ANALYSIS OF THE REDUCTION IN WASTE VOLUMES RECEIVED FOR DISPOSAL AT THE LOW-LEVEL RADIOACTIVE WASTE SITE IN THE STATE OF WASHINGTON

Stephanie Ko
Low-Level Radioactive Waste Program
Washington State Department of Ecology

ABSTRACT

The commercial low-level radioactive waste (LLRW) disposal site at Richland, Washington has been receiving waste from generators nationwide since 1965 and is one of the three sites in the nation currently receiving commercial LLRW for disposal. In the past, volumes of LLRW have been increasing steadily, however, this trend has reversed since 1986. This paper addresses waste volume and activity of the waste disposed, factors which have caused this dramatic reduction in LLRW volume, and regulatory concerns regarding environmental protection, and public and occupational health and safety.

Future volumes of LLRW that will be disposed at the Richland site depend on economic, technological, political and regulatory variables. Provided there is a continual increase in industrial growth, and a demand for medical research and diagnosis, the volume of LLRW will increase. However, this volume will also be offset by an increase in demand for volume reduction due to economic and institutional pressures. Yet, if all generators continue to volume reduce their LLRW, some time in future, a limit will be reached when the facility site operator will need to increase the unit disposal cost to cover the fixed cost and maintain a profit margin in order to operate the site. By then, regardless of the efficiencies of the volume reduction techniques available, further volume reduction on the waste will no longer be economically feasible.

INTRODUCTION

The purpose of this paper is to examine changes in waste volume and concentration, and the various factors which have contributed to these changes and to study the impact of these factors on future volumes of LLRW. The paper is organized into the following sections: waste volume and concentration, factors causing volume reduction, regulatory concerns regarding environmental protection, public and occupational health and safety, and implications of these factors on the future outlook.

WASTE VOLUME AND CONCENTRATION

The commercial low-level radioactive waste (LLRW) disposal facility at Richland, Washington has been receiving waste since 1965. During the 15 year period of 1970 to 1985, annual waste volumes received increased steadily. However, since 1986, dramatic changes to this trend have taken place. The volume of waste disposed at the site in 1987 was 83% of that of 1986, and the volume of waste received in 1986 was 47% of that received in 1985 (1,2).

Historical volumes of LLRW disposed at the Richland facility are shown in Fig. 1. The concentration of out-of-region LLRW was compared to that of in-region LLRW (Fig.2). During the period of 1982 to the present, the highest concentration of in-region waste received was in 1985, 0.084 curies per cubic foot. No trends in the concentration of in-region LLRW is observed, while the highest concentration of out-of-region waste has increased five-fold during the same period. The highest concentration was 0.232 curies per cubic foot in 1986. The highest annual volume of LLRW, 1.44 million cubic feet, received at the site since its operation was in 1981. To put it in perspective, the volume of low-level radioactive waste received in 1987 is equivalent to the volume of waste which was disposed in 1979.

Ninety eight percent of the LLRW received at the Richland commercial disposal site is Class A waste. Class A waste represents 100% of waste being volume reduced. Since the first supercompactor came on-line in 1984, concentration of Class A waste received at Richland has increased 98%. It appears that the increased use of various volume reduction technologies contributes to the overall increase in concentration of Class A waste that was disposed at the Richland disposal facility. The average annual concentrations of Class A waste disposed at the site are listed below (3).

Concentration of Class A LLRW
(millicuries per cubic foot)

1984	1985	1986	1987
4.2	6.5	7.7	8.3

Categories of generators who commonly use the Richland LLRW disposal site include fuel cycle, medical, governmental, industrial and institutional. Since there has been an increase in research and development activities in medical and academic institutions, radiopharmaceutical industries, and continuous production of energy from

