NON-FUEL CYCLE WASTE

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Introduction

Since the signing of the Atomic Energy Act of 1954, licensees in the "Atoms for Peace" program have generated a substantial volume of non-fuel cycle waste. During 1978, approximately 725,000 cubic feet of non-fuel cycle waste were received at commercial waste disposal facilities. If one were to package this waste in 55-gallon drums lined side-to-side, over thirty-seven miles would be needed to represent this volume. This waste, shipped by approximately 42% of the non-fuel cycle waste licenses, accounts for more than one-third of the total commercial radioactive waste disposed in the United States. If the current trend continues, the volume of non-fuel cycle waste disposed at commercial sites will be doubled by 1985.

SOURCES OF NON-FUEL CYCLE WASTE

The "Atoms for Peace" program authorized the development, use, and control of atomic energy to promote world peace, improve the general welfare, increase the standards of living, and strengthen free competition in the general enterprise. These programs which we shall consider are academic, medical, and industrial organizations.

The academic category includes universities, colleges, vocational, and secondary schools where radionuclides are used in biological or physical research and classroom demonstrations. The academic category generates 8% of the commercially disposed non-fuel cycle waste.

The medical category includes clinical and teaching hospitals, medical laboratories, and private physicians. Typical radionuclide uses are diagnostic or theraputic patient centers, in vitro clinical assays, and biological research. The medical category generates 65% of the commercially disposed non-fuel cycle waste.

The Industrial category includes radiography, electronic instrument, thickness gauge, and radiopharmaceutical manufacturers and private or governmental agencies conducting environmental or biological research. Also included are public works, civil defense, radiological consultants, and philanthropic organizations. This category generates the remaining 27% of commercially disposed non-fuel cycle waste.

PACKAGING

The basic philosophy in the packaging of all radioactive waste materials is that the containment shall be proportional to the degree of potential hazards of the contents. Protection is achieved by a combination of limitations on the package contents. These limitations, regulated by the Department of Transportation and Nuclear Regulatory Commission, are according to the quantities and types of radioactive material and the standards and criteria for package design and control. Since most radioactive shipments move in routine commerce on conventional transportation equipment, there is little a shipper can do to change the environment through which his package must travel. These radioactive waste shipments are subject to the same transportation environment as non-radioactive cargo so the shipper must depend on the integrity of the package to stand up under the conditions of transportation.

Non-fuel cycle waste shipped to commercial disposal sites basically has four distinct forms: solid, biological, scintillation vials, and liquid. Each form is packaged in accordance with Federal regulations and disposal site licenses.

SOLID WASTE

Approximately 41% of the non-fuel cycle waste transported to commercial disposal sites is dry solid material, varying from discarded rags, clothing, gloves, and paper to industrial gauges or medical therapy sources. Solid waste includes residual manufacturing products, broken scintillation vials, medical tubing, expendable hardware, and solidified radioactive liquids.

Solid material is packaged at the facility's control point normally in 55-gallon steel drums. A polyethylene liner is placed in each drum to minimize the spread of radioactive contamination and to prevent contact with any acidic or caustic residue. After filling, the plastic lining is sealed and the drum is locked in place by a steel bolt ring. The outside surface of the drum is then monitored for radiation levels and radioactive contamination.

BIOLOGICAL WASTE

Approximately 10% of the non-fuel cycle waste disposed at commercial sites is biological radwaste. This category includes pathological wastes, animal carcasses, and biological cultures. Biological wastes contain trace amounts of Tritium, Carbon-14, or other radionuclides emitting low energy radiation. Due to the small quantities of these nuclides the radiological hazard is minor compared to the personnel hazard resulting from the evolution of carbon dioxide gas. Gas pressure buildup in the sealed container due to tissue decay has resulted in container explosion.

Biological radwaste material depending on its relative size is accumulated and stored in freezer lockers. Freezing biological waste not only preserves the tissue and reduces carbon dioxide gas buildup, but provides easier handling. Immediately prior to transport, frozen biological waste is layered in a polyethylene liner with a preservative (salt) and dry adsorbent media (vermiculite). The adsorbent media and the plastic liner provides an additional barrier for any liquids that evolve when defrosting during transport. The liner is then twisted tight and sealed, and the steel drum is secured. Liquid preservatives such as formaldehyde proposed by ANSI packaging guidelines are not recommended since they may enhance chemical or radionuclide migration.

