Devices for Reducing Personnel Radiation Exposure

Gary W. Enos and Alan D. Budzier

Holy Family Hospital, Spokane, Washington

To reduce radiation exposure in the practice of nuclear medicine, the construction of two inexpensive devices is proposed: a compartmental waste disposal unit for "day-of-the-week" hot trash handling and a generator vault for weekly storage and elution. Each unit utilizes lead linings to reduce exposure within the hot lab by a factor of ten (central lab reading). Substantial cost savings are realized by in-house construction as well.

Conventional "open-top" lead brick barriers for hot trash still allow considerable exposure in the immediate area. These conventional methods also require frequent emptying and removal of contents to be stored elsewhere for decay and each lot of trash must be identified, stored, and surveyed prior to disposal. The closed compartment structure we devised (Fig. 1) provides ample daily storage, affords 14 half-value layers (HVL) of protection for 140 keV photons, and provides for 28 half-lives of Tc-99m for each day of waste prior to disposal (Fig. 2).

A generator vault was also constructed to provide greater shielding of Mo-99/Tc-99m generators now in use, and reduce exposure during elution. Figure 3 shows our nuclear medicine department's shielding structure prior to vault construction. It has no top generator shielding, which increases exposure during both storage and elution (Tables 1 and 2). Figures 4 and 5 show the vault structure, allowing for a saving in storage and set-up space, greater reduction in exposure during storage, and elution with lead shielding provided on the top and bottom of the structure. The vault is closed during non-use periods, and only opened for elution vial placement. The vault is closed during the milking procedure. Momentary exposure to personnel during elution vial placement is comparable to conventional vial placement exposure. Reduction in overall exposure from existing generators in and during use is recorded (Table 2).

As proposed, this vault provides an additional 2.4 HVL—a total of 6.4 HVL—for the 780 keV photons of Mo-99, and 51.4 additional HVL—a total of 85 HVL—for the 140 keV photons of Tc-99m. These figures include the intrinsic shielding of generator column.

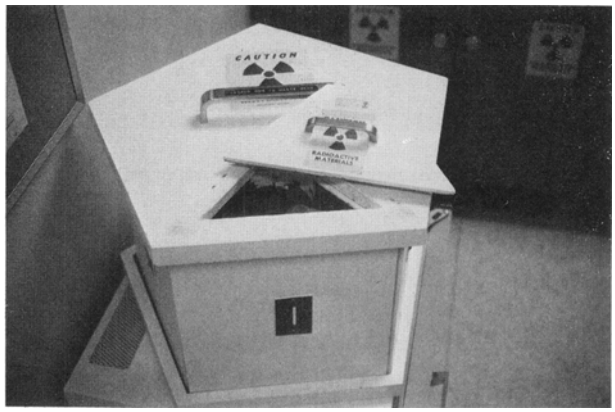

FIG. 1. Five-Compartment hot trash unit for day-of-the week storage and decay. Access door is lead lined; top is easily positioned to reveal other compartments.

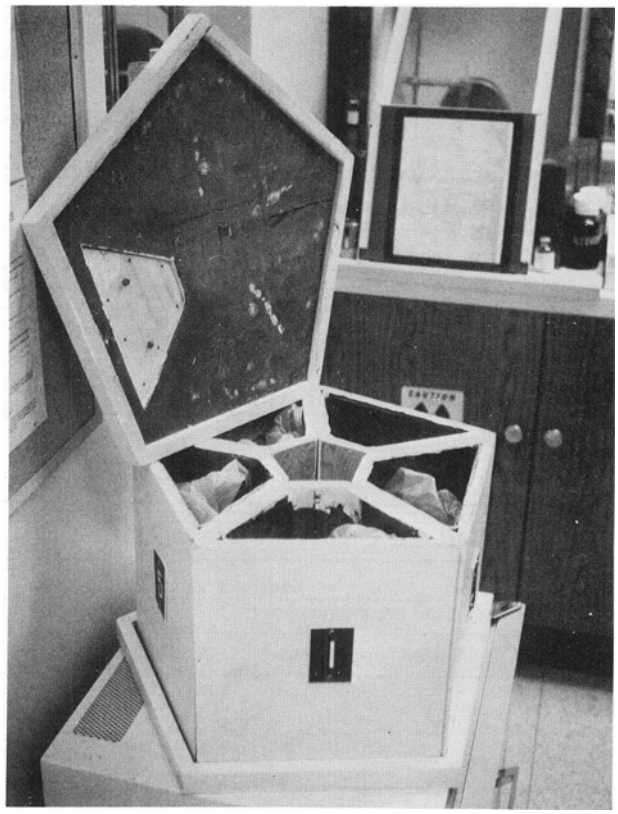

FIG. 2. Top of structure raised shows five separate areas for waste storage. Six- and seven-compartment units are conceivable.

