TRENDS IN LIQUID LOW-LEVEL WASTE MANAGEMENT FOR THE U.S. NUCLEAR POWER INDUSTRY

S. Bushart and V. Dang
EPRI

P. Saunders
CENTEC XXI

J. Edwards
Vomex Technologies

ABSTRACT

The aggressive implementation of process improvements and new technologies over the past decade has resulted in dramatic reductions in both waste volume and effluent release activity at nuclear power plants.

A cooperative ASME/EPRI LLW benchmarking program was initiated in 1993 to collect liquid processing data from commercial nuclear power plants. This benchmarking program has collected data from US power plants including liquid volume, waterborne mixed fission and activation, and tritium activity. These Benchmarking data can be used by Radwaste processing professionals to better understand the efficiency of their LLW management programs. Additionally, for the past seven years, EPRI has conducted nuclear plant LLW program assessments. These assessments have included a very detailed review of current and alternate processing options, source and resultant waste reduction options, and recommendations for improvements. EPRI's use of a small group of dedicated assessors has resulted in the development of a detailed database, consistency in the reviews, and accurate comparisons between stations.

Together these programs have helped to document significant improvements in LLW processing and industry trends over the period of seven years from 1993 to 2000. BWR liquid waste volumes during this period were reduced by 77% and PWR volumes were reduced by 85%. Similarly, the improvement efforts resulted in solid waste volume reductions for BWRs and PWRs of 56% and 37% respectively. Finally, and most importantly, the mixed fission and activation product release activity has been reduced by 97% for BWRs and 66% for PWRs.

Clearly these aggressive environmental stewardship efforts by utilities have resulted in significant reductions in liquid and solid waste volumes, and released activity for the US nuclear power plants. These changes indicate that the industry is highly successful in assessing, benchmarking, and implementing new LLW improvement techniques and technologies.

INTRODUCTION

Over the past decade, the United States nuclear power industry has launched several initiatives in their management strategies for liquid low level waste. These initiatives, often driven by factors such as economics, environmental stewardship, and deregulation, have resulted in dramatic decreases in volumes and activity of LLW discharges by U.S. plants.

Most plants in the U.S. have initiated aggressive LLW volume reduction practices over the past decade. Initiatives in radwaste input quality and volume reduction are often desired when optimizing a new processing technology, such as advanced membrane systems (1). The utilities have also pursued aggressive waste minimization programs to reduce solid waste generation form media and filter usage from liquid LLW processing (2). U.S. utilities have often pursued these reductions due to the uncertainty of disposal sites, for economic reasons, and to optimize process performance.

U.S. nuclear power utilities are continually looking for ways to decrease their already low activity discharges. The driving force for ongoing activity reductions are often upper management goals for environmental stewardship, and utility self-regulation by groups such as INPO. Advances in LLW management practices and new technology implementations often are the mechanisms for reaching these discharge goals (3).

The objective of this paper is to illustrate these trends in liquid LLW processing. Data will be presented from two EPRI programs that have benchmarked the U.S. nuclear power industry since 1993.

METHODS

1) Benchmarking data was voluntarily contributed by LLW managers from the U.S. nuclear power plants on an annual basis from 1993 to 2000. This data collection and compilation effort was carried out jointly by ASME, EPRI and Vomex Technologies. Data was collected for the following parameters; liquid volume generated; solid waste generated from liquid processing; Mixed-Fission activity products released (activity and dose), and tritium released (activity and dose). Participation varied somewhat by year, with from 86 to 101 units reporting data. Data was collected in a MS Access database, and is reported by plant type (BWR or PWR).

2) Economic and performance data for liquid LLW processing was also collected from 1993 to 2000 as part of the EPRI LLW Assessment program. Over 50 sites were visited during this time by EPRI and CENTEC XXI. Cost and performance data for processing and disposal were collected and analyzed using the EPRI WasteLogic^{TM} Liquid Processing Manager Software code. Plants are benchmarked anonymously against their peers using key performance parameters and standardized results. A key performance result, Liters processed per cubic

meter of media generated is shown, using data generated from 16 PWR units and 12 BWR units recently sampled.

