NRLSD Bulletin No. 89-4

MANAGEMENT OF RADIOACTIVE WASTE

A. ADDRESSEES

All licensees with sources for use in nuclear medicine.

B. PURPOSE

This bulletin is issued to remind the licensees of the proper management of radioactive wastes generated from the use of radionuclides in nuclear medicine and to stress the importance of implementing an effective control and disposal system that ensures the safety of the public and a safe environment.

C. DESCRIPTION OF CIRCUMSTANCES

Recent PNRI inspections/audits of licensed activities in hospitals and medical laboratories using unsealed sources revealed failure of many licensees to comply with the regulatory requirements on the establishment and implementation of an appropriate radioactive waste management program. The inspection findings reflected the licensees' neglect to exercise an effective control and disposal of radioactive wastes. Enumerated below are some of the licensees' radioactive wastes management unacceptable practices:

a. Disposal of solid wastes as an ordinary refuse.

1. usage of ordinary 5-gal. waste cans, discarded carton boxes and/or native woven waste baskets as radioactive waste containers, without the protection of a heavy gauge plastic bag liner and are not properly marked with radioactive material caution signs;

2. no segregation of wastes, i.e., uncontaminated wastes are mixed with contaminated ones;

3. radioactive wastes for storage-to-decay are not measured to check the limits of radioactivity per batch; and

4. records indicating the history and status of the radioactive wastes are not maintained.

b. Disposal as radioactive effluents released to the sewer systems.

1. radioactive liquid wastes of different classification (aqueous or non-aqueous, acidic, alkaline or neutral) are mixed altogether into one container for decay;

2. radioactive liquid waste containers are not monitored to check the limits of radioactivity;

3. no records showing the details of the chemical nature and activity level of the various radionuclides disposed into the sewer; and

4. no designated "hot" sink exclusively used for washing contaminated glasswares, etc.

c. Conditions of radwaste storage room.

1. radioactive wastes are stored-to-decay in fume hoods instead of in designated storage room, however, if there is a designated room it is not exclusively used for radwastes;

2. no records of stored radioactive wastes; and

3. storage room is not properly posted with radiation caution signs.

D. DISCUSSIONS

Long term storage of radioactive wastes is practiced only by the major nuclear industries. On the other hand, even work on a much smaller scale requires the storage of radioactive wastes for a short period of time before disposal. The principles involved in both cases are very much the same. It is important to remember that all radioactive wastes should be handled as radioactive materials and appropriate precautions should be taken.

SOLID WASTE MANAGEMENT

During the course of work with radioactive isotopes a variety of materials (i.e., ordinary and tissue papers, rubber gloves, syringes, straws, broken glasswares, empty vials, etc.) become contaminated. The activity content and the half-lives of radionuclides present in them show wide variation. Depending upon the physical/chemical nature and the activity levels of these wastes, the following are some of the methods that have been used for their collection, handling, storage, and disposal.

Relevant guidelines implemented by PNRI in connection with the disposal of radioactive solid waste wastes include:

Disposal as Ordinary Refuse.

a) No licensee shall release wastes containing licensed material as ordinary refuse unless:

   1) the material contains only isotopes of half-life less than 2 years; and

   2) the activity on or in any one article or batch released does not exceed 37 kBq (1 uCi) or the radioactivity is uniformly dispersed throughout the waste material and does not exceed 1.85 MBq/cu.m. (50 uCi/cu.m.).

b. The licensee shall calculate or measure the activities or concentrations to assure compliance with the limit (a)(2) above and shall maintain records of the results.

1. Segregation

In order to facilitate their collection, handling, storage and subsequent disposal, it is necessary to segregate wastes at the point of origin. It is essential to segregate the "inactive trash" from "active wastes" so that the volume and weight of active wastes handled will be minimized. For the active wastes, it is ideal that the materials should be categorized into two groups, i.e., (1) compressible and combustible, and (2) non-compressible and non-combustible, and collected separately. Most of the wastes produced in the laboratories of hospitals fall under the first category.

1.1 Collection practices for solid wastes normally consist of distributing suitable containers throughout the working area to receive separately inactive and active materials. The containers for active materials should be marked, using yellow paint, with the radiation symbol of magenta or black to distinguish them from bins meant to receive inactive wastes.

