

# EFFECT OF THE PROPOSED ADOPTION OF THE INTERNATIONAL ATOMIC ENERGY AGENCY REGULATIONS, 1985 REVISION, ON THE U.S. RADIOACTIVE WASTE TRANSPORTATION INDUSTRY

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## ABSTRACT

The Nuclear Regulatory Commission (NRC) is proposing changes to 10 CFR 71 transportation regulations to achieve compatibility with the 1985 IAEA regulations. The intent of these changes is to be more compatible with the international standard on shipping containers, package requirements, and performance criteria. The NRC has, however, modified part of its regulations to restrict the packaging of LSA by limiting the total activity rather than adopting the IAEA standard.

This paper addresses how the proposed regulations will affect the low-level radioactive waste transportation industry. It describes the impacts on the transportation industry in three major areas - IAEA consistency, economic impact, and risk assessment. Available transport data from the Barnwell disposal site was used in the analysis of the proposed changes. The impacts addressed include possible increased radiation exposures, transportation risks and liability, transportation and processing costs, and waste disposal costs resulting in little health and safety benefit. Although the health and safety benefits of any change to the current regulations are minimal, suggested alternatives to the proposed regulations are discussed that more closely conform with the international standards while still maintaining health and safety.

## INTRODUCTION

The Nuclear Regulatory Commission and the Department of Transportation are proposing changes to the regulations governing the transportation of low level radioactive waste (LLW). The NRC regulates the transport of greater than Type A quantities of radioactive material according to Title 10 Code of Federal Regulations Part 71. The Department of Transportation regulates the transport of all radioactive material according to Title 49 of the Code of Federal Regulations. Both regulatory bodies are preparing rulemaking to be more consistent with the 1985 International Atomic Energy Agency (IAEA) regulations, Safety Series #6.

Many changes are proposed in the new rulemaking. However, this paper focuses on the LSA limit proposed by the NRC and its effect on the LLW transportation industry. Other proposed changes affecting the transport of LLW include the redefinition of LSA, modifying and expanding the list of A1 and A2 values to meet the IAEA standards, and changing the regulatory authority for NRC licensed Type A casks from the NRC to the DOT. Enforcement of the proposed 2A1 LSA limit regulation is scheduled for one year from the regulation's implementation.

This paper reviews the proposed 2A1 LSA limit, describes three studies performed by Chem-Nuclear to evaluate the 2A1 value proposed by the NRC, reviews the draft EPRI economic report, addresses the Sandia LSA risk report, and recommends solutions derived from the studies to conform with the IAEA regulations. The three studies, performed by Chem-Nuclear in 1988, focus on the NRC consistency with the IAEA standard.

The first study was an evaluation to determine what multiple of A1 is equal to the IAEA standard of 1 rem/hr at 3 meters from the unshielded LSA material assuming Co-60 to be the only radionuclide in the waste. The second study

was an evaluation of the 2A1 limit using the dose rates from a select sample of 50 shipments made to the Barnwell Waste Management Facility (BWMF) and computer shielding equations. The third study was an evaluation of over 500 potentially affected cask shipments made to the BWMF over one year period to determine the equivalent A1 limit based on the recorded and calculated unshielded liner dose rates using correlation factors and statistical analysis. These studies and their results are described in detail.

## PROPOSED REGULATORY CHANGES

Transportation of radioactive material is regulated by the NRC in Title 10 Code of Federal Regulations (CFR) Part 71 regulations and by the Department of Transportation in the Title 49 regulations. The NRC regulations apply only to greater than Type A quantities of radioactive material. Current regulations require that greater than Type A quantities of low specific activity radioactive material consigned "exclusive use" be transported in an NRC licensed cask which meets Type A performance standards. No limitations are placed on the inner container's radiation doses. One of the objectives of the U.S. nuclear industry and the regulatory agencies is to be consistent with the international standards. The International Atomic Energy Agency has developed standards with input from the United States. Their regulations are listed in the 1985 IAEA Safety Series #6 document. The U.S. DOT and NRC are preparing rulemaking to be more consistent with these regulations.

One proposed change with potential impact to the low level radioactive waste (LLW) transportation industry is the restriction of LSA through dose rate or total activity limits. The IAEA regulations require an unshielded LSA container radiating more than 1 rem/hr at 3 meters to be placed in a Type B cask. Only six Type B casks licensed by the NRC for the transport of processed waste are available in the U.S. industry. A majority of the processed waste material is shipped in NRC licensed Type A casks. The NRC authorizes

the transport of LSA material which contains a total activity greater than A2 in Type A casks if the material is consigned exclusive use.