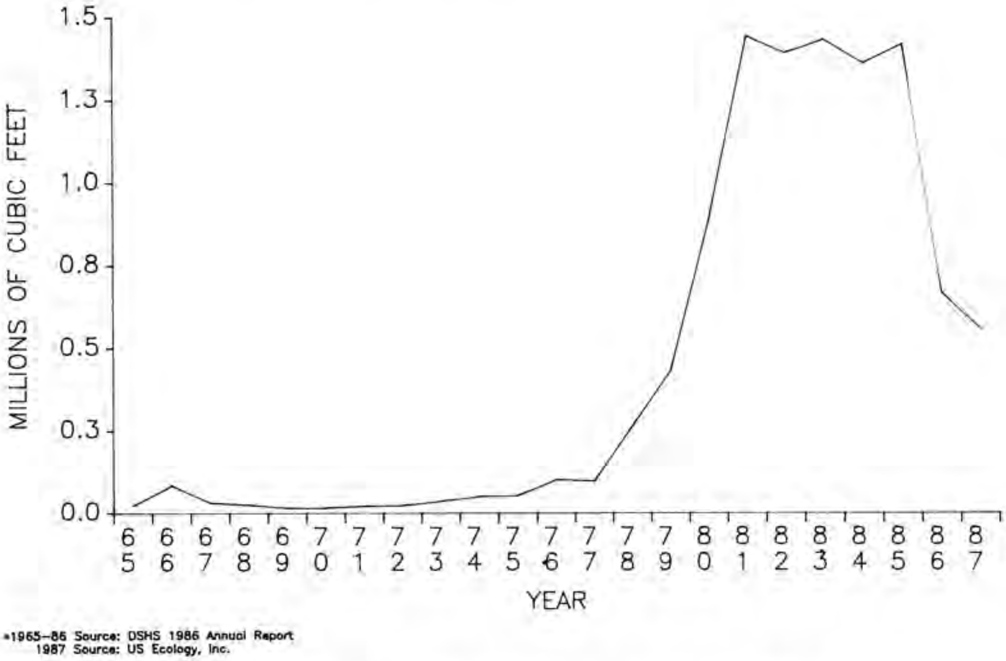


Fig. 1. Historical Volume of LLRW Disposed at Richland Facility.*

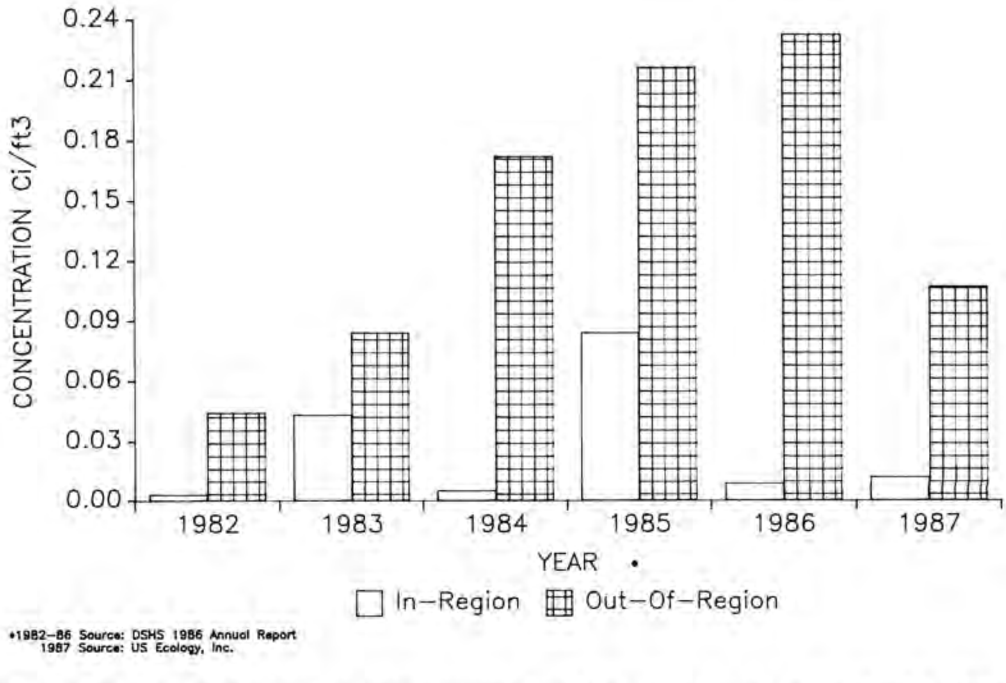


Fig. 2. In-Region & Out-Of-Region Concentration of LLRW Disposed at Richland Facility.*

commercial nuclear power reactors, one would expect to see an increase in the generation of commercial LLRW.

A comparison of 1983 and 1987 volumes of LLRW received at Richland from these generators indicates a tremendous decrease as follows (2,4):

	Percent Decrease in Volume
Fuel Cycle	70
Medical	73
Governmental	67
Institutional	79
Industrial	35

The question arises, then, where is the LLRW that is being generated by these facilities?

