FEE STRUCTURES FOR LOW-LEVEL RADIOACTIVE WASTE DISPOSAL

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ABSTRACT

Some compacts and states require that the fee system at their new low-level waste (LLW) disposal facility be based on the volume and radioactive hazard of the wastes. The fee structure discussed in this paper includes many potential fee elements that could be used to recover the costs of disposal and at the same time influence the volume and nature of waste that will arrive at the disposal facility. It includes a base fee which accounts for some of the underlying administrative costs of disposal, and a broad range of charges related to certain parameters of the waste, such as volume, radioactivity, etc. It also includes credits, such as credits for waste with short-lived radionuclides or superior waste forms. The fee structure presented should contain elements of interest to all states and compacts. While no single disposal facility is likely to incorporate all of the elements discussed here in its fee structure, the paper presents a fairly exhaustive list of factors worth considering.

INTRODUCTION

The cost of disposal of low-level radioactive waste (LLW) in existing disposal facilities is usually quoted in terms of a price (dollars) per cubic foot of waste. However, a closer inspection of the schedules of charges for existing facilities indicate that there are several other aspects of the waste that are included in determining the unit cost of disposal. These include the radiation exposure rate at the container surface, the weight of the waste containers (extra charges for larger or heavier containers), the nature of the waste, such as liquid wastes or biological wastes, charges for large numbers of curies per shipment, etc. While these elements of the present systems of pricing low-level radioactive waste disposal reflect the cost of special procedures and equipment that are needed to handle packages of waste that have specific characteristics, the major underlying price determinant is still, however, volume of the waste being disposed.

Compacts and states developing new low-level radioactive waste disposal facilities are often required by the compact language or by state laws to establish pricing structures for those disposal facilities that will in some way reflect characteristics of the waste other than the volume. This paper presents a long list of potential waste characteristics that could be used to form the basis for a pricing system. While it is unlikely that all of the waste characteristics described here would be used in a pricing system for any one new disposal facility, the list provided is one that each compact and state may want to consider when developing a pricing strategy.

The fees charged for disposal of low-level radioactive waste depend on the cost of developing, operating, closing, and caring for a disposal facility. These costs are used as inputs to economic analyses that determine the amount of money that must be raised in a given period of time, generally over the operating period of the disposal facility. The fees are used to recover all capital costs and interest on money borrowed, pay costs of operating the facility, raise monies needed to provide sufficient funds to ensure that closure and long-term care can be achieved without requiring the use of public funds, and provide profit for the disposal facility operator.

The fee structure can be viewed as a structure of charges that seeks to recover in a given year of facility operation a certain amount of money that is determined by the cost and economic analyses referred to above. Those costs and economic analyses are not the subject of this paper. It is presumed here that the analyses have been conducted and that a specific amount of money must be raised. Then the elements of the fee structure, individually and collectively, would be adjusted to ensure there is a good probability of recovering that amount. How the individual fee elements are adjusted to ensure cost recovery is not considered. This paper only describes a candidate list of individual elements of the fee structure.

GENERAL FEE STRUCTURE

The fee structure can include a number of elements intended to provide financial incentives and penalties to the waste generators in order to induce them to take certain favorable actions. Other elements can be included to ensure that the cost of operations at the disposal facility and special activities and equipment are properly allocated to the generators whose waste demands the use those activities and equipment. The general pricing structure is:

$$C = P_1 + \sum_{i=2}^{M} P_i f_i + \sum_{j=M+1}^{N} P_j \qquad (1)$$

where,

C = cost to the generator (per container)

P_1 = base fee

P_i = a linear fee element (price per unit of volume, radioactivity, weight, shape, etc.)

f_i = pricing factor (such as volume, radioactivity, etc.)

P_j = a nonlinear fee element. This can be negative (e.g., a credit) as well as positive.

The cost per container includes a base fee that accounts for basic administrative costs of disposal that are unrelated to the volume or characteristics of the waste. The fee elements indicated in the second term in the right side of the equation establish charges that are linearly proportional to key parameters of the waste, such as volume and radioactivity. Finally, the third term in the right side of the equation represents nonlinear elements in the fee equation. Disposal fee schedules at existing facilities generally tend to be nonlinear because charges to the waste generator or broker increase in increments as certain threshold values of such waste package characteristics as volume, weight, or radiation exposure at the container surface are exceeded.

