A LOGICAL APPROACH TO DETERMINE A WASTE SEGREGATION/VOLUME REDUCTION PROGRAM

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ABSTRACT

This paper discusses advantages and disadvantages of hand sorting versus use of automated radioactive waste segregation monitors and makes an analysis of costs/versus benefits based on volume with time. Many programs can be employed to prevent unnecessary waste generation with little or no additional cost to the power plant. The parameters needed to perform a cost analysis and methods used to obtain them are discussed. Recommendations on use of vendor-supplied services for segregation, volume reduction, and decontamination are given. The data provided will enable the selection of a program(s) to benefit the individual user's requirements.

INTRODUCTION

The Low-Level Radioactive Waste Policy Act of 1985 will heavily impact burial costs and space allocations. The act is based on the notion that each state is responsible for the radioactive waste generated within its jurisdiction. The law reaffirms the right of each state to enter into an interstate compact for disposal of low-level radioactive waste. Once a compact is formed, a disposal site located within that compact may refuse to accept radioactive waste generated outside of the interstate compact. The act adopts the definition of low-level waste used by the Nuclear Regulatory Commission, specifically Classes A, B, and C.

The act, as passed, has strict schedules for the states to follow. According to the schedule, each state must either be a member of a compact or must unilaterally undertake to develop its own disposal site by July 1, 1986. By January 1, 1988 siting plans for disposal sites have to be developed. A license application must be submitted to the NRC (or the state agency, if the state is the licensing authority) by January 1, 1990.

Significant penalties are imposed upon waste generated outside of a compact or from a state without a disposal site. This penalty is in the form of a surcharge to be paid by the waste generator over and above the normal disposition fee. The surcharges are set as follows:

1986 and 1987	$10/ft^3$
1988 and 1989	$20/ft^3$
1990 and 1991	$40/ft^3$

If the deadlines are not met, the surcharges are higher. Missing the deadline of January 1, 1990 results in denial of access to the disposal site.

The act provides for a limit on volume of the waste which each nuclear power plant may ship to the presently operating disposal sites and describes in detail the method of calculation and the usage of aggregated volumes. The allocated volumes are larger for those reactors located in regions with disposal sites than those without such sites.

ASSESSING COMPACTIBLE WASTE STREAMS

In evaluating compactible waste streams, the following actions should be taken. A survey of disposable items purchased for a 3 or 4 year period should be performed. The purchasing department is a valuable resource to aid in determining a yearly average of disposable items. This information is needed to perform waste generation projections and cost studies. Cost evaluations on reusable items versus those which are disposable are necessary to determine the most cost effective program for the waste generator. It should be emphasized that cost is only one item to consider - radiation safety, ALARA, and various site specific circumstances must also be taken into account.

Nonradioactive waste should be segregated from radioactive waste at the point of generation with a system of marked containers within the radiologically controlled area. Cotton glove liners should be surveyed on the user's hand and, if release limits are met, be disposed of as nonradioactive waste to reduce volume and thereby burial costs. Packing materials and boxes should be removed prior to moving tools, equipment, or parts into the radiologically controlled area.

Although a common term, any discussion of "compaction ratios", defined as the volume of the dry active waste (DAW) before compaction divided by the volume of the DAW after compaction, tends to be misleading. The density of DAW is variable and there is no "standard" waste, hence, there is no standard for comparison of compaction efficiencies. Density (lb/ft^3) is not a perfect basis of comparison, but it is far more accurate than "compaction ratios." The maximum practical density of paper, cloth, plastic, etc. not including the container, is in the neighborhood of 70 lb/ft^3. Compactible waste has an average density of 8 to 10 lb/ft^3 before compaction and typical densities of 20 to 50 lbs/ft^3 after compaction. Recommendations should be established as to a minimum weight of material that should be placed in each container of compactible material. The average density of compacted waste generated by the site is of little importance because container damage, caused by the compactor itself, usually occurs before the maximum density is obtained. A desirable method to determine the minimum weight of each compacted container is to take the previous yearly average as a base line. The monthly average weight of the container should be compared to the established yearly average. If the average monthly value of these containers changes, an investigation should be performed to determine the cause.