FACTORS CAUSING VOLUME REDUCTION

A combination of economic, political, regulatory, social and technological factors can potentially cause changes in the volume of LLRW being generated and disposed.

Economic Factor

One major factor which relates to the volume reduction of LLRW is economic. The steadily increasing cost of disposal has resulted in generators minimizing the volume of LLRW to be shipped for disposal. The historical cost of LLRW disposal charged by US Ecology, Incorporated, site operator of the Richland facility is shown in Fig. 3. The current minimum disposal fee charged by the facility operator is $29.60 per cubic foot or a minimum charge of $485.00 per shipment (2). Major causes of recent increasing disposal fees for LLRW include an increase in the unit disposal fee set by the facility site operator, increase in the surcharge on out-of-region waste, and inflation.

All out-of-region waste generators are required to pay the surcharge rate set by the Federal Low-Level Radioactive Waste Policy Amendments Act of 1985 (Amendments Act). A $10.00 per cubic foot surcharge has been assessed since March 1986, and a $20.00 per cubic foot surcharge has been assessed since January 1, 1988. Collection of the surcharge and the increase in disposal fees at the site coincide with the decreasing trend in the volume of LLRW being disposed at the site. They represent major driving forces for all generators to reduce their volumes of LLRW. This may encourage out-of-region generators to store LLRW which contains short-lived radionuclides for decay and eventually dispose the waste as non-radioactive waste. Since the majority of LLRW disposed at Richland have been out-of-region wastes (Fig.4), it is expected that the volume of LLRW disposed will continue to decrease significantly in the years to come.

Political Factor

A second factor which relates to volume reduction is political. Congress promulgated the Amendments Act in 1985 in order to manage the nation's LLRW on a regional basis. To comply with the Amendments Act, unsited states and compact regions must develop and operate their own LLRW disposal site by January 1, 1993. Some generators of LLRW indicate that they store LLRW for as long as a few years. Since new LLRW disposal sites will be operating in 1993, out-of-region generators may already have started storing increasing volumes of LLRW on site and plan to have these wastes disposed in their state's or region's new LLRW disposal site in the future. Furthermore, pursuant to the Amendments Act, all commercial reactors must dispose of their waste within the Amendments Act's reactor volume allocations. The Amendments Act requires a volume reduction of 17.5% for all in-region reactors between 1986 and 1989, and a 25% volume reduction between 1990 and 1992. For all out-of-region reactors, volume reductions of 30%, and 45% respectively are required (5,6).

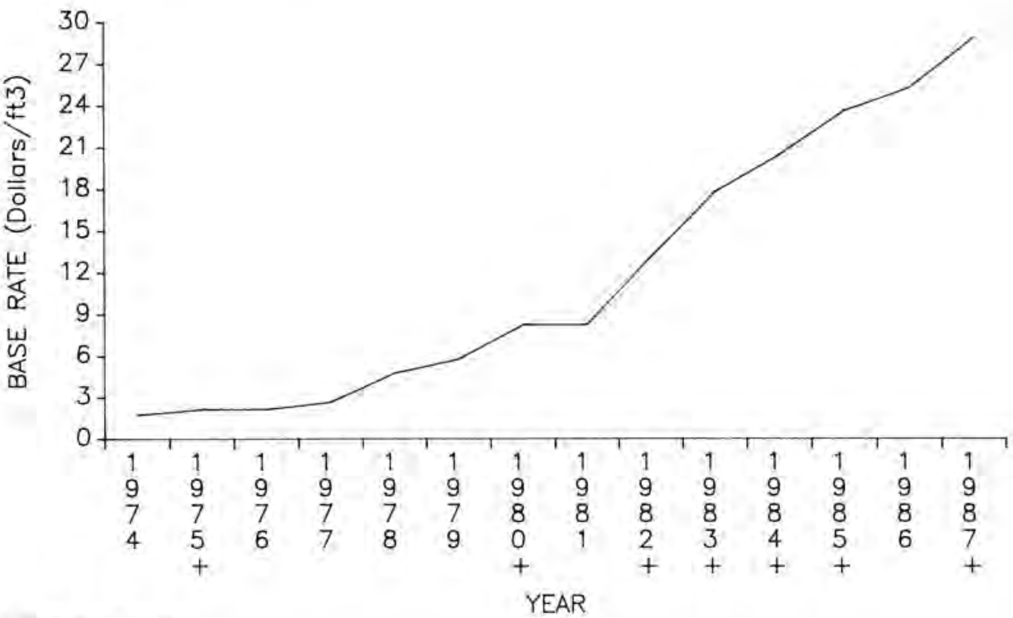
Technological Factor

The third factor which relates to volume reduction is the availability of technology. Recently, a number of volume reduction techniques have become available. Generators practice various methods to decrease the volume and activity of LLRW such as source reduction and volume reduction.