RESULTS

Figure 1 shows changes in average liquid waste volume for US BWRs from 1993 to 1999. As shown, Liquid waste volumes steadily decreased throughout the sampling period, from 8.5-8.6 million Liters in 1993-1994 to 1.9 million Liters in 1999. PWRs experienced a similar decrease in liquid waste volumes during this period, from 24.2 million Liters on average in 1993 to 3.7 million Liters in 1999.

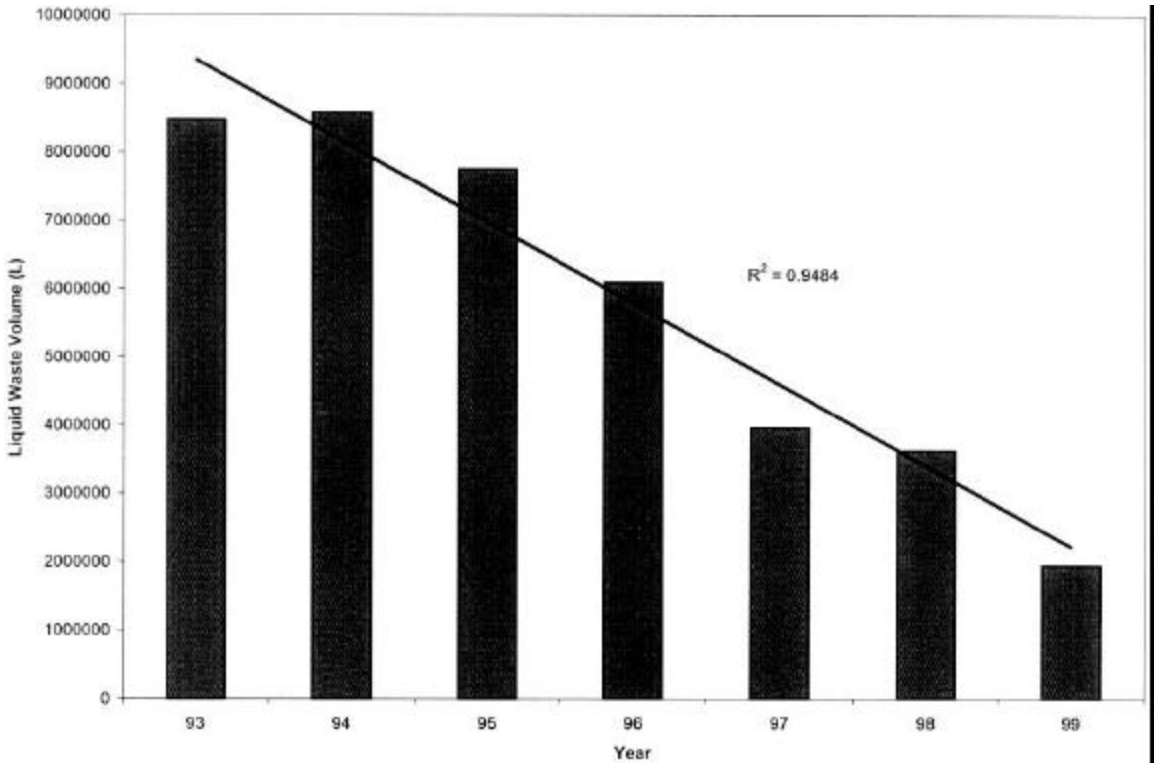

Fig. 1: US BWRs Average Liquid Waste Volume 1993-1999

Figure 2 shows trends in the amount of solid waste generated form liquid processing during the benchmarking period for BWRs. The amount of solid waste generated from BWRs showed an average decrease from 75.8 m^3 in 1993 to 33.4 m^3 in 1999. Similar trends for PWRs were seen, from 12.5 m^3 in 1993 to 7.8 m^3 in 1999.

