CONTAINER MATERIAL AND DESIGN CONSIDERATIONS FOR STORAGE OF LOW-LEVEL RADIOACTIVE WASTE

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ABSTRACT

With the threat of increased burial site restrictions and increased surcharges; the ease with which waste is sent to the burial site has been reduced. For many generators of waste the only alternative after maximizing volume reduction efforts is to store the waste. Even after working through the difficult decision of deciding what type of storage facility to have, the decision of what type of container to store the waste in has to still be made.

This paper explores the many parameters that affect not only the material selection but also the design. The proper selection of materials affect the ability of the container to survive the storage period. The material selection also directly affects the design and utilization of the storage facility. The impacts to the facility include the functional aspects as well as its operational cost and liability as related to such things as fire insurance and active environmental control systems. The advantages and disadvantages of many of the common systems such as carbon steel, various coatings, polyethylene, stainless steel, composites and concrete will be discussed and evaluated.

Recognizing that the waste is to be disposed of in the future differentiates it from waste that is shipped directly to the disposal site. The stored waste has to have the capability to be handled not only once like the disposal site waste but potentially several times before ultimate disposal. This handling may be by several different systems both at the storage facility and the burial site. Some of these systems due to ALARA considerations are usually remote requiring various interfaces, while not interfering with handling, transportation or disposal operations.

INTRODUCTION

In this time of changing regulations and political influences on the final disposal of low level radioactive waste, we would all like to know what the future will hold. For some, knowing the future becomes a necessity as the current way of doing business is restricted and modified as the politicians struggle to set the course for the future. Sometimes their mere attempts make the future now. Through whatever means the forcing of generators to store material causes them to be betting on the future.

It is not enough that a generator must build and license a storage facility to insure his continual operation, but he must decide what rules will be in effect in the future. He must decide what form the waste material should be in, what geometry and type of container will be required several years in the future when the regulators and politicians are having difficulty deciding about the requirements for today. Unlike the regulator and politician he knows where the material is going, into his storage facility.

Before he places the material in that facility, he has to consider many parameters both in the present tense and in the future sense. Of course, one of the most difficult questions that must be asked is how long it will be stored. This may sound simple since many facilities by law can only store for a certain period of time. Yet we all know how in this industry deadlines slip and alternative solutions disappear. This only adds uncertainty to predicting what the disposal and transportation regulations will be when the material is finally disposed of. In addition to the regulation the generator must consider the effect of handling requirements and the effects of the chemical composition of the waste on the containers while maintaining a safe secure facility for its duration.

REGULATORY CONSIDERATIONS

There are really two different categories of regulations that are of prime concern: final disposal and transportation. The main documents that contain the applicable regulations are 10 CFR 61 for final disposal and 10 CFR 71 and 49 CFR 173 for transportation.

Final Disposal

In this area, one must first ask what type or classification of material is it, what are the current requirements, how will these regulations change and how will the material to be disposed of change? Currently, 10 CFR 61 classifies the material into three basic categories: Class A, Class B, and Class C. The first category does not require stabilization as the last two do. The material is placed in these classifications depending on the type and quantity of the isotopes that are present. Hence, we have the interesting phenomena of the material possibly changing categories due to decay if it is stored for long periods of time. In addition to the material physically changing, there is the distinct possibility that the rules will change.

This is particularly true when the reason for building the storage facilities is examined. Many of these facilities are being created to allow for the various state compacts to have the time to put their programs in place for establishing new disposal facilities. Many of these programs are required to develop "better" than shallow land burial facilities that are now the current state of the art. What type of requirements these facilities will place on the waste form is difficult to predict.

Currently, class A material may be disposed of in a strong tight container that is not made of fiberboard or cardboard. Class B and C material must be stabilized by either some form of solidification or by placing the material in a high integrity container (HIC) or by being inherently stable such as solid hardware. This even gets confusing because the various sites that are currently accepting waste have slightly different requirements. Barnwell is basically a wet site with a twenty-five foot burial depth and the Hanford site is a dry site with a fifty-five foot burial depth. Additionally these sites have other requirements that differ slightly from the 10 CFR 61 rules by using a one microcurie per cubic centimeter rule for filtration media and ion exchange resins and slight difference in the interpretation of allowable free water.

