# ASPECTS OF THE MANAGEMENT OF BIOMEDICAL WASTES POLLUTED BY RADIONUCLIDES

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## ABSTRACT

The management of radioactive wastes produced by radioisotope users in the biomedical field displays specific characteristics related to the dispersion of the producers, the variety of the wastes, and the small quantities produced. Unlike fuel cycle wastes, the risks to be considered throughout the management process are essentially associated with the physicochemical nature of the waste (chemical toxicity, risks of contagion, flammability) rather than those resulting from its radioactive properties, due to the very low activities involved and the relatively short half-lives of a large share of the radionuclides encountered.

This paper describes the measures taken in France for the collection and disposal of these wastes, under the regulations in force, and reports the detailed costs of the different services leading to their controlled disposal.

## THE CONTEXT OF BIOMEDICAL WASTE PRODUCERS

About 250 small radioactive waste producers in France enlist the services of ANDRA (Agence Nationale pour la Gestion des Déchets Radioatifs - National Agency for Radioactive Waste Management). They issue about a thousand disposal requests annually, for a total volume of about 1000 m³.

Compared to the big producers (nuclear power plants, fuel cycle facilities, large research laboratories), the small producers exhibit the following features:

- concerning the wastes themselves:
  - small quantity of wastes per production unit: for instance, in the year 1981, 1071 disposal applications were handled for a total volume of 860 m³, or less than 1 m³ per request on the average,
  - low or very low activity, with a non-negligible proportion of short-lived radionuclides,
  - wide variety of physicochemical properties: non-putrescible solids, putrescible solids, aqueous and organic liquids, solid/liquid mixtures,
  - frequent presence of associated risks such as corrosion, putrescibility, flammability, toxics of biological origin etc,

  concerning the producers themselves:
  - wide geographic dispersion throughout the national territory,
  - general absence of in-house pretreatment, treatment and packaging capacity,
  - low interim storage capacities.

Biomedical waste producers account for a major fraction of this category (see Figure 1).

The very large majority of radionuclides used to label the tracers employed in nuclear medicine display relatively short half-lives (usually less than a few days, or even a few hours), except for radioisotopes such as strontium 89 (51 days), iodine 125 (60 days), strontium 85 (64 days), calcium 45 (164 days), cobalt 57 (270 days), and obviously tritium (12.26 years) and carbon 14 (5730 years).

In the biological field, radioisotopes used in the form of unsealed sources are essentially phosphorus 32 (14.3 days), phosphorus 33 (25 days), sulfur 35 (87.9 days), and, once again, tritium and carbon 14, both in biochemistry and in pharmaceutical research.

From the long-term management standpoint, the problem boils down to taking over wastes which, after a relatively short interim storage period for decay, only exhibit generally very low activity (a few $10^5$ Bq/kg), due exclusively to beta emitters (tritium and carbon 14). This means that radioactivity is not the predominant risk associated with this type of waste, which also exhibits physicochemical and biological characteristics such that condiderable attention must be paid throughout the management process to the risks of corrosion and chemical toxicity, flammability, and even putrescibility and contagion.

## THE WASTES

In the following discussion, the wastes are assigned to categories adapted to the different disposal circuits. Hence the following are encountered:

- solid wastes, non-putrescible, consisting of laboratory wastes (cotton wool, plastics, glassware, syringes, small apparatus) and

safety apparel (overalls, gloves, masks, overshoes etc),

- putrescible solid wastes consisting of animal corpses, litter, and miscellaneous organic materials,
- aqueous liquids,
- organic liquids, generally solvents,
- special wastes consisting of polyethylene and glass bottles a few $cm^3$ in volume, containing liquids for scintillation analysis, based on benzene, xylene, toluene and dodecane, and essentially labelled with tritium and carbon 14.

The volume distribution between the different waste categories is shown in Fig. 2.

With respect to biological risks associated with their radioactive wastes, radioisotope users in the biomedical field classify germs in four main categories.

(a) Non-pathogenic germs, but liable to become pathogenic with time.

(b) Pathogenic germs.

(c) Germs transformed by genetic recombination from pathological human cells.

(d) Labelled germs.

The taking over of the wastes by ANDRA implies prior neutralization of the biological risk, or a presentation of the waste guaranteeing the protection of workers and the environment throughout the disposal process.

## COLLECTION OF BIOMEDICAL RADIOACTIVE WASTES

Biomedical radioactive wastes are treated within the broader framework of wastes generated by small producers, including hospitals, research laboratories and universities.

The management of these wastes is reflected by a handling organization corresponding to a very complete service. The services rendered by ANDRA range from collection of the wastes in the different facilities, grouping in transit areas to form batches which are then transported, in complete loads, to the treatment or disposal installations.