1.2 Refuse cans with foot-operated lids are particularly suitable for radioisotope laboratories. These should be lined inside with heavy-gauge plastic bags, which can be sealed and taken out when full. The use of plastic bags for trash containment has the advantage that water from wet material will not seep through and contaminate the floor. Such containers may be used for collection of combustible-compressible wastes. The containers should be emptied regularly and a limit of 37 kBq/batch (1 uCi/batch) should be set as the maximum in a container.

For non-combustible and non-compressible wastes such as empty vials, broken glasswares, metal pieces, disposable syringes and capped needles, etc., a container made of tin or cardboard cans may be used advantageously to prevent cuts to those handling the wastes.

1.3 A practical system exclusively for Tc-99m wastes is to have two waste containers which are alternately filled every other week. For instance, the first container is filled Monday (1st day) to Friday (5^{th} day) and emptied 7 days later (Friday-12^{th} day); the second is used the next Monday (8^{th} day) until Friday (12^{th} day) and emptied 7 days later (Friday-19^{th} day). On the 15^{th} day the first bin is used again and emptied on the 26^{th} day, etc. A period of 7 days for decay ensure complete decay of the Tc-99m before the wastes are disposed as ordinary refuse.

1.4 The remains of Mo-99 generators require a longer period of time before it can be considered non-radioactive. The generators will have to be kept at least 3 to 6 months, preferably in their lead containers but removed from the laboratory to a storage room. The time needed for decay will be determined by the longer-lived radionuclide impurities (e.g., Zn-65, Cs-134, Sb-124, Zr-95, Nb-95, Nb-92) in the column rather than by the Mo-99. After 3 to 6 months of decay-in-storage, the generators can be dismantled. When dismantling the generators, keep a radiation detection survey meter "on" at the work area. Dismantle the oldest generators first, then work forward chronologically. Hold each individual column in contact with the radiation detection survey meter in a low background (less than 0.05 mR/hr) area. If the survey meter reading could not be distinguished from background, the column could then be discarded as an ordinary waste. Log the date the generator was brought to storage for decay, disposal date and dose rate at contact of bare column for waste disposal records. Remove or deface the radiation labels on the generator shield before disposal.

1.5 Work with RIA kits results in two forms of radioactive wastes: liquid and solid (beads or tubes). If I-125 could be effectively removed from the beads/tubes, all radioactivity could be transferred into the sewer as liquid and the non-radioactive beads/tubes could be disposed of as a common trash. A successful method of removing the I-125 from the beads/tubes was reported by means of soaking the beads/tubes overnight in 50% solution of household bleach, decanting the solution and rinsing the beads/tubes with tap water the next day.

NOTE: Account should be taken of the possible physico-chemical changes of radioactive iodine which may lead to its volatilization.

1.6 Users may arrange to transfer damaged sealed sources to PNRI for disposal. To transport the sources, licensees must comply with the Rules and Regulations on safe Transport of Radioactive Materials in the Philippines.

2. Delay to Decay

Most solid wastes produced by medical users of radioactive materials contain small amounts of short-lived radionuclides. In such cases, the wastes can be stored in a designated storage room for 10 half-lives or until the activity decays to background level as surveyed with a detection survey meter that they can be considered inactive as per regulations and disposed as ordinary refuse. Records containing information on the type of radionuclide, activity, nature, period of storage or decay, date of disposal and the initials of the person who made the radiation survey are required to be kept and maintained.

LIQUID WASTE MANAGEMENT

Liquid wastes containing small quantities of radionuclides are produced in medical laboratories. The activity limits of liquid waste that may be disposed into the sewer system for commonly used isotopes in nuclear medicine are specified below.

Relevant guidelines implemented by PNRI in connection with the disposal of radioactive liquid wastes include:

Disposal by Release into the Sanitary Sewer System.

a) No licensee shall discharge licensed materials into the sanitary sewer system unless:

   1) the material contains only isotopes of half-life less than 2 years;

   2) the material is in a form that is readily soluble or dispersible in water;

   3) when released, the concentration does not exceed 4 Bq/cc (0.0001 uCi/cc); and

   4) the total quantity of radioactive material released in any one day does not exceed the larger of the following:

      i) that quantity which, if diluted by the average daily quantity of sewage discharged into the sewer by the licensee, will result in an average concentration equal to the applicable Derived Water Concentration (DWC) value. Given below is the DWC value of some radionuclides:

Table 1 - Concentrations in Water Above Natural Background

I-131	2.22	kBq	(0.00006 uCi/ml)
I-125	1.48	kBq	(0.00004 uCi/ml)
Tc-99m	7400	kBq	(0.2 uCi/ml)
Tl-201	333	KBq	(0.009 uCi/ml)

ii) the quantity of discharged radioactive effluent is equal to the quantity specified for some radionuclides such as those below:

Table 2 – Quantity Specified For Some Radionuclides

I-131	370	kBq	(10 uCi)
I-125	370	kBq	(10 uCi)
Tc-99m	37	MBq	(1000 uCi)
Tl-201	37	MBq	(1000 uCi)

b) The licensee shall calculate or measure the concentration and quantities to assure compliance with the limits as above and shall maintain records of the results.