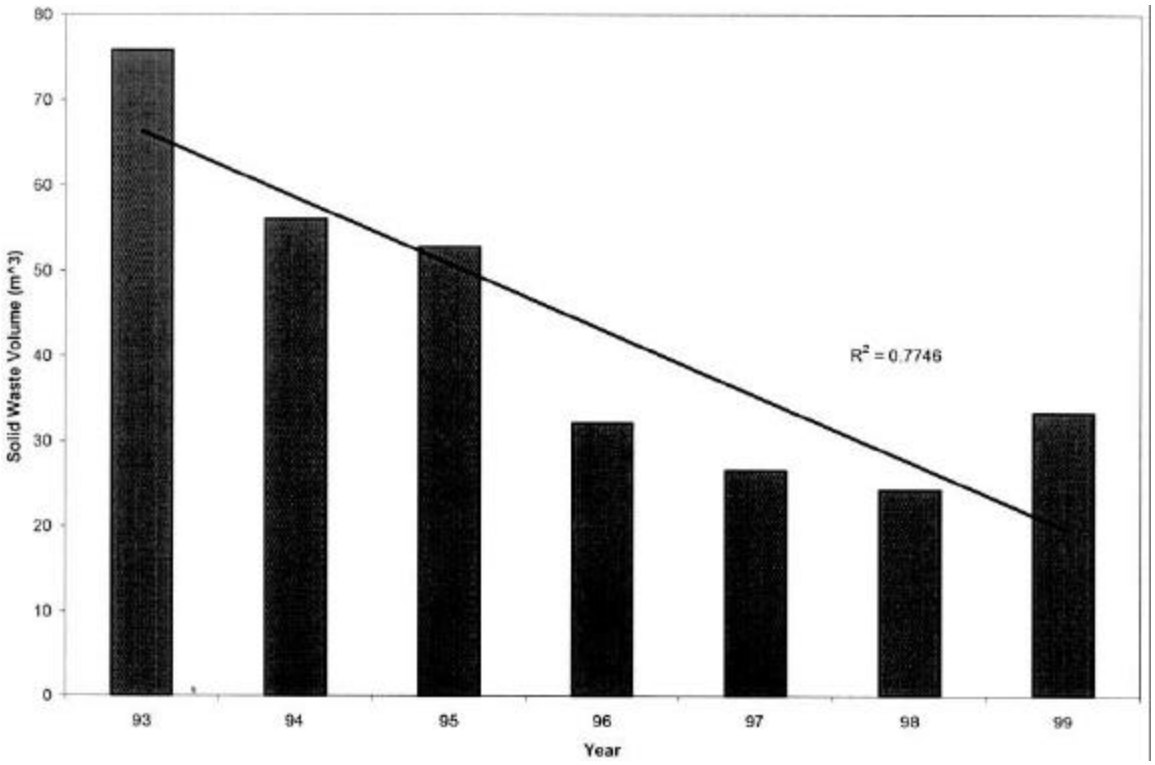

Fig. 2: US BWRs Average Solid Waste Volume Generated 1993-1999

Figure 3 shows the data for changes in mixed fission activation (MFA) products discharged for BWRS. These MFA releases also decreased significantly during this period for BWRs, from an average 0.355 Curies in 1993 to 0.0084 Curies in 1999. For PWRs, reductions were seen as well, from 0.366 Curies in 1993 to 0.126 Curies in 1999.