To practice source reduction generators may use smaller quantities of radionuclides. They may also substitute radionuclides which have long half-lives by using radionuclides which have shorter half-lives. If generators start using shorter half-life radionuclides, LLRW may then be held for decay, and the waste ultimately can be disposed of as non-radioactive waste.

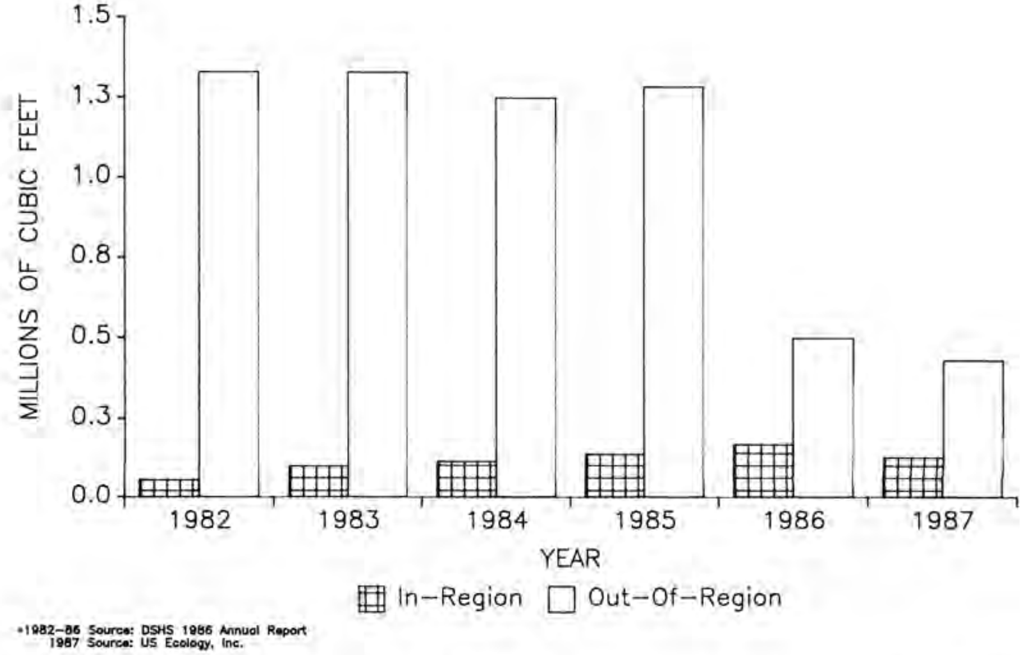
By practicing decontamination and recycling, generators can also achieve volume reduction. Quadrex Recycling Center in Tennessee has decontaminated a volume of approximately 800,000 cubic feet of LLRW since 1982. Therefore, this volume can be reused. This is cost effective for large volumes of LLRW, as it results in a savings of at least 15 percent of the average disposal costs, depending on the distance LLRW would have to be transported to the disposal site. Also, purchasing costs for new materials are then eliminated by using the recycled material (7).

Other practices to reduce the volume of LLRW include segregation of uncontaminated wastes, mechanical compaction and incineration. These are ideal volume reduction techniques when processing LLRW which is high in volume and low in curie content. LLRW generators and processors reported that a significant, though undocumented, number of generators such as utilities have purchased a variety of commercially available trash compactors and regularly use



* Source: US Ecology, Inc.
+ Average cost per year.

Fig. 3. Historical Cost of LLRW Disposal at the Richland Facility.*



*1982-86 Source: DSHS 1986 Annual Report
1987 Source: US Ecology, Inc.

Fig. 4. In-Region & Out-Of-Region Volume of LLRW Disposed at Richland Facility.*

them on site. This is practical for generators who produce a substantial volume of LLRW on a regular basis, while it is more cost effective for small generators to use outside vendors to compact their waste.

