HOW TO OVERCOME THE DIMINISHING RETURNS ASSOCIATED WITH VOLUME REDUCTION

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ABSTRACT

There are many factors affecting the volume reduction of low level radioactively contaminated materials. Most nuclear utilities achieve volume reduction in the range of 90%. Greater volume reduction can be achieved, but at substantially greater cost per percent improvement. It is this relationship that results in the diminishing returns associated with volume reduction by properly applying the correct volume reduction techniques to the proper candidate materials. Simply stated, if non-contaminated materials are removed from the waste stream, deconnable materials are cleaned, contaminated incinerables are burned, and the remaining non-deconnable materials are cleaned, contaminated incinerables are burned, and the remaining non-deconnable, non-incinerable contaminated materials are volume reduced and disposed of in a stable waste form, additional volume reduction can be achieved at substantially reduced costs. This paper provides the details of the application of the appropriate mix of volume reduction processing techniques.

INTRODUCTION

This paper has been prompted by discussions throughout the industry over the past 12 months regarding volume reduction in general and decisions about how best to treat contaminated material -- note I didn't call it waste. Since 1985, many of you have heard me discourage material classification as waste unless it's contaminated and can't be cleaned. A lot of people ask me to explain what I mean by that.

I don't know about most of you, but when I'm finished with a meal at home and the dishes are dirty, I clean them. If I were made out of money, I'd throw them away and use new ones at each meal. But, I'm not made out of money and the dishes have a beneficial reuse, once they're decontaminated.

"It's not waste if it can be cleaned," is a philosophy that has been important in the disposition of contaminated materials. There are some interesting parallels to be drawn between public and nuclear waste disposal problems.

In recent years trash compactors were a popular household item. Compactors are also a popular method of volume reduction for low level waste. On garbage pick-up days in my neighborhood you see lots of curbside bins overflowing with cans, bottles, and newspapers destined for recycling.

At the completion of a recent nuclear recycling project to decontaminate 1.2 Million pounds of heat exchanger tubing, the customer got a check for a hundred thousand dollars, instead of an invoice for disposal. In that case, the value of the materials as scrap more than off-set the costs of decontamination processing.

THEN AND NOW

For those who remember the '70s and early '80s when burial prices were in the single digits, and access to disposal sites was unrestricted, you'll also remember how little attention was paid to minimization of waste volumes.

When disposal prices were $10/ft^3$, 90% volume reduction at a total cost of $9/ft^3$, was a breakeven proposition. Obviously, at $100/ft^3$, 90% volume reduction is breakeven at $90/ft^3$. As unsited disposal rates approach $300/ft^3$, the expenditures for volume reduction can be far greater, and still yield an acceptable savings. However, the relationship between volume reduction percentage and the cost to achieve the volume reduction is anything but linear.

In 1982, the nation's first large scale facility for processing contaminated materials opened for business. For several years the marketplace resisted this alternative to burial. Burial seemed more of a permanent solution and "we've always done it that way" were commonly heard objections in those early days.

Due to the high cost of establishing a recycle center, it took several years for the volume shipped to such a facility to reach the breakeven point of the associated economies of scale. This time period was shortened by the rapid rise in burial prices and the uncertainty of site access, resulting from the 1985 amendments to the Low Level Radioactive Waste Policy Acts Amendments (LLRWPAA) and the associated allocation system.

Once market acceptance to offsite processing became high, we saw many new entries into the marketplace and more could be spent by processors on the development of volume reduction techniques.

As the economies of scale kicked in for alternatives, such as decontamination, compaction, and incineration, the costs of the services decreased, with the exception of the cost component for disposal of wastes generated from these processes.

BURIAL PRICE/VOLUME RELATIONSHIP

In a 1985 paper entitled The Recycling Alternative an inverse relationship between burial prices and volumes buried was predicted. That wasn't clairvoyance; it was economics 101 price-volume curves. This relationship is illustrated in Fig. 1. This is the same relationship that is driving the per cubic foot disposal estimates through the roof for new compact disposal sites.

There will be too little volume to cover the costs so the unit price must be made huge since the site development contractors are guaranteed cost recovery plus profit over the facility life. As the unit price increases, the pressure to reduce volume increases among generators using the same burial sites.

One generator achieving 90+% volume reduction will cause the unit rate disposal price to increase. Another generator whose volume reduction is lower will be penalized by the resulting price increase and will be caught in an upward spiral of disposal costs.

