INTEGRATION OF INTERIM STORAGE AND THE PERMANENT DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTE

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ABSTRACT

A modularized system for the packaging and disposal of low-level radioactive waste has been developed. This system uses hexagonal, reinforced concrete modules to package the waste in a structually stable form. The modules are closely packed into the disposal unit to virtually eliminate subsidence. The same modules can also be used for on-site storage of waste. This approach for on-site storage of waste is less expensive than using storage buildings. It also reduces handling and eliminates the need to dispose of modules used for storage alone. An overpack is required to allow the concrete modules to meet the regulations for transporting radioactive material.

INTRODUCTION

With the enactment of the Low-Level Radioactive Waste Policy Act in December 1980, responsibilities for the disposal of low-level radioactive waste were defined as follows:

- Each state was made responsible for the disposal of low-level radioactive waste generated within its borders.
- States were required to make provisions for handling their waste by January 1, 1986.
- States were encouraged to enter into Compacts for the development of regional low-level waste disposal facilities.
- Regional Compacts must be approved by the U.S. Congress.
- Congress may withdraw consent of Compacts after five years.
- After January 1, 1986, the regional Compacts may restrict the use of the facility for waste generated outside the Compact.

Although significant progress has been made to establish Compacts and plan for regional disposal facilities, no new low-level waste disposal facilities will be available by January 1, 1986. The current situation can be characterized as follows:

- Only the three existing sites will be in operation.
- Restrictions on the use of the existing sites are being proposed.
- Volume reduction will be mandatory.
- Deferral of Waste Policy Act implementation is being considered.
- Increased waste storage is a virtual certainty.

Authorities in the three states with disposal facilities have indicated a willingness to continue to accept waste from states that are making a concerted effort to provide their own disposal facilities. Public pressure could change this position, leaving generators in the other Compacts with the problem of storing all of their waste until disposal facilities become available.

ON-SITE STORAGE FACILITIES

Nuclear utilities and other major generators of radioactive waste have recognized that new disposal facilities will not be available and that the use of existing facilities may be curtailed. Many of the major generators have undertaken the planning, and in some cases the construction, of on-site storage facilities. In most cases, the design and construction of on-site disposal facilities will require a year or more. To have a storage facility available by January 1, 1986, a generator should have started detailed design work in 1984. The majority of the on-site disposal facilities have been buildings. However, a number of generators have provided on-site storage modules. The use of storage modules is expected to increase since the time required to design and construct buildings has passed. The alternatives for onsite storage of radioactive waste can be summarized as follows:

Warehouse-Type Buildings

Pre-engineered and prefabricated buildings are being used for the storage of low activity waste. In most cases, the waste is placed on pallets and stored in stacks within the building. In some cases, concrete block walls within the building are used to provide shielding.

Shielded Buildings

Reinforced concrete buildings with relatively thick exterior walls and internal partitions are being designed and constructed for the storage of high activity waste. These facilities generally use remotely operated handling equipment to place the waste in

storage cells. Some facilities use shield bells to handle the waste within the facility.

Concrete On-Site Storage Modules

Cylindrical reinforced concrete containers are commercially available for the storage of radioactive waste. These containers have interior cavities sized for the various types of steel liners and high integrity containers. The walls of the containers are sized to provide shielding to reduce the external radiation to less than 100 mR/hr. With the amount of shielding, these containers are quite heavy, weighing from of 60,000 pounds to 90,000 pounds when loaded.

Transportation Steel Storage Modules

Applications have been made to certify steel storage containers as transportation packages for greater than Type A quantities of radioactive material and as high integrity containers for disposal. The packages are designed to allow transport of a gross vehicle weight of 80,000 pounds.

Concrete Storage, Transport and Disposal Modules

A new concept for the disposal of low-level radioactive waste was recently introduced (Reference 1) which uses hexagonal, reinforced concrete modules to provide structural stability to disposal units. The application of these units as on-site storage modules with provisions to transport these modules to the disposal site is the subject of this paper.

Comparative Costs

Table I shows the comparative costs of the various types of on-site storage facilities and modules.

TABLE I

Comparative Costs

	Cost per Cubic Foot
Warehouse Building	$20 to $40
Shielded Building	$60 to $100
Concrete Storage Modules	$40 to 60
Steel Storage Modules	$50 to $100
Concrete Storage/Disposal Modules	$25 to $60

Storage Modules Versus Storage Buildings

The on-site storage of low-level radioactive waste is considered to be a interim need. The current situation should be resolved before the end of the century. Regional low-level radioactive waste disposal facilities will then be available to dispose of waste as it is generated. Considering the temporary nature of the on-site storage requirement, storage modules have the following advantages:

- o Available with a short lead time.
- o Reduced initial investment.
- o Capacity adjustable to meet actual need.
- o Lower overall cost.

The principal disadvantages of storage modules, when compared to buildings, come when they are no longer needed:

- o Modules have limited salvage value.
- o Modules have limited potential for alternative use.
- o If contaminated, the cost of disposal can be very high.