In addition to the radiological and waste form considerations the changing interpretations on what is a mixed or hazardous waste and how they should be handled increases the uncertainty of what the future will hold. Not only must the necessary NRC rules be met along with those imposed by agreement states' radiation control departments, but the state and federal environmental protection agencies may have an increasing say as to how various materials may be disposed of.

This uncertainty encourages the generator not to store to long. If he has to store he must consider the likely outcome of the political decision making process while keeping his material in a form that will allow him flexibility to meet the disposal requirements at the time that he must dispose of the material. This flexibility means not placing the material in a form that cannot be changed, placing it in a container from which it cannot be removed (or mixing it even with small amounts of material that could possibly be consider hazardous in the future). This last consideration is particularly important since chemicals don't decay like radioactive material. Temporary isolation from the environment for even 300 years may be insufficient protection. As this issue of mixed wastes is worked out, increasing requirements for tracking the chemical composition of the wasted streams may be required.

Transportation Regulations

Transportation regulations play a passive but important role in the type of container one would choose for storage. These regulations classify the waste differently than those for ultimate disposal. They also can be met by a transportation-only package, eliminating many of the restrictions on the storage package. However, by a combination of highway and NRC restrictions along with the laws of physics, transportation regulations determine the geometry of the storage container.

Currently in the USA the transportation rules closely follow the IAEA rules of 1973. The transportation regulations are administered by the Department of Transportation in conjunction with the NRC. In general quantities of material less than the A_2 quantities of activity listed in the regulations fall only under the DOT rules with quantities in excess of that being governed by both DOT and the NRC. The separation of responsibilities creates a category in which large quantities of waste is currently shipped. The category covers material meeting the low specific activity definition but having a total greater than the A_2 quantities of activity. From this category comes what is referred to in the USA as type A casks.

These packages are licensed by the NRC but are not designed for the accident conditions and don't qualify as a type B license. Technically this is a category that is not recognized by the IAEA.

By not being recognized by the IAEA, its future requirements are even more difficult to predict than other transportation regulations. As stated earlier, the US is now operating with rules that closely follow the 1973 IAEA version. These were placed in effect in September of 1983. It is obvious that the IAEA regulations give us a preview of what may be coming for transportation regulation here in the US. The IAEA has a 1985 version of its transportation regulations out. If fully adopted some changes in both the DOT regulations and the NRC 10 CFR 71 regulations would result. The IAEA regulations do not however give us a preview of what may happen to the NRC type A cask classification and regulations. Currently there has been considerable discussion of imposing a shielding restriction as well as an activity restriction. Depending on the form of the restriction there is the possibility that some of the "Type A" shipments of today would be required to be shipped in Type B packages in the future.

These changing regulations present the problem of changing the container in which the material can be shipped. As more restrictions are imposed on the package the weight of the package has a tendency to increase. The increased weight could easily prevent a cask with the same capacity as a type A cask today moving at all as a type B package in the future. This would include even moving it as a overweight shipment.

As far as the waste generator is concerned, he must insure that the waste he stores is in a form that can be transported in the future. He can store the waste in a form that can be changed at a later date. He can store it in containers of a geometry that he is confident can be shipped in the most restrictive scenario. He can store it in a container that he can still handle after the material decays off to a category that would allow shipping in a larger size container.

In Plant Handling

In designing a radwaste storage facility, it is not clear whether the facility design controls the container design or vice versa. Typically a design base container or containers are chosen, but by the time the facility gets to the point of being unchangeable the container has changed because of some of the many considerations listed above. This process causes the interface between the facility and container to be constantly changing as discussed below.

CURRENT DESIGN REQUIREMENTS - What are the current interface requirements for the container and the facility? Has this interface been sized to a standard product like the 55 gallon drum? Are there safety factors like three on yield for lifting equipment? Is this required on new material or corroded material? What is the expected length of storage? What is the expected worst case for length of storage?

FUTURE DESIGN REQUIREMENTS - Will there be increased ALARA considerations requiring the use of handling shields or other specialized equipment? Will remote handling be required where it isn't currently being used? Will the storage time be extended causing unplanned for corrosion considerations. Will the casks of the future be able to interface with the facility?

