CHARACTER OF INSTITUTIONAL RADIOACTIVE WASTE AND OPTIONS FOR DISPOSAL

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ABSTRACT

Institutional radioactive waste, as exemplified by that generated at the University of Arizona, is characterized by relatively low activity and large volume, resulting in low specific activities. The major fraction is generated as liquid waste containing a wide variety of chemical compounds, both aqueous and organic. The radionuclides involved are predominantly ^{3}H and ^{14}C together with small amounts of some 30 other nuclides of various half-lives. Options for disposal of this waste are dependent on the radionuclides involved, and the physical and chemical forms of the waste.

Introduction

Academic and medical institutions generate a significant fraction of the low-level radioactive waste produced in the United States.[1] In addition, considerable low-level waste is produced by commercial operations which exist, at least in part, to supply these institutions with radioactive materials.

These sources combined rival nuclear power generation in terms of low-level waste volume. Consequently any activity, regulatory or otherwise, which influences the disposition of radioactive waste will have a profound impact on universities.

It is the aim of this paper to review the types of low level waste generated at a large, research oriented university and to explore, briefly, those contraints which influence institutional programs to a different degree than other waste generators.

The University of Arizona (UA) at Tucson is representative of major universities which incorporate a medical school and hospital, and which support a wide range of basic and applied research.

Student enrollment is approximately 30,000 with a full time faculty of 1,700. Some 200 of these faculty members are approved, under the University's two broad licenses, to use and possess radioactive materials. These approval holders are distributed throughout 33 different departments with some radioactive material operations located off campus.

The University of Arizona is atypical in that it maintains its own low-level waste burial site which has been in use since 1962. However this fact does not materially affect the nature of the waste generated, except where noted below.

Low-Level Waste Characteristics

The annual activity of radioactive waste disposed of by the University of Arizona from 1966 to 1982 is shown in Fig. 1.

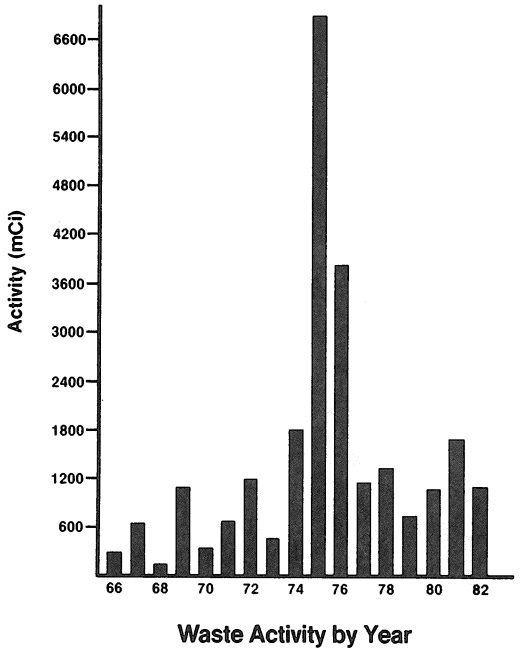

Fig. 1. Annual Activity of Radioactive Waste Disposed of by the University of Arizona from 1966 to 1982.

Unusually high activities in 1975 and 1976 resulted from specific research projects. With the exception of these unusual situations, the annual waste activity is generally low, with minor unpredictable fluctuations.

By contrast, the volume of waste over the same period (Fig. 2) consistently increased until 1980 with a slight drop in the last 2 years.

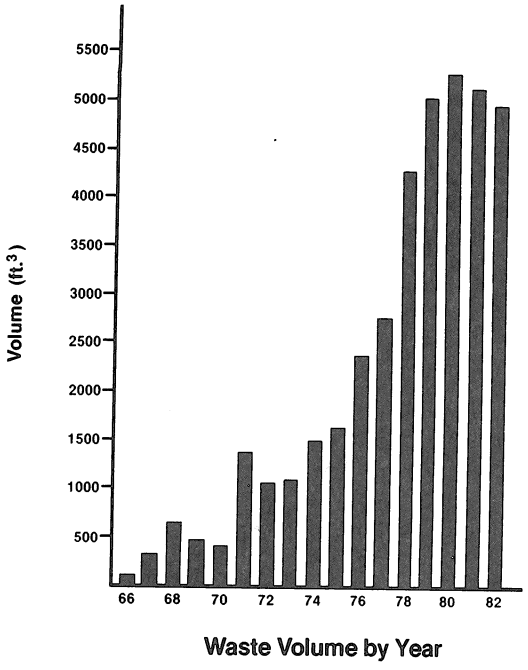

Fig. 2. The Volume of Waste Disposed of by the University of Arizona from 1966 to 1982.

