plant data indicated that costs for a non-certified container are 10% to 12% less than for certified containers. To be conservative, we estimated that a plant will realize a 15% reduction in cask lease costs for all shipments less than the NRC's lower limit of control.

## EVALUATION RESULTS

**Impact to Total Number of Shipments**

The results of these evaluations are summarized in Table II, which summarizes the total number of Type A and Type B shipments for each container size based on current regulations, 1 R/hr @ 3 meters, and 2 x revised A1 values, assuming projected industry volumes are shipped in each of the containers shown. The table summarizes the results assuming all resins are dewatered in High Integrity Containers (HICs). The relative results for solidified resins are similar.

Keeping in mind that the evaluation was based on industry average data, which resulted in zero Type B shipments under current regulations, significant results of the evaluation are as follows:

Adoption of IAEA standards (1 R/hr @ 3 meters) will result in Type B shipment classifications for much of the primary grade waste currently being shipped as Type A ( 150 - 250 additional Type B shipments per year). Therefore, the relative difference between adoption of the IAEA standards and NRC's proposed 2 x revised A1 values with respect to the increased number of Type B shipments is insignificant for primary-grade waste.

For non-primary grade resin, a significant increase in the total number of Type B shipments could result from adoption of NRC's 2 x revised A1 values, relative to both current regulations and IAEA's 1 R/hr @ 3 meters. The overall increase is dependent upon whether or not plants would continue to ship in large-size liners.

The actual number of Type A versus Type B shipments will be dependent upon numerous variables. These variables include, among others:

- Availability of Type B casks in the future
  If Type B casks are not available (currently only 7 are used), plants may be forced to make more Type A shipments in smaller size containers.
- Relative costs for future Type B casks
  If Type B cask costs increase enough, relative to Type

A costs, it may be more economical for a utility to ship in smaller size containers.

- Plant operating conditions
  If the spent resin tank(s) at a plant are full and no storage space is available, the radwaste manager may have no choice but to ship several smaller size liners as Type A (independent of cost) rather than wait for a larger Type B cask to become available.

**Detailed Cost Breakdown**

Based upon 1988 packaging, transportation and burial costs, the increased cost to the industry for both regulation changes (1 R/hr @ 3 meters or 2 x revised A1 values) is estimated at about $ 1,000,000 per year for primary grade resins. For non-primary grade resin, adoption of IAEA's 1 R/hr @ 3 meters would result in a relatively insignificant economic impact if plants continued to use large size liners. Adoption of NRC's 2 x revised A1 values, however, could result in a significant increase in the number of Type B shipments (more than 500 additional Type B shipments which would increase total costs by about $4 Million based on current Type B cask fees). NRC's proposal could, however, lead to an increase in costs of up to $15 Million per year (based on 1988 costs) if demand for Type B casks exceeded supply and plants were forced to ship in smaller size liners. As Type B cask costs escalate due to increased demand, the additional cost to the industry will also increase.

Based upon 1988 cask lease fees, the proposed regulation changes will increase the overall cost to the industry because of increased Type B shipments. The changes result in a higher percentage of total costs attributed to cask lease fees, as follows:

Cask Lease Fees / Total Cost

| Regulation | Primary Resin | Non-Primary Resin |
|---|---|---|
| Current Reg's | 8% - 16% | 7% - 8% |
| 1 R @ 3 Meters | 17% - 25% | 9% - 13% |
| 2 x Revised A1 Values | 18% - 25% | 11% - 16% |

**Effects of Increased Type B Cask Costs**

As discussed above, NRC's proposal to use 2 x revised A1 values as its threshold of control has the potential to:

1) Increase the relative number of Type B shipments without significantly increasing the total (A + B) number of shipments, OR
2) Depending on the availability and cost of future Type B casks, the total number of shipments could be increased significantly.

To evaluate the effects of increased Type B cask costs relative to total industry costs and total number of shipments, Type B cask lease rates were escalated based on multiples (2, 3, 4, etc.) of current costs. All other costs, including Type A cask lease rates, remained unchanged from the previous economic evaluations.

For Primary Grade Resin, it becomes slightly less expensive to ship smaller size containers as Type B cask costs

**TABLE II**
Total Number of Type A and Type B Shipments by Scenario

| Resin Grade | Regulation | Case Evaluated | # Type A Shipments | #Type B Shipments |
|---|---|---|---|---|
| Primary | Current | CNS 6-80 | 343 | 0 |
| | IAEA (1R/hr @ 3m) | CNS 6-80 | 98 | 245 |
| | NRC (2 x Rev A1) | CNS 6-80 | 95 | 248 |
| Primary | Current | CNS 8-120 | 250 | 0 |
| | IAEA (1R/hr @ 3m) | CNS 8-120 | 71 | 179 |
| | NRC (2 x Rev A1) | CNS 8-120 | 64 | 186 |
| Non-Primary | Current | CNS 6-80 | *** | *** |
| | IAEA (1R/hr @ 3m) | CNS 6-80 | 2,913 | 0 |
| | NRC (2 x Rev A1) | CNS 6-80 | 2,821 | 91 |
| Non-Primary | Current | CNS 8-120 | *** | *** |
| | IAEA (1R/hr @ 3m) | CNS 8-120 | 1,970 | 65 |
| | NRC (2 x Rev A1) | CNS 8-120 | 1,758 | 277 |
| Non-Primary | Current | CNS 14-195 | 1,613 | 0 |
| | IAEA (1R/hr @ 3m) | CNS 14-195 | 1,522 | 98 |
| | NRC (2 x Rev A1) | CNS 14-195 | 1,145 | 505 |