CLEARANCES - Most containers that are currently being used for disposal have relatively long cables for lifting. The longer the cables the lower the lateral load and the smaller diameter the cable. This allows relatively easy storage in the cask during transport. However these long cables require large amounts of vertical space which is not readily available in most storage facilities. This is especially true in getting over shield walls. Another area that commonly has clearance problems is in the interface for the transport cask. There are many types of clearance problems in this area that range from insufficient vertical height for getting the container in and out of a cask, to too steep of access ramps for some trailer designs, to not allowing for regulatory imposed geometry changes on certain casks.

REMOTE HANDLING - As ALARA becomes more and more important more facilities are going to remote handling of the containers. This puts a severe design restriction on the container. The volume of the containers must be maximized for transportation and burial purpose, the overall dimensions are fixed due to being transported in a cask, the basic cable system is still required for final disposal and a remote grapple system has to be fitted in somehow. Many successful remote systems have been developed. Some of these to be made compatible with existing containers have had to have special adapters build. These adapters reduce clearances adding to the problems discussed above. On other containers special features have had to be added that in turn cause difficulties in interfacing with processing equipment.

Unlike "disposal only" containers which are handled only once or twice in basically new condition, storage containers are handled several times and after a period of possible deterioration. Due to the requirements of having to upright tipped over containers, lifting orientations other than those normally analyzed for disposal purposes have to be addressed.

The consideration of the complete load path is critical since there is a strong possibility of deterioration by time. There have been several cases where the lifting eyes and cable have been performed adequately only to have the bottom of the container fail during the lift. Not only the question of how the load gets into the shell but also what are the modes of failure of each of the components must be asked. The effect of corrosion or other time related deterioration mechanisms must be examined for each component.

Although final disposal lifting configurations and corrosion considerations are addressed for class B and C waste per 10 CFR 61 they are not addressed for storage. The containers for solidified material are not necessarily analyzed for lifting after sitting around for an extended period of time in what can be a fairly aggressive environment. Even small amounts of liquid can cause corrosion as the small amounts of chemical in the waste form tend to be concentrate by the condensing cycles within the closed container. Various waste forms can cause this environment to be either acidic or basic. The exterior environments can also become corrosive depending on the environmental control and the stacking arrangement within the facility.

Material Considerations

Many different materials can be utilized for containers depending on the type of waste stored, the length of storage time, and type of storage facility. The final selection of these materials is dependent on cost, handling, as well as other considerations. A brief discussion of currently considered materials follows.

CARBON STEEL - The most popular and one of the most economical of materials. It is the most susceptible to corrosion and failure. If used as a storage container, considerations should be given to the use of high quality coatings and/or designing with a corrosion allowances especially in the lifting areas.

POLYETHYLENE - A fairly economical solution to the basic container corrosion problems. It still doesn't address the lifting device corrosion. Adapting these containers to remote handling can also prove difficult. Additional problems may result in the impact on insurance due to relative flammability.

CONCRETE - It has the advantages of being economical, durable, and corrosion resistant. The corrosion of the lifting features still must be addressed. The relative container mass to usable volume ratio may be a drawback for larger containers.

STAINLESS STEELS - A good solution to almost all of the major technical problems. The most significant short coming is the initial container cost. This may be offset for some materials by the fact that certain designs are licensed for ultimate disposal.

COMPOSITES AND NEW MATERIALS - There are many new materials and combinations that are being developed. Some of these like composites are very corrosion resistant and have high strength to weight ratio. The uncertainties associated with them are cost, chemical compatibilities, regulatory acceptance and handling features.

CONCLUSION

In general there are many considerations for selecting a storage container that are not normally imposed on containers that are shipped directly to disposal. Many of these are based on what future requirements may be imposed on the containers at time of disposal. ANSI N14.9.2 draft standard attempts to impose requirements on containers to minimize some of these future problems. However a general standard can not address all the specific considerations for a specific waste form in a specific storage facility.

The waste generator must look at his particular situation and anticipate the changes. His best options are the ones that give him the greatest degree of flexibility in the future. This flexibility should not only be in meeting the future disposal requirements, but also in meeting future transportation requirements. The material and container design must be selected to insure compatibility with the waste form and the handling requirements both at the storage facility now and in the future.