SCINTILLATION VIALS

Scintillation vials comprise approximately 29% of the non-fuel cycle waste destined for commercial disposal sites. An estimated volume of 10 milliliters of scintillation cocktail is in each 20 milliliter vial. These vials are used in radionuclide counting laboratories to detect low energy beta emitters such as Carbon-14 and Tritium. Along with the radioactive hazard, the scintillation cocktail includes flammable organics, toluene and xylene. Toluene, soluble in water, is proposed to increase nuclide migration at disposal sites.

The discarded, sealed scintillation vials are deposited in polyethylene lined steel drums. A two-to-one ratio of adsorbent media to liquid is also placed in each drum. The plastic liner and adsorbent media again provide an additional barrier in case of any liquid released from vial breakage.

LIQUIDS

Liquid radioactive material accounts for 22% of the non-fuel cycle waste disposed at commercial sites. Liquid radwaste may consist of residue sludges, contaminated chemicals, or byproduct material. Not including the volume of scintillation vials disposed intact, the source for more than one-half of the liquid radioactive waste material is collected scintillation cocktail.

Commercial disposal sites may require total liquid solidification or stringent packaging criteria to insure containment of liquid radioactive waste. The criteria is dependent on the disposal site restrictions and packaging practicallity.

One packaging method consists of adsorbing 15 gallons of liquid radioactive waste onto adsorbent media in a 30-gallon steel drum. The 30-gallon drum is then sealed and placed inside a 55-gallon steel drum. Additional adsorbent media is then placed inside the 55-gallon drum and this drum is also sealed.

A second alternative consists of placing a 5-gallon carboy container full of liquid inside a 30-gallon drum. The 30-gallon drum is filled with adsorbent media and then sealed.

These packaging criteria are acceptable since double wall containers reduce the possibility of leakage during transport and also minimize nuclide migration at the disposal site.

TRANSPORTATION

Trucks transport all radioactive material to commercial disposal sites according to exclusive use or mixed shipment criteria. Exclusive use or sole vehicle shipment is defined as any shipment from a single consignor having the exclusive use of the transport vehicle and for which all loading and unloading is carried out by or under the direction of the consignor, consignee, or his designated agent. Mixed shipments can be defined as any shipment not meeting the exclusive use definition.

Mixed shipment criteria due to the additional material transferring, handling, and storage with non-radioactive produce, have more stringent requirements than exclusive use shipments. Strict container contamination limits and external package radiation levels of 200 millirem per hour must be strictly adhered insuring public safety. Low Specific Activity radioactive material shall also be packaged in an approved container meeting Department of Transportation Spec 7A Criteria.

Spec 7A container criteria includes withstanding a thirty-minute water spray test, a four-foot free drop test, a one-foot free drop test on each package corner, a penetration test in which a thirteen pound steel cylinder is dropped from forty inches onto the package surface, and a twenty-four hour package compression test equal to five times the weight of the package.

Exclusive use shipments such as a private carrier are permitted an additional allowance for radiation contamination control and package external radiation levels increase up to 1 Rem per hour at three feet. Low Specific Activity radioactive waste may also be packaged in strong tight containers. This criteria provides an additional incentive to the shipper to maximize exclusive use shipments thus minimizing public radiation exposure.

COMMERCIAL DISPOSAL SITES

Upon shipment arrival at the disposal site, the package is monitored for contamination and radiation levels. This monitoring is also performed on the outside van surface, in the cab of each truck, and inside each van to insure that package radiation levels have not been exceeded.

The shipment is then directed to a trench especially designated for non-fuel cycle waste. The van is unloaded by randomly positioning packages in the trench. This disposal method minimizes radiation exposure and reduces disposal costs.

After documenting the shipment and disposal location, the truck is routed back to the survey station where the tires, truck van, cab, and driver are checked for radioactive contamination prior to release.