When the activity of the wastes is partly due to the presence of radionuclides with half-lives not exceeding a few weeks, the wastes are stored for decay in a grouping area, or in another interim storage area, and then sent to the appropriate treatment installation.

Specific indications of the biological risk are adopted in all the producing establishments. To guarantee both quality and standardization, the different packings are supplied at the time of collection operations, by the furnishing of an empty packing in exchange for a full packing. The disposal scenario is illustrated in Figure 3. Depending on their physicochemical characteristics, the wastes are packed differently for transport on the public thoroughfare by the Operator responsible for collection.

Solid non-putrescible wastes, which are collected in 100 or 200 liter removable head drums, with sealed lids and internal polyethylene bag linings, can be collected directly in these packings at their production site. If the packages are too bulky, intermediate use is made of 30 to 50 liter peddle-opening trash cans with built-in metal seals, lined with a polyethylene bag, which are only removed when full.

When they are produced, solid putrescible wastes are placed in polyethylene bags smaller than 5 liters, welded after desorption of flammables such as ether. These materials are not recommended for sacrificing the animals due to their inherent fire and explosion hazards. In these bags, the wastes are stored in freezers while awaiting their removal in isothermal 30 to 50 liter packings supplied by the Operator responsible for waste collection.

Wastes consisting of scintillating liquids contained in small bottles, generally a few centiliters in volume, are packed like the solid non-putrescible wastes in metal drums, preferably 200 liters in volume. An additional precaution is observed by the addition of a sufficient quantity of absorbent material in the polyethylene bag lining the drum interior. Whenever possible, these wastes, like all solid wastes destined for incineration, must not not contain halogenated materials, especially fluorinated and chlorinated substances.

Organic liquid wastes, essentially solvents, are collected in 30 liter polyethylene carboys fitted with two handles, or directly in closed head drums (with bung), of the petroleum type, 110 or 220 liters in volume. When carboys are used for collection at the production site, depending on their transport by public thoroughfare, they must either be emptied into closed head drums, or placed in removable head drums lined with a polyethylene bag with absorbent material.

Aqueous liquid wastes, after being made non-putrescible by the addition of suitable additives, are collected and transported in the same types of packing as organic liquids.

Sealed sources are generally recovered in their original packing or equivalent, apart from certain alpha sources, including radium, which must often be repackaged on site in packings to satisfy regulations governing the transport of dangerous materials.

## DISPOSAL OF BIOMEDICAL RADIOACTIVE WASTES

Depending on their physicochemical character, different treatments are applied for the controlled disposal of these wastes:

- compaction and storage in a surface center for non-putrescible solid wastes,
- incineration in 5 kg packages of frozen putrescible wastes,
- industrial incineration of small bottles containing scintillating liquids,
- evaporation or controlled disposal of aqueous liquids,
- incineration of solvents including chlorinated solvents,
- alpha sources are stored temporarily while awaiting subsequent vitrification and deep disposal.

For the special case of radioactive wastes also incurring a biological risk, certain measures are

taken by the producer and in the treatment lines.

At the production site, special attention is paid to the tightness quality of packings, bags, carboys and drums.

For aqueous liquids, the addition of pure Javel water appears to be the simplest, most effective and most economical solution. For organic liquids and solvents with which the biological risk is minimal, the destruction of the risk takes place when the wastes are incinerated. This treatment applies to wastes consisting of small bottles with scintillating liquids.

For non-putrescible solids, suitable pretreatment includes immersion in Javel water for five hours and autoclaving. Failing such pretreatment, the biological risk is eliminated by incineration. For putrescible solids, the ideal treatment is obviously incineration.

These particular rules are summarized in the table in Figure 4.

## PROCEDURE

French regulations governing the protection of workers against the dangers of ionizing radiation outside the nuclear industry require that, when the use of sealed or unsealed sources is definitively suspended, these sources must be removed by an organization approved by Service Central de Protection contre les Rayonnements Ionisants (Central Department for Protection against Ionizing Radiation) of the French Ministry of Health.

Disposal application forms, duly filled in by the producer, are hence centralized by this Department, which then transmits them to ANDRA, which then takes over the disposal process and billings for its services.

## COSTS

The cost structure includes the following:

- collection, grouping, and sorting by category,
- transport in complete loads of a given category to treatment of disposal installations,
- treatment, if applicable,
- final disposal.

The rates applied are nationwide, set with a concern to avoid penalizing the isolated producer located far from the transit centers and treatment facilities.

The table in Figure 5 shows the breakdown of rates charged in 1982.