! ***Under current regulations, CNS 6-80 or 8-120 containers would not typically be used; therefore, the scenario was not evaluated. Note: Actual container/cask combinations varied according to Fig. 2.

increase. For Non-Primary Grade Resin, Fig. 3 shows that if demand would cause Type B cask costs to increase by a factor of 4 - 5 relative to current Type B cask costs, then it would become more economical for plants to ship a greater number of Type A shipments in smaller containers rather than ship fewer large containers.

**Composite Scenario**

ARI was asked to define a "representative industry scenario" to quantify the effects of the proposed regulations. Assumptions relative to defining this scenario are as follows:

For Primary Grade Resin, 50% by volume is shipped in 6-80 size casks and 50% by volume is shipped in 8-120 size casks. For Non-Primary Resins, the 14-195 scenario, as defined, was representative for non-primary grade resins. This scenario assumed that non-primary grade resins were shipped in a large size container (14-195) unless radiation levels prevented its use, in which case smaller (6-80) containers were used.

Increased demand for Type B casks will increase Type B cask costs by 50% relative to current costs. Reduced costs for material less than the NRC threshold of 2 x A1 remained at 15% savings from the use of non-certified containers.

Based on the assumptions outlined above, the results of the evaluation relative to current regulations are as follows:

| | |
|---|---|
| Reduced Number of Annual Shipments in Type A Casks: | 684 |
| Increased Number of Annual Shipments in Type B Casks: | 722 |
| Increased Number of Total Annual Shipments (A + B): | 38 |
| Increased Annual Industry Cost: | $ 7.8 Million |

A 50% increase in Type B cask costs was assumed for this scenario; however, this may or may not be an accurate assumption. Figure 4 illustrates the economic impact to the industry relative to Type B cask costs, based on adoption of NRC's proposed changes.

## REFERENCES

The references listed herein have been reviewed during the course of this project and have contributed to the preparation of this document.

1. Regulations for the Transportation of Radioactive Material, Safety Series No. 6, 1985 Edition, International Atomic Energy Agency, February 1985.
2. Transportation Regulations; Compatibility With the International Atomic Energy Agency (IAEA), Nuclear Regulatory Commission, 53FR21550, Dated June 8, 1988.
3. Radwaste Generation Survey Update. Palo Alto, CA; Electric Power Research Institute, NP-5526, Volumes 1 and 2, February 1988.
4. Identification of Radwaste Sources and Reduction Techniques. Palo Alto, CA; Electric Power Research Institute, NP-3370, Volumes 1, 2 and 3, January 1984.
5. Microcomputer Spreadsheets for Radioactive Waste Management and Shielding Analysis. Palo Alto, CA; Electric Power Research Institute, NP-4757, September 1986.
6. Utility nuclear transportation and disposal service contracts, 1988.
7. Tri State Motor Transit Company, Hazardous Material Tariff, 1988.