The following examples illustrate the calculations in conducting disposal to sewers under the above guidelines:

Isotope to be disposed of: I-131
Table 1: 0.00006 uCi/ml
Table 2: 10 uCi

Case A – average daily sewage flow from installation = 15,000 liters
Under 4(i): 0.00006 uCi/ml x 1000 ml/L x 15,000 L per day = 900 uCi per day
Under 4(ii): 10 uCi/day
Therefore, installation could dispose of up to 900 uCi of I-131 per day

Case B – average daily sewage flow = 100 liters
Under 4(i): 0.00006 uCi/ml x 1000 ml/L x 100 L per day = 6 uCi per day
Under 4(ii): 10 uCi/day
Under these circumstances, installation could operate under 4(ii) and dispose of up to 10 uCi per day.

c) Excreta (urine and feces) from individuals undergoing medical diagnosis or therapy with a radioactive material shall be exempt from the aforementioned limits. Make a record of date,

radionuclide, estimated activity that was released, and of the toilet at which the material was released. Excreta should be flushed down the pipe with abundant stream of water, e.g., flushing the toilet bowl three times.

1. Segregation, Collection and Disposal

The RHSO must examine the extent of the liquid radioactive wastes to determine whether direct discharge of low-level liquid wastes is permitted by the regulations or relevant disposal options will require the segregation, collection and treatment of wastes before disposal.

1.1 Segregation

Users should keep the radioactive content of liquid wastes generated in the laboratories to the minimum. In some instances the wastes need to be classified as aqueous and non-aqueous, acidic, alkaline or neutral.

Acidic and alkaline wastes are best stored separately from each other. If mixed, precipitation of the inactive ions present may occur and could co-precipitate the radioactive ions. Also, appreciable heating of the solution may cause the release of active aerosols which could contaminate the laboratory atmosphere and work area.

Non-aqueous liquid wastes should be stored separately from aqueous ones because mixing with aqueous solution will pose problems in the subsequent treatment.

1.2 Collection

Ten- or twenty-liter polyethylene carboys with sealing disc and screw cap are suitable for collection of aqueous wastes. Each carboy should be distinctly marked "acidic" or "alkaline" with proper radiation symbols pasted on. Non-aqueous wastes (organic liquids) must be stored in glass bottles. Organic liquids are likely to attack polyethylene chemically; polyethylene containers cannot be used for the collection of non-aqueous wastes. If glass bottles have to be used, these should be provided with secondary containers to protect them from breaking or to secure the contents should the bottle break.

All the containers should be kept closed when not in use to prevent evaporation. When the containers are full, the activity level and chemical characteristics can be obtained from user records. The containers should be monitored for radiation levels and tagged, giving details regarding the chemical nature and activity level of the various radionuclides present. Wipe samples should be taken from the external surface of the container and counted to make sure that there is no removable contamination.

2. Delay to Decay

The liquid wastes must be stored for a period of time, e.g., 10 half lives, that will allow the radionuclide present to decay to background level before disposal.

3. Direct Disposal

For small quantities of radioactive liquid wastes containing nuclides of short half-life, as in the case of hospitals and other medical laboratories, the most convenient and widely practiced method is to discharge the wastes into sewers under controlled conditions. It is not always necessary to dilute the liquid wastes before discharge because a dilution factor of at least 100 is generally obtained in the sewer system before the liquid wastes finally reach the main stream. Before the discharge, however, the specific gross activity of the liquid as well as the concentration of individual radionuclides in the mixture should be assessed. Some other guidelines for the discharge of liquid wastes containing radionuclides are given below:

a) A user may dispose of radioactive liquid wastes into the sewer system provided the quantity and concentration are within the limits on p.5 of this bulletin, "Disposal by Release into the Sanitary Sewer System".

b) All radioactive material released into the sewer system should be completely soluble and dispersible in water. Liquid wastes, if containing suspended solids or sediment need to be filtered prior to discharge. Non-aqueous wastes which are immiscible with water should be completely disallowed.

c) Acidic or alkaline wastes should be neutralized and, if necessary, filtered before they are discharged into the sewer system.

d) A complete and up-to-date record of all the discharges made is to be maintained until PNRI authorizes their disposition. This record should be available for inspection by the PNRI, as required by the regulations.