INTEGRATED STORAGE, TRANSPORT AND DISPOSAL MODULES

Figure 1 shows the modules designed to package various types of radioactive waste packages for disposal. The modularized radioactive waste packaging system is described in Reference 1, and uses hexagonal shaped, reinforced concrete modules to overpack all waste packages. This creates a structurally stable waste form that can be densely packed in the disposal units to virtually eliminate subsidence.

Fig. 1. Storage/Disposal Module.

These modules are designed to be handled using either fork lift trucks or cranes. Figure 2 shows a module being transported with a forklift. The design characteristics for a standard disposal module are listed in Table II.

Fig. 2. Modules Being Transported With Forklift.

TABLE II

Design Characteristics
Standard Disposal Module

Outside Dimensions	
Across Flats (in)	83
Across Edges (in)	91.3
Overall Height (in)	90
Cavity	
Diameter (in)	77
Height (in)	75
Volume (CF)	202
Weight	
Module (lbs)	15,200
Cover (lbs)	2,800
Contents (lbs)	30,000*
Total	48,000
Burial Volume (CF)	350

*Includes Grout

Integrated Use

In addition to disposal, a single module designed for on-site storage and transportation to the disposal site offers many advantages. Compared to storage buildings, such a module retains the advantages of being available with a short lead time, requiring minimal initial investment, and having only the capacity required to meet actual needs. Compared to modules designed only for on-site use, a disposable module has several important advantages. These are:

- o Eliminates the need for disposable liners.
- o Eliminates the need for casks to transport waste to the disposal site.
- o Solves the ultimate disposal question when no longer needed.
- o Avoids the risk of contamination and the associated high cost of disposal.

The use of an integrated module for storage, transport and disposal introduces some inherent disadvantages compared to modules used only for storage.

- o The size and weight of the modules must be conformed with the limitations for highway transport.
- o The capacity will be less for storage modules having an equivalent amount of shielding.
- o Special provision will be required to permit highway transport of the modules.

Transport Considerations

Concrete storage modules are much less expensive than modules made of other materials. Unfortunately, concrete has a relatively low strength and is quite brittle. Unless heavily reinforced, a concrete module would not be able to meet the requirements for transport of radioactive materials. Additional reinforcement would significantly increase the cost of the module. A transportation overpack is considered to be the best approach to meet the transportation requirement and still retain the advantages of a low cost storage and disposal module. Figure 3 is an artist's concept of a transportation overpack for hexagonal concrete modules.

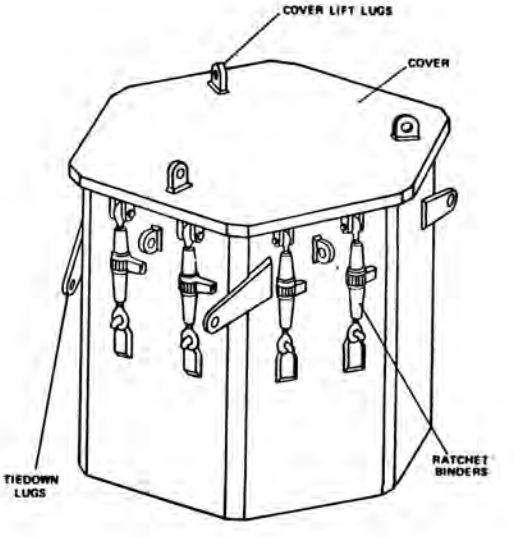

Fig. 3. Transportation Overpack.

Other Features

The integrated modules can also be designed to provide other desirable features. For example:

- The full volume of the cavity can be used for the waste.
- The module can be designed to permit in-container processing such as resin dewatering and solidification.
- Waste need only be handled on a one-time basis.
- Solidification can be used to reduce external radiation levels thereby reducing the shielding required and increasing the capacity of the module.
- Shielding can be reduced based on the time that the module will be stored and the decay that will occur during the storage period.

Volume Reduction

The integrated module represents an ideal overpack for compacted drums. The large cavity allows drums to be selectively placed to completely fill the module. The void spaces are then filled with grout, and the grout and the module provide a double barrier to water infiltration or the release of waste. Fig. 4 shows a module filled with compacted drums.

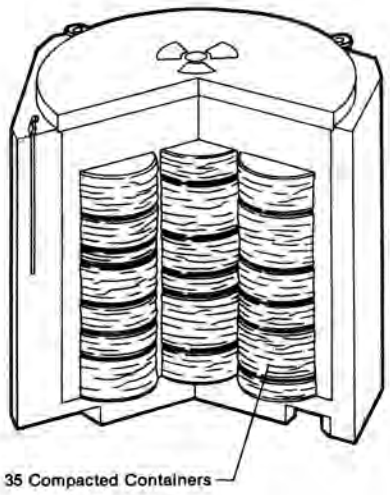

Fig. 4. Module Filled with Compacted Drums.

Qualification of Integrated Modules

Work is now underway to qualify the integrated storage, transportation and disposal modules for use by the nuclear industry. Applications are being made to the Nuclear Regulatory Commission for the certification of concrete modules as high integrity containers and as transportation packages for greater than Type A quantities of low specific activity radioactive materials.

REFERENCES

Mallory, C.W., DiSibio, R. *"A Modularized System for the disposal of Low-Level Radioactive Waste"*, Waste Management '85.