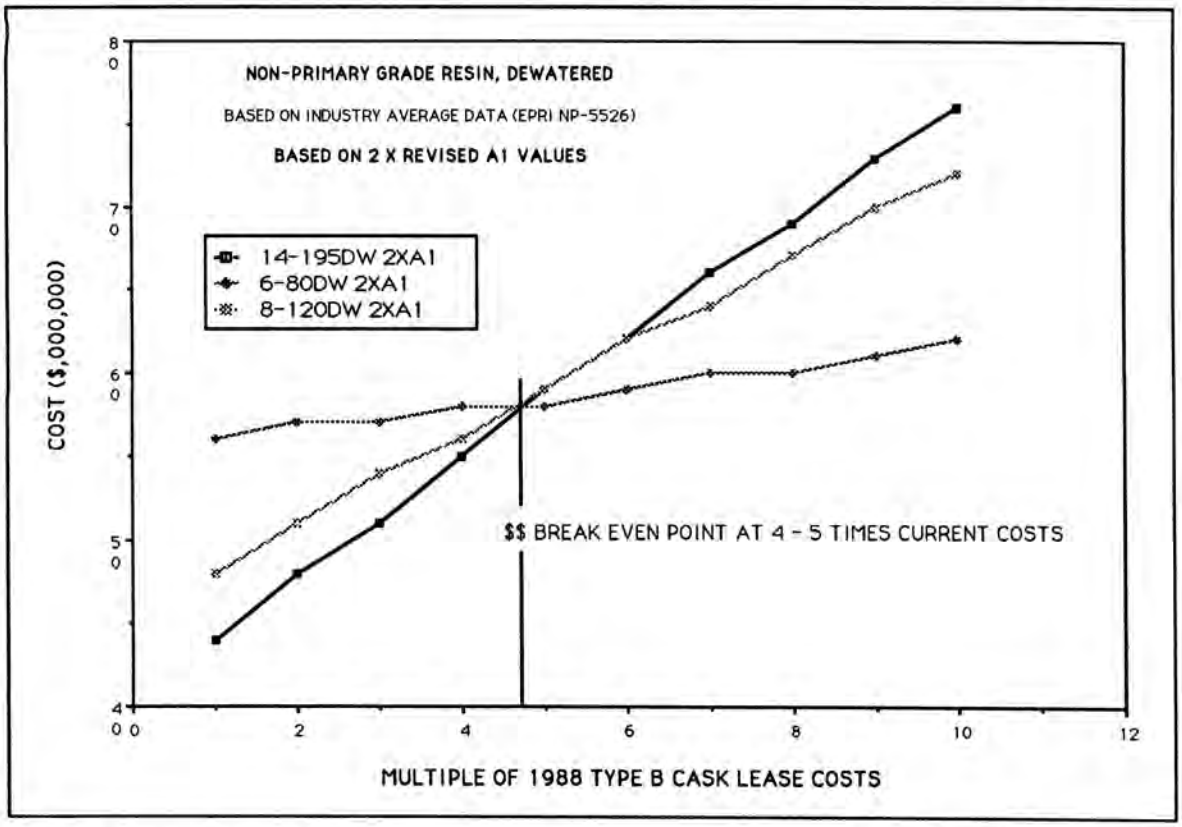


**Fig. 3. Industry Radwaste Costs vs Type B Cask Costs: More Shipments in Smaller Liners vs Less Shipments in Large Liners.**

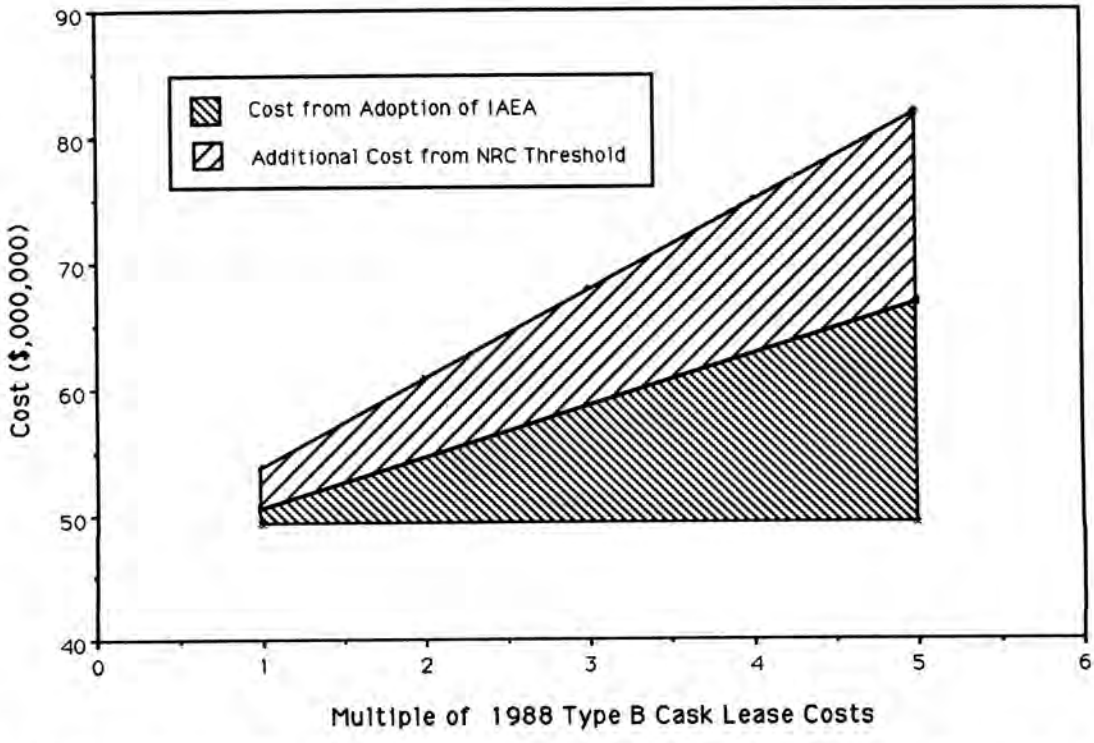


**Fig. 4. Industry Radwaste Costs vs Type B Cask Costs: Composite Scenario of Primary and Non-Primary Grade Dewatered Resin.**