For reprints contact: Gary W. Enos, Holy Family Hospital, Dept. of Nuclear Medicine, N5633 Lidgerwood, Spokane, WA 99207.

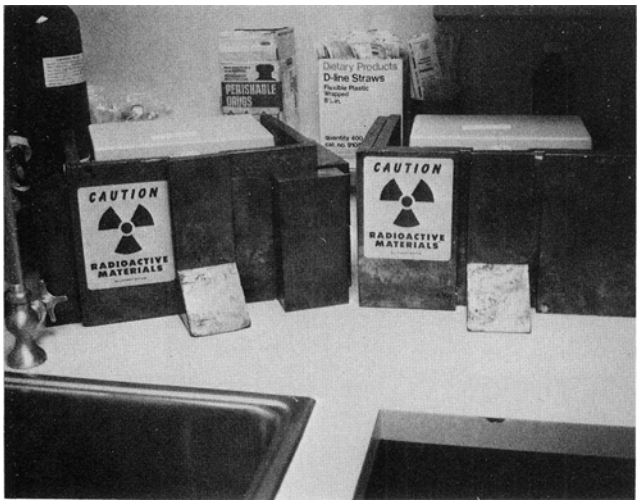

FIG. 3. Conventional method of generator setup; front lead piece is removed for elution vial placement.

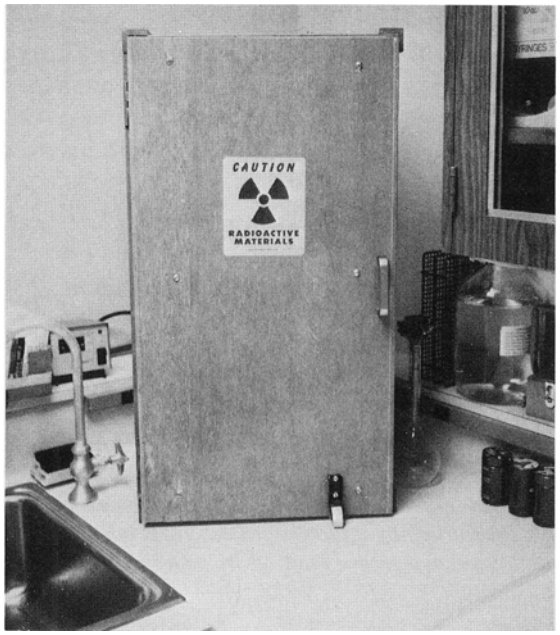

FIG. 4. Generator vault structure during daily storage and elution.

Construction

The waste disposal unit contains five "day-of-the-week" compartments, each 10 in. × 10 in. × 12 in. in size. It is constructed from one 4-ft × 8-ft sheet of 3/8-in. plywood, and 20 ft^2 of 1/16-in. sheet lead (approximately 80 lb); this is sufficient to line each compartment and the top and bottom pieces with 3.5 mm of shielding. This degree of shielding provides 14 HVL of protection for 140 keV photons (*1*).

The generator vault is constructed of one 4-ft × 8-ft sheet of 3/4-in. plywood; heavy duty cabinet hinges; one 29-in. × 13-in. × 3/4-in. lead shield for the door; three 3/4-in. lead "L" auxiliary shields (Mallinckrodt Nuclear, Inc., St. Louis, MO) for routine generator shielding (i.e., for side and back shielding); two 14 3/4-in. × 11-in. × 1/2-in. lead shields (for top and bottom shielding); two

TABLE 1. Exposure Rates (mR/hr)

	Compartment Waste Disposal	
	Lead Brick Structure	Compartmental Unit
Top (6 in.)	3.0	0.4
Side (6 in.)	2.0	0.4
Central Hot Lab	1.4	0.15

TABLE 2. Exposure Rates (mR/hr)

	Generator Vault			
	Lead Brick Structure		Vault	
	Elution*	Storage†	Elution*	Storage†
Top (6 in.)	35	16	1.1	0.4
Side (6 in.)	1.7	1.4	1.3	0.5
Front (6 in.)	2.5	1.4	1.3	0.5

*Measured with both generators eluting; door closed.

†Measured with previous and present week 500-mCi generator in place.

FIG. 5. Vault structure open reveals two shelves for current and previous week generators.

iron "L" brackets for shield supports; and one support roller for the excess door weight.

Discussion

A significiant cost savings can be realized with these devices when compared to other commercial devices for the same purpose. The generator vault can be constructed in-house at a cost of approximately $175.00; most commercial products start at $500.00. The waste disposal unit can be constructed for approximately $125.00, while commercial hot trash units start at $300.00.

Acknowledgments

We wish to thank Roy Raymond and the Holy Family Hospital Engineering staff for their assistance in the construction of these devices, and Doris Schaub for typing this manuscript.

References

1. Rhinehart GL, Modine NF: *Half value layers at photon energies for 10 KeV to 10 MeV.* US DHEW, PHS, National Center for Radiological Health, 1968, pp 1–3.