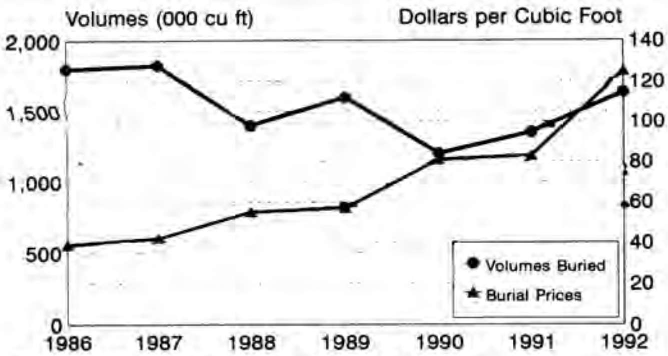

Fig. 1. Relationship between burial prices and waste disposal volumes (unsited generators).

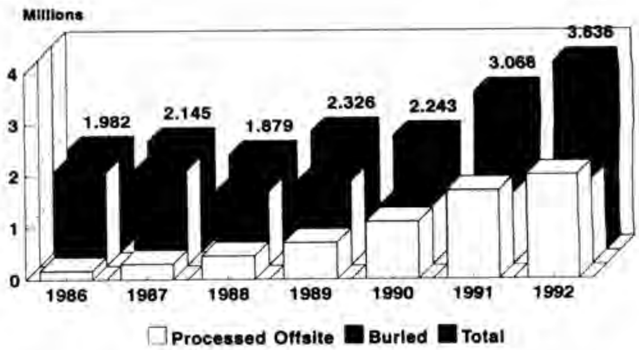

Fig. 2. Materials processed and wastes buried-million cubic feet.

FACTORS AFFECTING DISPOSAL DECISIONS

Obviously, there are many factors affecting the volume reduction of low-level waste. We all know we need to minimize volumes, but how do we know when to stop? After all, the more we reduce volume the greater the probability of increasing the waste class, or of the resulting product becoming mixed waste. And what are the best ways to balance the economic driving forces of budgetary constraints, the motivational drivers that make many radwaste managers' performance reviews predicated on whether less volume was buried than the previous year, the political uncertainty of site access restrictions, and the environmental issues resulting from heightened public awareness?

LLW VOLUMES BURIED '86-'92

Over the past seven years the forces of economics, motivation, politics, and environmental concerns have been acting on burial volumes. NRC chairman Ivan Selin recently spoke of a proposed rule to minimize reliance on waste storage. Selin stated that the rule would require waste generators who store wastes after January 1, 1996 to maintain documentation demonstrating that all other reasonable waste management options have been exhausted.

I contend that the industry performance over the past eight years and the market drivers, which are only getting stronger, provide adequate evidence of and incentive for continued disposal volume minimization. However, take or pay schemes such as that recently imposed for the Barnwell site can remove the incentives for the development and implementation of improved volume reduction techniques. Part of the reason for the decrease in disposal volumes is the increase in volumes processed by off-site contractors. Over the past seven years this volume has increased more than ten-fold from 170,000 cubic feet to over 2 Million cubic feet.

MATERIALS PROCESSED AND WASTES BURIED

In fact, in 1991 for the first time volumes processed surpassed volumes buried. It's also important to note that the overall volume generated has actually increased over the past seven years. The spike in 1991 and 1992 volumes resulted in large part from the housecleaning that took place due to the uncertainties associated with site access and disposal costs that existed toward the end of both years. Figure 2 illustrates the relationship between materials processed and volumes buried.

WAYS TO PROCESS MATERIALS

Let's take a look at how we can continue to reduce volumes buried and reduce costs to dispose of volumes generated. Most plants are achieving in the range of 90% volume reduction. Greater volume reduction can be achieved with the same mix of processing techniques, but at substantially greater costs per % improvement.

It is this relationship that results in diminishing returns of volume reduction and it's like throwing hundred dollar bills after dimes.

There are basically five approaches to processing materials to achieve volume reduction and waste minimization.

First, non-contaminated materials should be removed from the waste stream in accordance with NRC IE information Notice No. 85-92 entitled "Surveys of Wastes Before Disposal From Nuclear Reactor Facilities." Survey for release can have a major effect with the existence of new sophisticated algorithms and computer-based survey techniques.

Many of you are familiar with the 1989 EPRI report #NP-5676, "An Evaluation of Dry Active Waste Sorting", which evaluated 32,000 items of DAW. Of those 32,000 items, 10,210 were classified as contaminated. But, as they use to say in the national football league, "upon further review" 77% of those items were actually clean. Of the 32,000 items, only 2,300 were contaminated. By conservatively treating items as contaminated, we can actually increase waste volumes, if we're not careful. That is, if we call materials waste when they're not contaminated, waste volumes could grow to unmanageable proportions.

Contaminated materials, which can be decontaminated, should be cleaned. Contaminated materials which can be incinerated should be burned. Contaminated materials which can be neither cleaned nor burned should be volume reduced to the maximum extent possible via orthogonal compaction techniques and packaged in a stable form for burial. Contaminated wood should be planed to remove contaminants and the contaminated chips should be incinerated.