Much of the increase in volume reflects the growth of research within the College of Medicine which was first occupied in 1967. At present further growth is limited by the availability of research space which in turn influences the volume of waste generated.

The relatively large volume of waste is due both to a conscious, conservative policy which encourages laboratory staff to dispose of all potentially contaminated materials as radioactive, and to a reduced incentive for volume reduction because of on-site burial.

Waste is collected from the individual users who identify the waste as to nuclides, activity and reference date.

It is then classified by the Radiation Control Office into the following categories:

*Dry waste - absorbent paper, disposable containers, pipettes, gloves.
*Liquid waste - numerous chemical forms both aqueous and organic.
*Animal bodies.
*Animal waste - contaminated bedding, excreta, etc.
*Liquid scintillation vials.

The relative volume of each type of waste is shown in Table I.

Table I

Type	Percent Volume
Dry waste	40.0%
Liquid waste	20.3%
Animal bodies	7.8%
Animal waste	6.2%
Scintillation vials	25.7%

Relative activities, and the associated specific activities for all nuclides of each waste category are given in Table II.

Table II

Type	Percent Activity	Specific Activity ($\mu Ci/cm^3$)
Dry waste	7.3 %	2.2×10^{-3}
Liquid waste	81.4 %	5.6×10^{-2}
Animal bodies	1.7 %	2.9×10^{-3}
Animal waste	0.03%	2.0×10^{-4}
Scintillation vials	9.6 %	4.0×10^{-3}

All of this waste falls within the 10 CFR 61 classification of "Type A segregated"[2] both in terms of source and specific activity, and also satisfies DOT requirements for classification as Low Specific Activity.[3]

Scintillation vials have been included, although for ^{3}H and ^{14}C they have been designated "nonradioactive" by the Nuclear Regulatory Commission, since they are not readily disposable because of toxic chemical considerations. Although the major part of liquid scintillation counting involves ^{3}H and ^{14}C, vials containing ^{35}S, ^{32}P, ^{125}I are also collected.

As has been previously reported for institutional waste nationally,[4] Tritium represents by far the predominant radionuclide generated at the University of Arizona.

Between 1966 and 1982, Tritium represented 83% of the total activity disposed of, with Carbon-14 labelled materials accounting for an additional 8%. The remaining 9% of waste activity is distributed between some 30 other radionuclides, most notably ^{35}S, ^{51}Cr, ^{32}P and ^{57}Co.

A list of the radionuclides other than ^{3}H and ^{14}C regularly collected for disposal is shown in Table III.

Table III

Nuclides Other Than ^{3}H, ^{14}C Collected For Disposal

Half-Life	
< 10 Days:	^{24}Na, ^{67}Ga, ^{99}Mo, ^{99m}Tc, ^{131}I
10 - 50 Days:	^{32}P, ^{57}Cr, ^{59}Fe, ^{74}As, ^{141}Ce, ^{169}Yb, ^{203}Hg
50 - 200 Days:	^{35}S, ^{45}Ca, ^{46}Sc, ^{73}As, ^{85}Sr, ^{125}I
> 200 Days:	^{22}Na, ^{36}Cl, ^{57}Co, ^{60}Co, ^{63}Ni, ^{65}Zn

At present, no attempt is made to identify the numerous chemical forms which comprise the University's radioactive waste. While the identity of incoming shipments is known, most users employ a variety of compounds which are not separated for disposal. Furthermore, radionuclide labelling, chemical reactions, and plant and animal metabolism add a wide range of compounds.