The Electric Power Research Institute (EPRI) study of 1984, concluded that 60-70% of all nuclear utility waste is dry active waste (DAW), and an average of 60% of all DAW is compactable (8). Reductions range between 1.5 and 9.0, depending on the original density of the DAW. Uncompacted DAW has an average density of 7-10 pounds per cubic foot. A standard drum compactor typically reduces DAW to a density of 17-30 pounds per cubic foot. Shredder/compactors can reduce it to 41-45 pounds per cubic foot, and horizontal compactors may further reduce it to density of 50-60 pounds per cubic foot (9,10).

Regulatory Factor

Another factor contributing to the reduction in volume is regulatory. The Nuclear Regulatory Commission's amendment to 10 CFR 20 (section 20.306) (11) in 1981 resulted in the deregulation of .05 microcuries per gram of Carbon-14 and Hydrogen-3 in certain biomedical wastes, allowing wastes to be disposed of as non-radioactive waste. This declaration of certain wastes as below regulatory concern (BRC) causes substantial reductions in certain biomedical waste streams (12).

In 1985 the State of Washington banned the disposal of scintillation fluids which contain any organic liquids and in 1987 prohibited the disposal of lead. This caused a reduction of LLRW being sent to the state of Washington to a limited extent (9). Coupled with other driving forces to reduce low-level radioactive waste, this resulted in the volume of biomedical waste dropping from 79,000 cubic feet in 1983 to 21,000 cubic feet in 1987 (2,4).

Future declarations of certain concentrations of LLRW as BRC waste could cause drastic decreases in the volume of LLRW requiring disposal. Since the amendment to 10 CFR 20 in 1981, generators have requested that other wastes with the same concentrations of Carbon-14 and Hydrogen-3 be declared BRC wastes. Regulatory changes in reclassification or declassification of LLRW remain a major controlling factor affecting the kind of wastes which are required to be disposed of in a LLRW disposal facility.

REGULATORY CONCERNS REGARDING ENVIRONMENTAL PROTECTION AND PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

With various activities being carried out by generators and processors to reduce the final volume of LLRW that needs to be shipped to disposal sites, a few concerns have arisen relative to environmental protection, occupational exposure, and public health and safety.

Processing of Waste

Utilities are generators who require LLRW decontamination services. Demands for this service will increase as cost for disposal increases, and the continuous pressure to volume reduce commercial reactor waste under the Amendments Act remains. As a consequence, more decontamination and recycling services will be available in the nation. It is understood that decontamination is a labor intensive process. That means that in the future, more workers will be employed in this field and cautions need to be taken to ensure minimum occupational exposure to radiation.

Generators who volume reduce their LLRW by segregation and storage for decay need to maintain a good LLRW management program on site to ensure workers' safety. Also, extra effort needs to be taken to track records of waste streams. Plans need to be developed accordingly to reflect administrative changes in LLRW management.

If the trend of increasing concentration of Class A waste continues, more caution should be taken by workers involved in handling the waste from collection, segregation, packaging, and transportation to final disposal.

According to waste processors, because of increases in the weight of compacted waste, more and more drums are handled by remote, mechanical methods rather than by workers. This change in handling the drums can actually decrease the workers' exposure. On the other hand, presorting is usually necessary to exclude any uncompactable waste before waste is collected for compaction. During this process, workers' exposure to the waste will be increased due to the length of time in contact with the contents of waste packages.

After waste is supercompacted, some waste processors believe that workers' exposure to the waste is actually decreased during handling and transportation of the compacted and supercompacted drums sent for disposal. Usually the waste which has the highest activity is centered in the drum. After compaction, these higher activity packages are surrounded by higher density packages and these higher density packages function as a shield around the side of the drums. Thus, exposure to workers is actually reduced as a consequence of waste compaction.

Transportation and Disposal of Waste

On the other hand, compacted waste creates problems for inspectors who need to inspect waste for compliance with waste regulations. Compacted waste, with its high density, makes sampling difficult if not impossible. In order to reduce workers' exposure during inspection and clean up (should an accident occur) procedures for waste inspection may need to be changed in order to be compatible with changing technologies in waste processing, packaging, and the increasing concentration of the majority of waste being disposed.