COMMINGLED DAW, INCINERATE/COMPACT

So what can be done to improve? As mentioned earlier, existing methods typically yield 90% volume reduction. The use of a combination of incineration and compaction techniques have been used to achieve 9 to 1 volume reduction at a cost of about $43.75/cubic foot. The model illustrated in Fig. 3 is based on the assumptions of a 40-foot cargo container (2,100 cubic feet) containing 16,800 pounds of material of which 35% is incinerable. The costs shown are indicated for a generator, not located within a sited compact region, that is in compliance with LLRWPAA milestones. In this model, 35% of the material is incinerated and the balance is compacted. The resultant waste volume buried is 232 cubic feet. Total cost of this processing mix is $91,900.

COMMINGLED DAW, SURVEY, DECON, COMPACT

The use of a combination of survey for release, decontamination of deconnables and compaction of what's left has been used to achieve a 14 to 1 volume reduction at a cost of about $33.40/cubic foot. The model illustrated in Fig. 4 is based on the same assumptions as the previous model. In this case, new computer-based mathematical algorithms are applied to survey techniques to remove non-contaminated materials from the waste stream. A conservative assumption is made here, based on utility surveys and EPRI NP5676, that 20% of these materials are found to be clean. For the balance of the materials, the decontaminable items are cleaned and the non-decontaminables are compacted via orthogonal two-stage compaction techniques. The resultant waste volume buried is 154 cubic feet. The total cost of this processing mix is $70,100.

COMMINGLED DAW, SURVEY, DECON, INCINERATE, COMPACT

But the best volume reduction at the lowest cost incorporates a mix of services available within the vendor community. A combination of survey for release, decontamination, incineration, and compaction best services the needs of the marketplace -- that is, minimizes volume disposed and minimizes cost. Figure 5 illustrates this combination of techniques applied to the same base materials described in Figs. 3 and 4. In this model, clean materials are separated out of the waste stream (20%). Of the remaining contaminated materials, 35% are incinerated. The deconnable, non-incinerable materials are decontaminated and the remaining materials are compacted. The result of this mix of processing techniques is a burial volume of 107 cubic feet at a cost of $59,300 ($28.23/ft^3).

SUMMARY

The marketplace is all knowing and all seeing. Like water, the market will seek its own level and follow the path of least resistance. As described earlier, when discussing the nation's decreases in burial volumes, those decreases didn't result from mandates, they resulted from the forces of a free market economy.

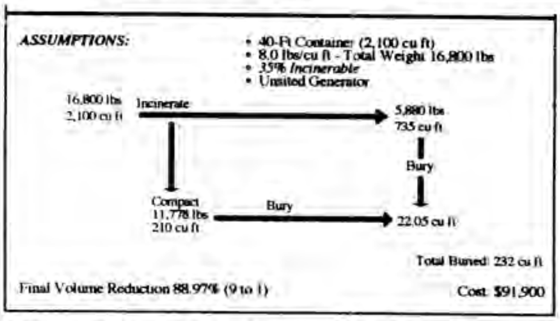

Fig. 3. Commingled dry active waste-incinerate & compact.

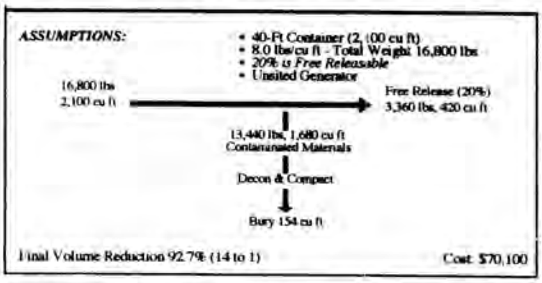

Fig. 4. Commingled dry active waste-survey, decon, compact.

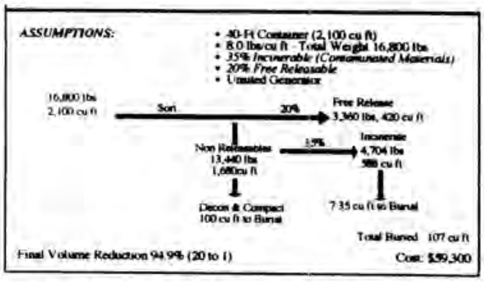

Fig. 5. Commingled dry active waste-survey, decon, incinerate, compact.

Users of off-site processing services will soon discover that a combination of techniques, properly applied to materials which are thought to be contaminated, will yield the next significant reduction in waste disposal volumes, at substantially lower costs.

If the LLW generators follow the guidelines presented here, and judiciously apply processing techniques to the appropriate material, we will all see that . ."Waste is not such a terrible thing to mind".