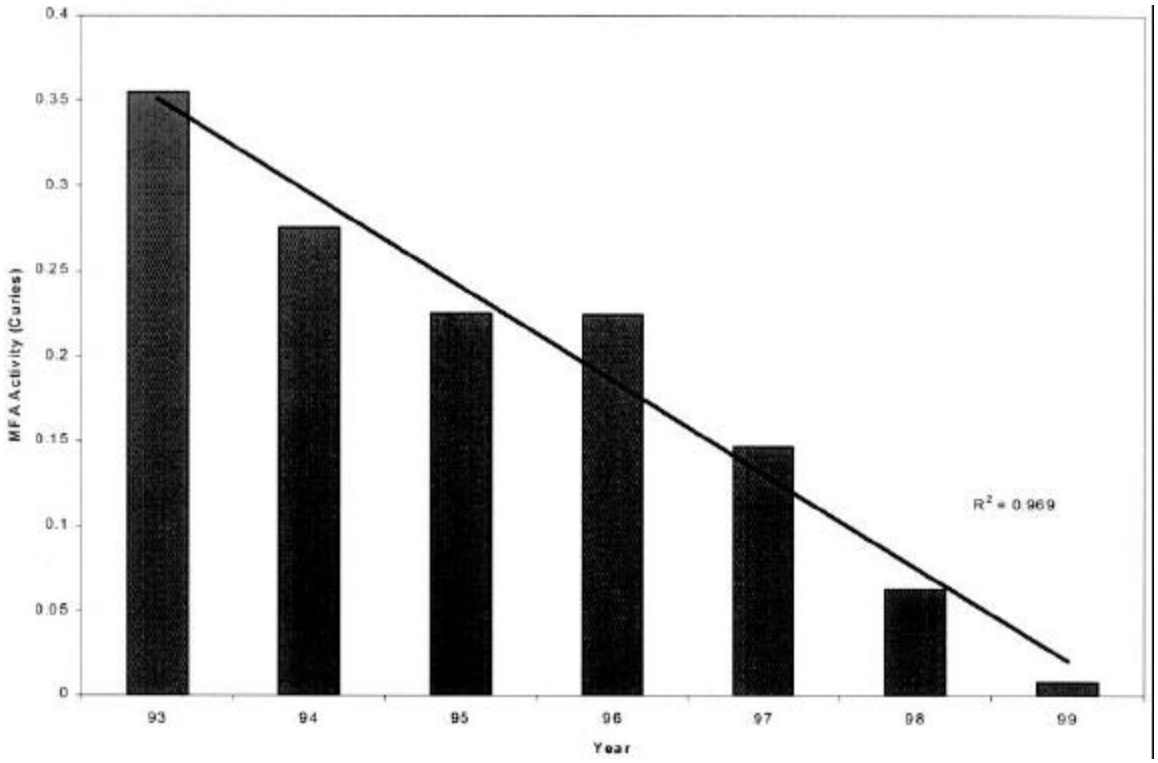

Fig. 3: US BWRs Average MFA Activity 1993-1999

Overall changes from 1993 to 1999 are detailed in Table I. Significant decreases for both PWRs and BWRs are shown for MFA products, Liquid waste volumes, and Solid waste generated from liquid processing.

Table I: Average Reductions for Liquid LLW Discharges from US Power Plants (1993 -1999)

	Liquid Volume	**Solid Volume**	**MFA**
BWR Avg. 1993	8484717 L	75.839 m^3	0.354693 Ci
BWR Avg. 1999	1947441 L	33.42 m^3	0.0084 Ci
BWR Reduction Factor	**4.36**	**2.27**	**42.23**
PWR Avg. 1993	24194908 L	12.48 m^3	0.366 Ci
PWR Avg. 1999	3676156 L	7.807 m^3	0.126 Ci
PWR Reduction Factor	**6.58**	**1.60**	**2.90**

A key LLW liquid processing performance parameter is benchmarked for several PWR units in Figure 4. Identical data points are the result of twin unit plants with shared outputs that have been averaged. Units, which fall above the average line show improved performance, while units below the line show less than average performance. Table II shows this same performance measurement for BWRs.