The NRC proposed rulemaking (NRC 1988) provides an alternative to the IAEA restriction of 1 rem/hr at 3 meters by limiting the total radionuclide activity. Current regulations identify activity limits signified by A1 and A2 values for each radionuclide. A1 values (for special form material) and A2 values (for normal form material) are used to determine the activity limits in packages. Due to the industry's difficulty in complying with the 1 rem/hr at 3 meter radiation level standard, the NRC chose not to adopt the IAEA dose rate limit but proposed a multiple of the A1 value as the limit to meet the objective. Proposed rulemaking suggests that a total activity limit of 2x revised A1 value would equal the IAEA limit of 1 rem/hr at 3 meters from the unshielded LSA material. No information was provided on how the 2xA1 limit was derived. The NRC staff position stated that it was a close approximation of the IAEA standard.

#### ANALYSIS OF 2A1 LIMIT

Chem-Nuclear Systems evaluated how closely the 2x the revised A1 limit approximates the 1 rem/hr at 3 meters IAEA standard as it applies to LLW packages (Anderson 1988). The relationship of activity to dose rate depends on numerous factors including the type and quantity of radionuclides, material self-attenuation, and container volume. Actual LLW shipment data was used to analyze the impact of the proposed regulation change on the current LLW transportation industry.

Three studies were performed by CNSI to analyze the relationship. The data was compiled from records obtained at the Barnwell Waste Management Facility operated by Chem-Nuclear. The data reflects cask shipments during a twelve month period in 1987 and 1988. The data includes unshielded dose rate, waste material, radionuclide type, and concentration. This data and radiation shielding programs were used in the three studies with the results summarized in the table below.

The first study involved theoretical calculations of the multiple of A1 equivalent to 1 rem/hr at 3 meters. Since the Co-60 isotope is the predominant contributor in LLW dose through the walls of a shielded cask, a theoretical calculation of the surface dose and corresponding 3 meter dose was made using Co-60 only. The MICROSHIELD computer program (Grove, 1987) was used to calculate dose rate values and the A1 equivalent for a 200 cu.ft. disposal liner. The proposed A1 value of 10.4 curies for Co-60 was assumed. Based on limitations of 1 rem/hr at 3 meters and the density of resin waste, a multiple of the A1 was calculated to be 3.52. Dewatered resin waste was used in this analysis as the most conservative waste form. A limit of 3.52A1 is 76% greater than the 2A1 value proposed by the NRC and would allow a correspondingly greater activity content in the LSA package without exceeding the dose limit established by the IAEA.

The second study involved data from 50 representative shipments received at the BWMF. The 50 shipments

involved six different cask/liner types containing either solidified or dewatered resins. Solidified and dewatered resins waste forms were used in this study because they represent the type wastes that might be affected by the NRC's proposed change. The multiple of A1 for each shipment ranged from 0.18 to 21 with an average of 4.27. The Microshield computer program was again used to determine the theoretical dose rate from the unshielded LSA material based on the specific radionuclide mix. The average multiple of A1 that corresponded to a dose rate of 1 rem/hr at 3 meters was calculated. This study showed an average A1 value of 2.73 with a standard deviation of + 1.37. The data showed little correlation between activity and dose rate as indicated by a correlation factor or R squared equal to -0.2. The third study involved the use of radiation dose and isotopic concentration data for over 500 shipments. Only cask shipments received at the BWMF spanning one year in 1987 and 1988 containing either solidified or dewatered resins were used. Data reflecting the measured container dose rate on contact recorded by the shipper, isotopic quantity and type were input into a computer program. The multiple of A1, again, based on the proposed A1 limits was calculated for each shipment. A normalization formula was used to relate a value of A1 to a dose rate at 3 meters. The statistical average A1 multiple calculated was 3.72 with a standard deviation of  $\pm 2.57$ . A plot of the data showed little correlation between total activity and dose rate on radioactive waste packages.

TABLE I  
CALCULATED A1 VALUE EQUIVALENT TO THE  
IAEA STANDARD OF 1 REM/HR AT 3 METERS

	xA1 $\pm$ Standard Deviation
Case 1 - All Co-60 In Waste (Theoretical)	3.52
Case 2 - Select Cases Using Microshield Calculations (50+ Cases - Theoretical)	2.73 $\pm$ 1.37
Case 3 - Database of 1987/1988 Shipment Records (500+ Cases - Experimental)	3.72 $\pm$ 2.57
NRC Proposed Value	2.0

#### ECONOMIC IMPACT

Chem-Nuclear's analysis indicates an additional 300-600% increase in Type B processed waste shipments (i.e. solidified or dewatered resins) will be made in order to comply with the proposed 2A1 LSA limit. There are approximately 20-30 processed waste shipments made each year to the BWMF that are required to be shipped in Type B casks. There are many more shipments made in Type B casks that are only require an NRC Type A cask. Type B casks are often scheduled and used prior to processing of the waste and an evaluation of the type package needed. The

2A1 limit will increase the number of Type B processed waste shipments to 90-120. Since the six(6) current Type B casks are utilized approximately 70% of the time, there be a shortage of available Type B casks and an additional 8 to 16 new casks will need to be manufactured to service the industry. Historically, design, licensing and manufacturing of new Type B casks take 3-4 years.