Release of radioactive materials other than to Radiation Control for disposal is actively discouraged both in order to maintain record keeping as accurately as possible and to minimize release to the environment. Some activity is unavoidably lost to the atmosphere during radiolabelling procedures and certain metabolic studies. Disposal to sewage is limited to large volumes containing only trace levels of radioactivity. These releases are documented by the individual user for inventory control.

Finally, most of the 192 Curies of radioactive material purchased during 1982 was for medical use, either diagnostic studies performed in Nuclear Medicine or sealed sources for radiation therapy. In the former case, patient administration and the short half-life of the remaining activity combine to produce only small amounts of active waste. Sealed sources for patient treatment can generally be returned to the manufacturer at the end of their useful lifetime.

Consequently, strictly medical uses of radioactive materials do not present a significant waste disposal problem. Hospitals tend to encounter problems only when biomedical research is involved.

Sealed sources other than those intended for patient use are occasionally collected for disposal, for example obsolete soil moisture probes containing Americium-Beryllium sources and density gauges employing ^{137}Cs.

In summary, only a small fraction of the radioactive material acquired by the University must be disposed of as waste. The major part of that waste results from research uses of ^{3}H and ^{14}C labelled compounds with the predominant physical form being liquid waste.

Options for Disposal

Options for the disposal of low-level radioactive waste consist of:

*Commercial disposal
*Release to sewage
*Incineration
*Store to decay
*Release to common refuse

Commercial disposal remains the most straight forward means of disposal with the major drawback being cost. Institutions generally are well aware of the importance of a sound radiation protection and waste disposal program but radiation safety must compete for limited funds with other programs much more easily identified with the function of the University. The pressure to utilize disposal options other than commercial is heavy and will increase.

Further conflict arises from the special relationship which often exists between the University and the community (frequently urban) in which it is located. In many cases, a considerable effort is made to foster community support so that ill feeling which may result from incineration or sewage disposal of radioactive waste may be particularly damaging. Local ordinances governing incineration may also be difficult to comply with.

Storage to decay is the option of choice for most institutions, but may be limited because of the amount of space which can be allocated to the secure storage of radioactive waste.

Release to common refuse is permissible for animal carcasses containing less than 0.05 μCi per gram of ^{3}H and ^{14}C only. This option is not available for liquid scintillation vials because of EPA restrictions on the disposal of xylene, toluene and related toxic chemicals.

The overall situation may be simplified by considering these options in terms of waste classification:

Dry waste - (1) Incinerate.
(2) Store to decay (not practical for ^{3}H, ^{14}C and other long lived waste). Compaction can be used to reduce storage space required.

Liquid waste - (1) Sewage disposal (soluble, dispersible liquids only).
(2) Store to decay (not practical for ^{3}H, ^{14}C).
(3) Incinerate.

Animal bodies - (1) Common refuse (^{3}H, ^{14}C only).
(2) Incinerate.
(3) Store to decay (practical only for short half-lives because of freezer space required).

Scintillation vials - (1) Dispose to toxic chemical waste site as nonradioactive (^{3}H, ^{14}C only).
(2) Incinerate.
(3) Store to decay for nuclides other than ^{3}H, ^{14}C.

Efficient, economical waste disposal programs must rely heavily on the cooperation of individual users. In order to take advantage of all available disposal options, radioactive waste must be identified and separated according to half-life, chemical form in the case of liquid wastes, and nuclide. This can only be done at the user level. In order that all applicable regulations are complied with, the institution must commit adequate funding, personnel and space to the radiation control program.

Radioactive materials are employed as research tools in a wide variety of disciplines. The potential benefits of this work far outweigh the risks associated with disposal of the low-level radioactive waste generated.

REFERENCES

1. Anderson, R. L., Beck, T. J., Cooley, L. R., and Strauss, C. S. Institutional radioactive waste. NUREG/CR-0028.

2. U. S. Nuclear Regulatory Commission. 10 CFR 61.55.

3. U. S. Department of Transportation. 49 CFR 173.392.

4. Beck, T. J., McCampbell, M. R., Cooley, L. R. A profile of institutional radioactive wastes generated in 1977. Proceedings of Health Physics Society 12th Midyear Topical Symposium. p. 27. 1979.