Additional considerations dealing with discharge of radioactive wastes to sewers:

1) Waste water from installation showers and laundries and from washings of floors and walls, etc., may be discharged into the normal sewer system provided that its activity, without preliminary dilution does not exceed the levels indicated on p.5 of this bulletin, "Disposal by Release into the Sanitary Sewer System".

2) High contamination of the drains might present a hazard during repairs. Monitoring should be conducted before starting any repair work. Drains or

sinks should be connected directly to the main outlet pipe; connections to open channels are not allowed.

3) Direct discharge into the sanitary sewer system is permitted for the disposal of excreta from patients given radioactive materials for diagnosis and therapy. The relationships between quantities of radioactive releases, radioactive half-lives, and quantities of sewage handled by the system will usually be such as to require no special precautions other that those which may be necessary to protect plumbers near points of discharge.

4) To restrict the possibility of general sink contamination each laboratory or group of rooms should designate one sink as a "hot" sink. Only this sink should be used for the initial cleaning of contaminated glasswares or for disposing liquid wastes. Note: Initial washings (e.g., of vials) should be collected in carboys and never be disposed into the sink. The "hot" sink should be labelled with caution tapes or tags both on top and on the drain. Traps and pipes should be monitored for radioactive materials that have been precipitated, adsorbed, or plated on surfaces before disassembly for repairs to avoid radiation exposure of maintenance personnel.

NOTE: Expired products (e.g., radiopharmaceuticals and kits) should be transferred to the waste storage area or room for decay prior to disposal.

AIRBORNE WASTE

Volatilized or airborne contaminants resulting from handling more than 1 mCi of some radioactive materials, e.g., I-131 and I-125, are likely to pose hazard to the workers if special equipment were not available. Detailed information on this matter could be found in NRLSD Bulletin No. 89-3, "Use of Fumehood in Nuclear Medicine".

NOTE: Used filters in air exhaust equipment such as in fumehoods or glove boxes should be handled as solid wastes.

RECORDS OF SURVEYS AND DISPOSALS

a) Each licensee shall maintain records showing the types and quantities of radioactive materials disposed of, the date, the method used, the location and the conditions of each disposal made under paragraphs, "Disposal as Ordinary Refuse" and "Disposal by Release into the Sanitary Sewer System" on p.3 and p.5, respectively, of this bulletin.

b) Records of disposal shall be preserved until PNRI authorizes their disposition.

CONDITIONS OF THE RADWASTE STORAGE ROOM

1) Storage site should not be accessible to unauthorized personnel (control of animals should not be overlooked)

2) Method of storage should prevent accidental releases to the surroundings.

3) Records of wastes stored must be kept to ensure that the storage facilities are not overloaded.

4) The room should be so chosen as to minimize the hazards arising from flooding and fire accident.

5) The room should be properly marked with conspicuous signs stating that radioactive wastes are stored there.

6) The room should be used only for the storage of radioactive wastes.

7) Periodic inventories of the containers should be performed and recorded, e.g., regular inspection of liquid containments to ensure that leaks have not occurred.

8) Contaminated clothing, linen and the like should not be released to a public laundry. These items should be segregated into batches, as: 1) to the different radionuclide contaminants, and 2) the date of their storage-to-decay, to avoid cross-contamination. They are stored until the radioactivity has fallen to safe levels. If the clothing, linen, etc. cannot be decontaminated to a safe level it should be treated as radioactive wastes.

E. REQUIRED LICENSEE ACTION

In response to this bulletin licensees should:

1) Conduct a safety assessment of his radioactive waste management program and update the program, as necessary.

2) Submit to the Institute for review and approval his updated radioactive waste management program, including specific procedures for collection, storage, handling and disposal of each licensed radioisotope.

F. COMPLIANCE SCHEDULE

Licensees shall inform the Institute of the actions taken to comply with this bulletin within 60 calendar days after receipt thereof.

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