Non-fuel cycle waste trenches are designed as the primary radionuclide barrier. Twenty-two feet deep trenches with dimensions of 50 feet by 500 feet or 100 feet by 1000 feet are used at the Chem-Nuclear site. To further insure nuclide retention in the event of surface runoff leakage, each trench is sloped one percent from side to side. All foreign material would migrate to the lowest trench side where a one foot by one foot french drain is constructed. Sample wells in the french drain are provided at 100 foot intervals and checked monthly to insure prompt attention of any radionuclide or organic liquid transgression.

The clay trench also has an end-to-end slope of three-tenths of a percent forming a collection point at one corner. Before depositing waste, pervious sand is back filled three feet in each trench allowing any excess liquid to flow in the french drain trench and to the corner. A sump port is provided in this corner and if necessary, any collected liquid could then be removed and solidified.

After the waste material is positioned in the trench, a 10,000 pound compactor vibrates sand backfill into the void spaces around the packages. A five foot minimum clay cap is then compacted over the waste material as a moisture seal. The clay seal is sloped and grass is planted to aid surface runoff water with minimal erosion. Since radiation levels have been reduced to background, alternative land use is feasible.

COMMERCIAL DISPOSAL ALTERNATIVES

Ironically, over 58% of the non-fuel cycle waste licensees do not use commercial disposal facilities as the primary disposal route. As might be expected, the short lived nuclides with half-lives of a few days are more frequently decayed before release while waste with the longer lived nuclides are more likely disposed at commercial sites. Of the longer lived nuclides received at commercial disposal sites Tritium, Carbon-14, Phosphorous-32, Sulfer-35, Chromium-51, only Tritium and Carbon-14 are likely to be present one year after disposal. Even then their radioactive concentration will be within an order of magnitude of the maximum allowable concentration for public drinking water.

Incineration is used primarily for disposal by only four percent of the waste generators. However, many institutions burn at least a portion of their waste. Most commonly, incineration is used in the disposal of contaminated carcasses of research animals or scintillation cocktail. Research and the advancing incineration technology will insure the outstanding use of the 60-1 volumetric reduction technique.

On-site burial is the primary disposal route for seven percent of the waste generators. These are predominately rural institutions with sufficient real estate for disposal area. New regulations such as NRC proposed rulemaking 7590-01-M may eliminate this alternative in the future.

The proposed rules require NRC licensees to obtain the Commission's approval prior to the land burial of small quantities of radionuclides. The proposed amendments will contribute to the protection of the public health by encouraging the shipment of small quantities of radioactive waste to licensed disposal sites and improving the NRC's accountability data regarding amounts and locations of buried radioactive material.

The sewer and trash route accounts for 35% of the licensees who generate waste material. Short half-life gamma emitter such as Technetium 99-M, Xenon-133, Gallium-67, Iodine-123, and Iodine-131 are stored to decay to a releasable level and then deposited in the public trash system. Some licensees are also permitted to dilute scintillation vial cocktail and dispense in the public sewage system.

The remaining 12% of the licensees in the non-fuel cycle waste programs do not require waste disposal since this material is used for long term evolutions. This includes radiography and other sealed sources where the radioactive material is returned to the initial vendor.

FUTURE DEVELOPMENT

All alternative disposal methods using volumetric reduction techniques and radionuclide fixation must be investigated. Our research in the incineration technology and waste solidification must be expedited to insure immediate results. In 1985, six years from now, with the current growth trend, the volume of non-fuel cycle waste will be doubled. In contrast, in 1973, six years ago, the United States had available six commercial disposal sites, presently we have three. Operation of new commercial disposal sites must be allowed and new or revised waste handling and disposal methods applied. These programs must be initiated immediately insuring safe, viable, economical waste disposal in the future.

I. Andersen, R.L., Beck, T. J., Cooley, L. R. and Straus, C. S., 1978, "Institutional Radioactive Wastes", U. S. Nuclear Regulatory Commission, NUREG/CR-0028.

II. Chem-Nuclear Systems, Inc. Low Level Waste Disposal Statistics and other data for the period June, 1978 through December, 1978.