Figure 1 illustrates some of the kinds of nonlinear fee factors that could be included in Eq. (1). The top of Fig. 1 illustrates a nonlinear fee element that increases as a key parameter (in this case, container surface dose rate) increases. This is an example of the kind of surface radiation exposure fee element that is used at existing disposal facilities. It tends to reflect the more expensive equipment, more complicated operational procedures and, in some cases, shielding that are employed at disposal facilities when high surface exposure waste is encountered. This element is meant to operate as a surcharge on a volume-based fee structure. Therefore, for low container surface dose rates, there is no surcharge. Beyond a certain level of surface radiation level, however, additional equipment must be used or more complex procedures must be followed so a surcharge is applied. Beyond a second level, still more difficult procedures and more costly equipment must be applied and, therefore, a larger surcharge is levied. The nonlinear function used may continue to increase as a staircase. However, it is unlikely that there would be more than three or four separate levels of surcharge for most low-level

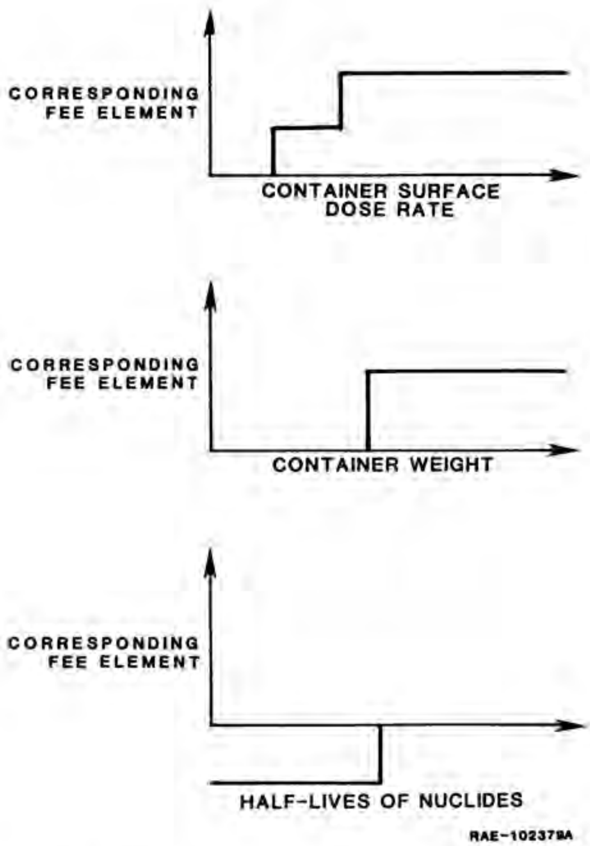

Fig. 1. Illustration of Nonlinear Fee Elements.

radioactive waste, reflecting three or four different sets of procedures and equipment.

The middle element in Fig. 1 illustrates a single-value surcharge placed on a volume-based charge for disposal of low-level radioactive waste. This single-value surcharge could be based, for example, on waste package weight. When waste packages heavier than a certain weight are received, special cranes or other equipment must be used to put them in the disposal units. Therefore, there is a surcharge levied. However, only one size crane is available beyond the normal operating equipment and, therefore, there is only one level of surcharge. The bottom element in Fig. 1 illustrates a negative surcharge or incentive that could be applied. For example, it could be used to encourage generators with radioactive waste that contains large amounts of short-lived radionuclides to send their waste to the disposal facility. It provides a fee reduction to those generators in order to encourage them not to retain the waste on site for decay. By sending their waste to the disposal facility, even at a lower than average cost, they will help to amortize the initial cost of siting and developing the facility and will add very little to the risks that might result from the disposal facility. Therefore, their low-level radioactive waste may be very welcome to both the operators of the facility and the other waste generators who would otherwise have to bear a higher portion of the cost of developing the facility.

ELEMENTS OF THE FEE STRUCTURE

This section presents a list of elements for fee structures. Each of these elements reflects a particular concern about risks associated with the disposal facility or costs of operating that facility. The list presented here is intended to be relatively exhaustive and it is not anticipated that any one disposal facility would use all of these fee elements. There are three major categories of fee elements expressed here; those based on administrative costs, those based on operating costs, and those based on risk. They include:

- Elements based on administrative costs
  - Per container flat fee
- Elements based on operating costs
  - Charges for waste volume
  - Surcharges for large or difficult to handle waste containers
  - Surcharges for high radiation exposure rates
  - Surcharges for Class B and C wastes
  - Surcharges for non-standard container shapes
  - Surcharges for mixed wastes
- Elements based on risks
  - Surcharges for Class B and C wastes
  - Surcharges for radionuclide activity
  - Surcharges for mixed wastes
  - Surcharges for certain waste forms
  - Credits for superior waste forms
  - Credits for short-lived radionuclides

In addition to these fee elements, certain states and compacts may levy flat fees on waste generators and may return to waste generators monies that are being collected at the present time to help fund the siting and development of new facilities.

Fees Related To Administrative Costs

A flat fee representing paperwork and general overhead activities that result from handling each waste container entering a disposal facility could be charged to the generator. Currently operating disposal facilities have minimum charges for each shipment, but not for each waste container. The size of this fee could be determined by estimating the cost of the paperwork and inspection associated with each container as it enters the facility.