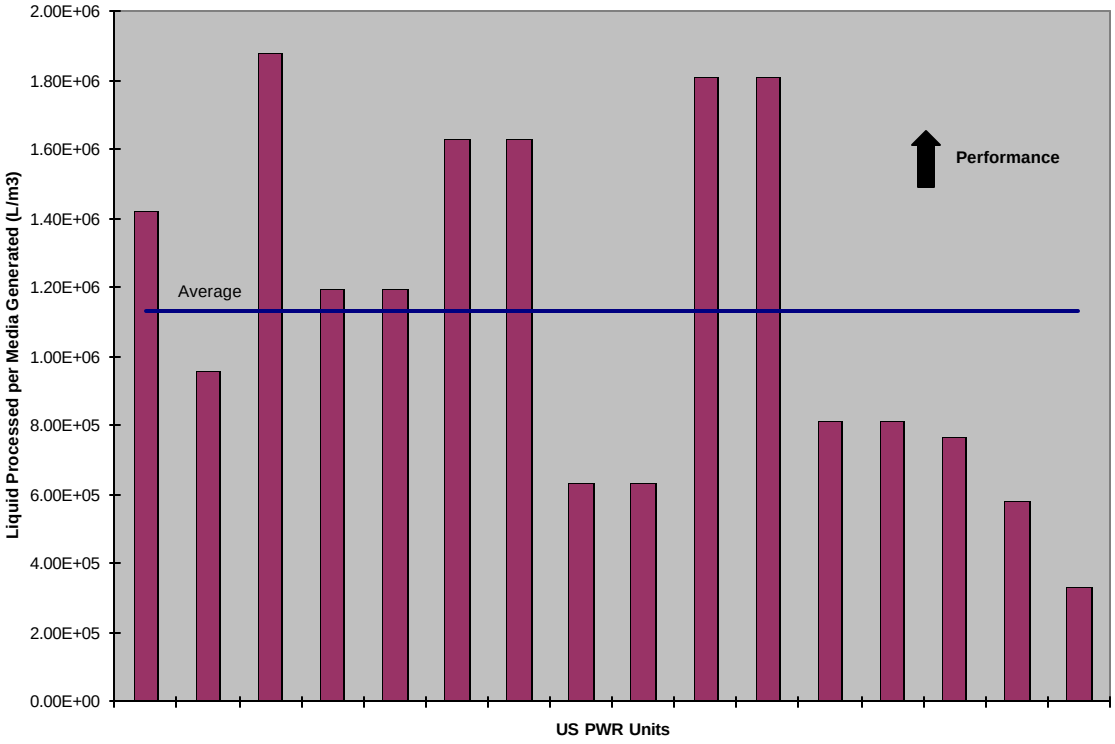

Fig. 4: Liters processed per cubic meter of media generated for US PWRs.

Table II: Performance Measurements of Liquid LLW Processing for U.S. Plants: Throughput of Media.

Throughput **(L/m^3)**	**Average**	**Minimum**	**Maximum**
PWR	1,131,583	330,184	1,875,500
BWR	2,062,381	798,190	4,360,570

DISCUSSION:

Trends in the reduction of liquid Low Level Waste Volumes and Activities show that the U.S. Nuclear Power Industry continues to be successful in improving performance and in responsibly managing environmental effluents. MFA product activity and dose, already well below regulatory limits, continue to be driven downward. This downward trend has not changed since deregulation, but continues perhaps due to self-regulation and the availability of new processing technologies. These technologies, such as reverse osmosis, ultrafiltration, nuclide-specific media and advanced polymer treatment allow LLW managers to more readily reduce activity from the waste streams, and to even target specific nuclides of concern.

The U.S. utility managers have also been successful in reducing the volumes of liquid and solid waste generated from liquid processing. Reductions in solid waste generation have allowed the utilities to be in a much-improved position in regards to potential

changes with LLW disposal facilities. Volume reductions in LLW have allowed for increased interim on-site storage capabilities in the event of a temporary unavailability of these facilities.

Reductions in liquid volume discharges are partially due to aggressive campaigns to segregate wastes, and to limit the input volumes for LLW processing (1). There is a direct economic benefit to this, as seen by increased media, filter and membrane lifetimes.

Performance benchmarking for LLW managers has been an increasing need in the drive to be cost-competitive. The average media throughput values give an indication of where U.S. plants stand on this parameter, and can be helpful as a comparison for individual plant performance. However, it should be noted that these values alone will not likely be useful without accounting for all of the other factors which are truly involved in calculating this kind of value, as would be done in the EPRI LLW assessment process. These performance values, and others, are derived from inputting a comprehensive list of plant cost, labor, disposal, and performance values into a standardized code, WasteLogic^{TM}.

By continually advancing these limits for economic viability and environmental stewardship, LLW managers are large contributors to the long-term success of nuclear power in the U.S. under deregulation.

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