Disposal volumes and associated costs will also increase. As the higher volume Type A cask shipments are required to be shipped in the lower volume Type B casks, disposal volumes increase. Each disposal liner is not filled to the maximum to prevent spillage during processing and the burial volume on each liner is greater than the fill volume. If, for example, the waste currently transported in 200 cu.ft. Type A casks is transported in 120 cu.ft. Type B casks due to the proposed 2A1 limit, it would take 1.7 Type B shipments to transport a Type A shipment. The disposal volume increase is 2% due to the inefficiency of processing smaller volume packages. Other associated disposal costs assessed by shipment that will increase due to an increase in the number of shipments include cask handling and curie surcharges that are assessed in activity ranges. The curie surcharge assessments favor a lower number of high volume, high activity shipments rather than a greater number of lower volume, medium to high activity shipments.

Adoption of the NRC proposed regulations will economically impact the U.S. nuclear industry by \$4 to \$5 million per year according to EPRI (Dalosio 1988). EPRI's study utilized shipping information from a 1985/1986 database. The study evaluated solidified and dewatered primary and non-primary resin from BWRs and PWRs that were transported in three different casks. The \$4 to \$5 million impact identified in this study is the direct cost increase in package use, transportation, and disposal. The study did not evaluate the cost of new equipment (i.e. cask and trailer) design, licensing, and manufacture.

### RISK ASSESSMENT

Sandia National Laboratories was contracted by the U.S. Department of Transportation and the Department of Energy to evaluate the impacts of the United States adopting the IAEA standards associated with LSA and the 1 rem/hr at 3 meters from the unshielded cask restriction. In their risk assessment (Ostmeyer et al. 1988), they assumed the worse case scenario of high radiation level LSA waste, dewatered spent resin, with a specific activity at the existing regulatory limit (0.3 mCi/g). Although Sandia used the worst case scenario for their risk assessment, they commented that in the typical accident the radioactivity levels are likely to be orders of magnitude less than those assumed for their calculation and a release of 100% of the waste material is unlikely. They assessed the radiological impacts and risks in the event of a highway accident. Some of their conclusions are:

- "... current LSA limitations are sufficient to prevent excessive external radiation exposure to an individual following a severe transportation accident. Although package dose-rate restrictions could provide a higher level of confidence that external radiation doses are

not excessive, these restrictions would have a substantial impact on shipping practices and costs for transportation of LSA material."

- "Additionally, because the package dose-rate restrictions would substantially increase the number of shipments, the number of traffic fatalities and injuries from accidents involving transportation of waste materials would also rise."

We agree with these qualitative conclusions. However, one of the risks that Sandia did not address is the increased dose to the worker at the nuclear facilities while processing and preparing to transport the additional shipments that will result if either the 2A1 or 1 rem/hr at 3 meter restriction is invoked by the NRC. The proposed, more restrictive limit, will lead to more shipments, higher risk of accidents, higher costs for transportation and disposal, and a higher dose to radiation workers.

### CONCLUSION

Based on Chem-Nuclear's analysis two conclusions were reached.

- 1) There is no close correlation between waste activity (multiple of A1) and unshielded dose rate (1 rem/hr at 3 meters). The activity of alpha and beta emitters have no bearing on the external dose rate, but would restrict the package using an activity limit.
- 2) If an activity limit is to be used, a limit of 3.4A1 for gamma emitting radionuclides is closer to the IAEA standard of 1 rem/hr at 3 meters than the proposed 2A1 limit for LSA. Based on these conclusions, it is doubtful that the objective of consistency with the IAEA regulations will be achieved using a 2A1 activity limit. The 1 rem/hr at 3 meters dose limit, while being consistent with the IAEA standards, also has its negative factors including ALARA concerns and the inability to determine classification and compliance prior to waste package preparation.

Chem-Nuclear is continuing to study these impacts to determine the need for additional Type B shipping casks, since many LSA shipments previously made in NRC Type A casks will now require NRC Type B casks. Since Type B casks are more expensive to use per day and typically have a smaller capacity, the proposed change will result in more liners processed, more shipments made, and higher burial costs. Type B casks will be harder to secure and more expensive to use in the future if and when the proposed regulations are implemented.

Sandia's risk analysis has concluded that any change to the current regulations would be costly with little health and safety benefit. EPRI has proposed a possible cost to the industry of \$4 to \$5 million per year. Many other independent studies were conducted by industry groups and shippers. At the time this paper was prepared comments on this proposed regulation change are being solicited and accepted by the NRC. Once adopted, the regulations have a one year implementation period. Comments and

preparations should be made by the affected LLW industry on this major regulatory change.

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