Fees Related To Operating Costs

Several fee elements could be related directly to specific costs of operating the disposal facility. They would reflect special equipment and/or procedures that may be required to remove the waste from its transportation vehicle and place it in the disposal units. They could also reflect the cost of building special disposal units for such wastes as Class B and C wastes, mixed waste, or waste that has a high radiation exposure rate at the container surface.

As noted in the introduction, fees based on the volume of waste entering the disposal facility are the major way of charging for low-level radioactive waste disposal in existing facilities. Fees based on waste volume are likely to play the major role in the fee structures in new LLW disposal facilities as well. The language of many compacts and state laws on low-level radioactive waste disposal indicate that there is a strong desire to minimize, or at least reduce, the volume of waste being placed in their new facilities. Evidence resulting from the rapid increase in overall costs of disposal of low-level waste over the last several years is that high volume-based fees have been quite effective at surpressing the volume of the waste entering disposal facilities. However, by the time new facilities are opened in 1993 or later, even high volume-related fees, at levels comparable to present charges or higher, may not be sufficient to continue the downward trend in the volume of low-level waste being disposed. Most of the easy and cost-effective ways of reducing waste volume will probably have been implemented by that time.

While charging according to the volume of waste being disposed is a direct way of recovering costs for the disposal facility, it encourages the waste generators to concentrate the radioactivity of their waste into ever-decreasing volumes. This in turn could result in higher potential doses to intruders at the facility and to members of the public who take up residence near to the facility. Also, since the cost of developing, operating, closing, and maintaining a disposal facility is not directly proportional to the volume of waste that is placed in that facility, massive application of volume reduction techniques generally results in significant increases in the charge per unit volume of waste that is necessary to achieve full cost recovery.

A fee element or charge levied for waste containers that are large or difficult to handle is generally a nonlinear factor of the kind illustrated in Fig. 1. This kind of fee element could be put into effect for containers that are too large or too small to be easily handled, or so heavy that they require special cranes and other equipment. This kind of surcharge could be placed on wastes that are not in standard size containers and would therefore require special planning and selection of equipment to ensure their safe emplacement in the disposal units.

One possible nonlinear factor in pricing LLW disposal would be one that penalizes containers that have high radiation exposures at the container surface. This kind of fee is already being employed at existing disposal facilities. It would seem that only three or four levels of a surcharge on the basic volume-related fee would be necessary, reflecting two or three distinct sets of procedures and equipment for placing high radiation exposure waste. The number of distinct levels of surcharge could be increased or the overall magnitude of the charge could be increased if, as has been suggested, the disposal facility will have separate and more elaborate disposal units for waste that provides high radiation exposure rates at the package surface.

Another form of surcharge added to the basic volume-based charge for disposal of LLW could be related to the waste class, as defined by 10CFR61 or state regulations. Many conceptual and preliminary designs for new LLW disposal facilities contain more elaborate disposal units for Class B and C wastes than for Class A wastes. The disposal units for Class B and C wastes are designed to provide greater protection to the public and the environment. The cost of their development and operation will be higher, they will be more elaborate, and they will be receiving only a relatively small volume of waste. Therefore the cost per unit volume of disposal in these units will be greater. A surcharge based on waste class would be applied only to Class B and C wastes. It is possible that there would be a different surcharge for Class C wastes than for ClassB wastes.

Following the same line of reasoning described above for Class B and C wastes, if mixed wastes are disposed at new LLW facilities, there may be surcharges for their disposal. Because of the overlapping requirements of the EPA regulations on hazardous waste and NRC regulations on low-level radioactive waste, more elaborate and separate disposal units will probably be developed if mixed waste is to be placed in future LLW facilities. Therefore, a surcharge could be placed on all mixed waste to help recover the cost of these separate disposal units.

Finally, surcharges could be placed on waste that has unusual shapes. The arrival of LLW packages different from the relative few standard container sizes would require special planning and possibly special operations and equipment to ensure the safe placement of that waste. Also, the presence of odd-shaped waste in disposal units may make the units less efficient, reducing the total volume of waste that could be placed in a given disposal unit. For example, if the normal mode of disposal is placing all waste in modular concrete containers, it may be impossible to get unusually-shaped wastes into the containers and special provisions will have to be made for their disposal. Since unusually shaped wastes tend to be one-of-a-kind items, it is unlikely that a fee schedule would be published that indicated what the cost would be for an unusually shaped piece of waste. That cost would have to be negotiated when the details of the nature of the waste were determined and communicated to the disposal facility operator.

Fees Related To Risk

The wording of some compacts and state laws on low-level radioactive waste requires that the fee structure for new disposal facilities reflect in some manner the risk associated with the waste being placed in those facilities. In other words, the fee structure is expected to result in higher fees for waste that provides a higher risk. The initial cost of the disposal units, costs of monitoring, potential remediation costs, and even the cost of finding and licensing a good disposal site can all be related to the risks from the waste placed in the facility. Therefore there are a number of motivations for additional disposal charges for low-level radioactive waste that provides significantly higher than average risks to intruders, the public, and the environment.