An investigation at TMI-2 revealed that higher compaction densities were obtained when the same work crews were routinely used to compact waste. This approach is recommended when labor or good ALARA practices are not compromised.

ASSESSING NONCOMPACTIBLE WASTE STREAMS

A literature search on noncompactible waste volumes has demonstrated a factor of 10 difference between high and low waste generators. For this paper, no attempt will be made to determine the amount of noncompactible waste that is normal for a plant. Most plants can estimate packing efficiencies obtainable for compactible waste but have little or no data for noncompactible waste. At each plant, historical data on noncompactible waste generation should be reviewed to determine the average volume of this type of material generated. This number is obtained by dividing the total number of pounds by the total cubic feet generated. This information is necessary to determine changes in noncompactible waste generation and as a baseline from which to increase packing efficiency. Comparing the total weight of each container to the maximum weight permitted in each container may give false indications of packing efficiency. A container filled to its maximum weight may only contain a fraction of its total volume; conversely, a container filled to its maximum volume may only weight a fraction of its permissible weight because of the variations in waste densities as shown in Table 1.

The density and voids in any noncompactible waste are highly variable and will vary from plant to plant, making comparisons impossible. Little or no information is available on the average "as-collected" density of noncompactible waste or what volume reduction factors are obtainable. All reports reviewed for the preparation of this paper had no discussion of obtainable volume reduction factors or assumed a volume reduction factor of 1 because of the difficulty to establish a packing efficiency for noncompactible waste. A reasonable approach to volume reduction is to determine, using historical data, the present density of packaged waste (lb/ft^3) and establish a realistic goal for increasing the average density. As with all comparative techniques this approach is not without limitations. The density goal should be increased until engineering and statistical data indicate that no further increase is viable. The ideal situation is to statistically prove that a maximum packing efficiency has been obtained and to monitor for a decline in performance.

TABLE I

DENSITY OF VARIOUS MATERIALS

MATERIAL	DENSITY (lb/ft^3)
Lead	708
Copper	558
Nickel	556
Iron	491
Zinc	446
Aluminum	169
Concrete	169-187
Cement	140-150
Sand	90-105
Paper	45-56
Wood	
Oak	37-56
Yellow Pine	23-37
White Pine	22-31

The choice of packaging containers is another important consideration - a 55-gal. drum or a low specific activity (LSA) box? Avoid advice recommending the use of either container exclusively without technical justification; both have their distinct advantages and disadvantages. The maximum density for 55-gal. drums and LSA boxes is approximately 107 and 36 lb/ft^3, respectively, with some variations depending on the manufacturer's specifications. A survey of all noncompactible wastes loaded into LSA boxes and drums performed at TMI-2 revealed that both containers were loaded to an average of 50% of their maximum allowable weight during a 3-year period. Based upon available records, both containers could have been loaded more efficiently by increasing the density. The investigation revealed the unit density burial cost for noncompactible waste for LSA boxes and 55-gal. drums are about the same for the first 36 lb/ft; thereafter, a LSA box may be as much as three times more expensive, as shown in Figure 1.

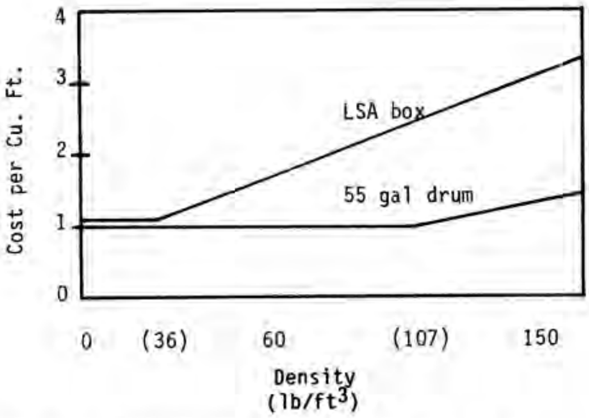

Fig. 1. Relation Between Relative Cost and Specific Weight

Figure 1 represents a relative cost based on container, transportation, and burial costs only; the relative value factors are not absolute because of other considerations such as:

1. ALARA
2. Plant variations
3. Shipping and storage costs
4. Labor costs
5. Schedules.

Case studies on disposal costs should be performed on a regular basis. A study on contaminated piping saved TMI-2 approximately $3800 by mixing contaminated pipe with contaminated sand. Pipe consumes more weight than volume of the container's rated capacity; therefore, mixing pipe and sand utilized more of the waste container's volume, resulting in an increased packing efficiency. The waste management organization should be involved in up-front scheduling to be aware of what types of wastes are going to be generated from all activities to enable planning for the most efficient packing. Case studies should be performed until optimum packaging techniques and densities of various materials and shipping containers are determined.

Another promising method of waste reduction is decontamination. The successful application of decontamination of metallic waste would permit a substantial reduction in expensive packaging, transportation, and shallow land disposal. A liquid abrasive system that continuously recirculates the liquid/abrasive slurry has been evaluated at TMI-2. Excellent results are possible for the gross decontamination of items with radiation levels declining from several hundred millirem per hour to less than one millirem in a relatively short amount of time. Testing of an abrasive unit to determine its effectiveness may be accomplished by renting a mobile unit from a variety of vendors. Electropolishing after liquid abrasive decontamination will remove nearly all radioactive material located in surface imperfections. Tests at TMI-2 have also proved electropolishing metal before use in contaminated areas provided easier decontamination.

The units described will be used in a new Waste Handling and Packaging Facility being constructed to aid in the cleanup of TMI-2. A plasma arc torch and other cutting devices will also be available to cut contaminated sections of metal off of clean sections and for volume reduction of items not able to be decontaminated.

AUTOMATED TRASH SEGREGATION MONITORS

Almost all contaminated compactible wastes have a certain percentage of clean waste that could be released and disposed of as nonradioactive waste. Some users estimate that as much as 75% could be disposed of as nonradioactive waste. The first step is to develop a testing program to determine the percentage of clean waste mixed with radioactive waste that could be segregated. This can be accomplished by setting up a frisking table in a low background area. Only bags of waste reading 1 mR/hr or less are considered. Bags with higher radiation levels will yield very little clean material. The material in the bags is placed on the table and items are individually frisked. Contaminated waste is segregated from the clean waste and placed in separate containers. The clean waste is then weighed and compared to all waste generated during the test period. Using total waste as a denominator will result in a realistic idea of the percentage of material that can be released as clean waste. The next step is to calculate the annual volume of clean waste that could be segregated by using previous yearly averages. This annual volume of clean waste is then multiplied by the cost of burial to determine the equivalent cost of burial. The equivalent cost of burial is compared to capital cost of the equipment, labor costs, and maintenance costs. This cost estimate can then be used to determine if automated waste segregation is cost beneficial to the reactor facility.

Several studies have been performed to determine the capability of detecting low levels of contamination. With good frisking techniques it is possible to detect beta contamination levels of 5,000 to 25,000 dpm/100cm^2, not 1000 dpm/100cm^2 as previously assumed. Consistent results are hard or impossible to maintain, worker fatigue and other variables such as waste component geometry contribute to this. Automated trash monitors are more sensitive and release clean items consistently. Following evaluation of two automated monitors, it was estimated that the equivalent of 3 to 5 ft^3 of trash could be segregated per shift. This is approximately the same rate as manual sorting but the better selectivity of the automated monitors makes them more attractive.

CONCLUSION

The Low-Level Radioactive Waste Policy Act of 1985 has encouraged waste generators to take a close look at volume reduction and waste segregation programs. Highly sophisticated products and technology are a valuable aid to waste generators; however, additional work needs to be performed on more efficient packaging and on contamination prevention. They must both be studied simultaneously to achieve maximum results. Case studies should be used as a tool to assist in the final decision process but are not without limitations. Knowledge of your present volume reduction and waste segregation is essential to develop goals for waste minimization and reduction.

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