The increased concentration of the majority of LLRW shipped for disposal at Richland also implies that trench curie content is higher than those trenches and parts of trenches, in which Class A LLRW was disposed prior to 1986. Currently, trenches are backfilled with the sandy and silty soil originally excavated from the trench during operations. The practice has been followed since the early years of the site's operation. With the increase in the concentration of Class A waste, which is the majority of the waste being compacted and disposed, questions arise. Is any change in this practice necessary to prevent additional workers' exposure? Is site closure based on the knowledge and operation procedures of the past still sufficient to assure workers' occupational safety, public health and safety, as well as perpetual care and maintenance of the site for optimum environmental protection? These questions require investigation.

IMPLICATIONS OF THESE FACTORS ON THE FUTURE OUTLOOK

Regulatory decisions and guidelines on disposal of mixed waste may certainly be the next major regulatory factor which will impact the volume of LLRW required to be disposed. This major change also depends on the capability of the latest technology to analyze mixed waste. Furthermore, future research may develop new technologies which are able to process mixed waste into hazardous waste or LLRW as the final waste stream. Also, the costs to have the mixed waste analyzed, processed, and disposed of are all critical factors for generators, and are unknown at this time.

Therefore, future technology and regulation of mixed waste may cause increases in the volumes of LLRW and hazardous waste, rather than increase the volume of waste that needs to be disposed in a mixed waste disposal facility (which has yet to be developed). The timing of regulations on mixed waste, available technology and economic incentives will all be critical factors affecting the final volume of various categories of wastes that need to be disposed.

The future of the nuclear industry is another major factor which will contribute to changes in volumes of LLRW. However, the future of nuclear industry depends on the future political climate, economic feasibility, as well as its acceptance by the public. A potential factor which is going to increase the volume of commercial LLRW is the future decommissioning of aged commercial reactors. Within the Northwest Compact Region this means the decommissioning of Trojan reactor, could occur as early as 2008. The destiny of the Washington Public Power Supply System reactor is not determined at this point. Waste volumes depend on which techniques will be used in decommissioning: immediate dismantlement or safety storage deferred dismantlement. Also, there is a possibility of retrofitting the reactor to extend its operational life of an additional twenty years after the present license expires.

We may expect a steady annual decrease in the volume of LLRW generated by commercial reactors until 1993 as required by the Amendments Act. A temporary increase in the volume of LLRW would be expected due to decommissioning of aged power reactors in the future. Some believe that volumes of non-reactor generated LLRW will decrease steadily between now and 1993 (9). Provided increases in industrial growth, and demands for research and services continue, the volumes of low-level radioactive waste generated will continue to increase. However, these volumes will be offset by an increase in demand for volume reduction due to economic incentives, and social and institutional pressures. Furthermore, by 1993, the Richland disposal site will only be accepting in-region LLRW. At that time, the LLRW volume disposed at the site will probably stay under 100,000 cubic feet per year.

Overall, the volume of LLRW that can be volume reduced is limited by the type of LLRW and the efficiencies of various technologies available. Yet, if all generators continue to volume reduce their LLRW, a limit will be reached when the facility site operator will need to increase the unit disposal cost to cover the fixed costs to keep the site operating and maintain its profit margin as well. When this limit is reached, further volume reduction will no longer be economically feasible, regardless of the efficiency of the volume reduction technology that is available at that time.

The final volume of LLRW that needs to be disposed will be the result of all the contributing factors which have a high degree of uncertainty at this point. Understanding the roles played by these major variables will provide us with improved predictive capabilities relative to impacts on the LLRW disposal and provide us with an improved ability to respond to changes in any of these variables in the future.

CONCLUSION

The volume of LLRW disposed at the Richland facility has decreased significantly in the past two years. This includes decreased volumes of LLRW from all categories of generators who use the disposal site. This is mainly due to the increasing unit disposal fees charged by the disposal site operator and the surcharge collected by the state on all out-of-region LLRW provided for in the Amendments Act. Other contributing factors which have caused this reduction in the volume of LLRW include regulatory and technological variables. Various activities carried out by generators and processors to reduce the volume of LLRW have also caused some regulatory concerns regarding public health, occupational and environmental safety. Questions have arisen and need to be investigated in the future.

In the future, the volume of LLRW will continue to be affected by economic, technological, political and regulatory variables. However, economic incentives appear to be the strongest driving force at present and we can expect that the volume of LLRW will continue to decrease. As this trend continues, a limit will be reached when the volume of LLRW received at the disposal site is so low that the facility operator will need to increase the unit disposal cost to cover its operating cost and maintain a certain level of profit margin. By then, further reduction of the volume of LLRW will no longer be economically feasible and the volume will remain at that level.

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