As noted earlier, separate disposal units may be constructed for Class B and C wastes because they require more elaborate isolation from people and the environment and, in many instances, require more complex handling equipment and procedures. In addition, Class B and C wastes tend to provide a greater risk to the public and the environment than Class A wastes, even when placed in special disposal units. Therefore, there is a double motivation for surcharges for Class B and C wastes. The two fee elements one reflecting the direct cost of disposal and the other reflecting the risks that are created by disposing of the waste could be combined into a single set of surcharges for Class B and C wastes. As with surcharges based on the cost of handling, separate schedules could be applied to Class B wastes and to Class C wastes.

The radioactivity of the waste is generally proportional to the risk to the public and the environment from disposal of the waste, all other things being equal. Of course, short-lived radionuclides are less likely to provide a major risk because the radioactivity will decay to insignificant levels before the disposal units could undergo significant deterioration or before the radionuclides could migrate to the general environment. It is possible that states and compacts would want to impose a surcharge on wastes containing high concentrations of long-lived radionuclides.

A more complex, yet more rational fee structure would address the radioactivity on a radionuclide-by-radionuclide basis. The toxicity of a given number of curies of radioactivity depends on the radionuclides involved. Therefore, the nuclides that provide the highest toxicity (e.g., potential risk as a result of migration through the most likely pathways, or risks to intruders) would receive the highest surcharges. It is generally recognized that certain radionuclides have both a relatively high ingestion toxicity and a high degree of mobility, including tritium, carbon-14, technitium-99, and iodine-129. They become likely candidates for surcharges based on radioactivity.

It is envisioned, therefore, that a complex but more directly risk-based surcharge related to radionuclide activity would take into account both the toxicities and the half-lives of the radionuclides. These characteristics would also be combined with an understanding of the projected long-term behavior of disposal units to determine the relative magnitudes of the surcharges.

It is also possible that a surcharge would be placed not on the total radioactivity in a given package of waste, but on the specific activity (that is, on the number of curies per cubic foot). This would have the effect of discouraging the volume-reduction activities that might otherwise be encouraged by volume-based charges. Since high concentrations of radionuclides in the waste can be shown to raise the potential risk to intruders, and in some cases to members of the general public, establishing surcharges on the specific activity of waste would have a sound technical basis.

While disposal of mixed waste could be more expensive because it would probably be placed in separate disposal units that will involve generally higher construction and operating costs, mixed waste can also represent a higher risk to the public. Because it contains both radioactive and non-radioactive contaminants, mixed waste can provide an increased risk to the public and intruders. Therefore, a surcharge on mixed waste based on risk would be appropriate. Of course, this surcharge would probably be combined with a surcharge of the kind described earlier, based on the higher cost of disposal.

Certain waste forms that increased risk associated with a disposal facility would be candidates for separate elements in the pricing structure. For example, uncompacted trash can result in void spaces within the disposal units as the waste consolidates. The presence of void spaces could endanger the structural stability of the disposal units and enhance the flow of infiltrating water through the waste. Other undesirable waste forms are ones that could create large volumes of gas due to chemically or radiologically induced decomposition, or chelating agents, which could accelerate the release of radionuclides from the facility and facilitate the movement to the environment. Some of the existing disposal facilities require that chelating agents be separated from other LLW in order to lower the risk of mobilizing radionuclides from other parts of the waste.

While the majority of the fee structure elements related to risk described here tend to be surcharges that is, additional charges above and beyond the basic charge for the volume of the waste the pricing structure could also include credits for superior waste forms. Wastes that have high structural and volumetric stability (minimizing the probability of collapse of the cover over the waste), contain little void space or are generally more durable than other wastes could be given credits in the form of lower disposal charges. These waste forms include glass, activated stainless steel, and compacted dry active wastes. While it is unlikely that the magnitude of the credits would be sufficient to cause most waste generators to change the form of their waste in order to get these credits, a few generators might find it convenient and economically feasible to produce a better waste form if their efforts were rewarded by lower.

Credits could also be given for generators of wastes that contain only short-lived radionuclides. The well-designed disposal units that will be featured in future disposal facilities should ensure that short-lived radionuclides will decay to insignificant concentrations before reaching the environment. As noted earlier, giving credits for radioactive waste that contains primarily short-lived radionuclides might encourage some waste generators to ship their waste to the disposal facility rather than keeping it on site for storage for decay. While these waste generators will be paying a lower than average charge for disposal, they will still be helping to pay for the relatively large capital costs required to develop new facilities in the 1990's. If their waste is not sent to the disposal facility other generators would have to pay still higher fees.