2007 International Nuclear Atlantic Conference - INAC 2007
Santos, SP, Brazil, September 29 to October 5, 2007
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR – ABEN
ISBN: 978-85-99141-02-1

INITIAL STORAGE OF RADIOACTIVE WASTE AT NUCLEAR MEDICINE SERVICES

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ABSTRACT

In Brazil, radioactive wastes generated at hospitals and Nuclear Medicine Services (NMS) must be placed in a temporary storage, called 'initial storage', until they decay below authorized levels for release or are transferred to an 'intermediate storage'. The volume of wastes generated by the NMS vary accordingly to the category of the service and initial storage times vary typically between a few days and eight months, depending on the radioisotopes present and their initial activity. Some requirements for the safe storage of this type of waste, set forth by CNEN in its regulations, are vague and compliance are sometimes doubtful. In this paper, we discuss some requirements that apply to the storage rooms for radioactive wastes in healthcare facilities in Brazil, giving guidance on how to comply with CNEN's regulations.

1. INTRODUCTION

In Brazil, radioactive wastes generated at hospitals and Nuclear Medicine Services (NMS) must be placed in a temporary storage, called 'initial storage', until they decay below authorized levels for release or are transferred to an 'intermediate storage' in one of the radioactive waste collecting centers of Comissão Nacional de Energia Nuclear (CNEN), the federal agency responsible for radioactive waste management in the country. Usually, 'initial storage', is an isolated room at the premises of the medical center.

Storage times at the initial storage rooms vary typically between a few days and several months, depending on the radioisotopes present and their initial activity, and therefore, the storage must have capacity to accommodate all wastes generated in those periods and must provide radiological safety as well security for the stored materials during the storage term.

The volume of wastes generated by the NMS varies accordingly to the category of the service. The International Atomic Energy Agency classifies NMS in three categories [1]: Class 1 NMS are the smallest, with only one gamma camera and one radioisotope handling room, working only in diagnosis; Class 2 NMS are those with many diagnostic image acquisition systems and handling rooms and with additional rooms for therapy with radioisotopes; Class 3 NMS have capacity similar to Class 2 but also develop scientific research on nuclear medicine and are usually linked to universities.

In the present paper, only NMS of Class 2 are dealt with.

In Class 2 NMS, most radioactive wastes are contaminated with ^{99m}Tc, a radioisotope with 6 hour half-life, that requires about few days to decay below levels at which release is authorized under current rules. However, radionuclides with longer half-lives such as ^{111}In, ^{201}Tl, ^{123}I, and ^{131}I, are used what requires longer decaying times for a significant fraction of the wastes. Table 1 shows the half-lives and typical activities of the radioisotopes currently used in routine examinations in Class 2 NMS. Table 2 shows the volume of wastes generated by three Class 2 NMS of the city of São Paulo.

Table 1 – Radioisotopes used in nuclear medicine services

Radioisotopes	Half-life	Typical activity per procedure (GBq) [2]
^{67}Ga	3.3 d	< 200
^{99m}Tc	6 h	< 100
^{111}In	2.8 d	< 0.05
^{123}I	13.2 h	< 0.5
^{131}I	8.0 d	< 11
^{201}Tl	3.0 d	< 0.2

Table 2 – Radioactive waste generated by NMS in São Paulo

Service	No. of examinations per month	Volume (L)	Weight (kg)
A	300	330	65
B	489	*	145
C	625	450	85
D	2125	13025	1302
E	800	4350	475

* not reported

The radioactive solid waste streams at these facilities usually contain vials, syringes, needles, paper towels, gauze, bandages, drapes, gowns, gloves, bedding, etc. Vials and syringes may contain small amounts of residual liquids.

2. DISCUSSION OF REGULATORY REQUIREMENT

The requirements for the safe management of wastes generated in NMS are set forth in two federal regulations issued by CNEN:

- Management of radioactive wastes in radioactive facilities – CNEN-NE-6.05 [3], and
- Radiation protection and safety requirements for Nuclear Medicine Services – CNEN-NN-3.05 [4].

Some requirements of these regulations are vague and compliance is sometimes doubtful. They are discussed below to provide some guidance on their implementation.

a. Storage space for radioactive waste must be located far from normal working areas:
   Here, the problem is on what CNEN accepts as ‘far’. There were instances, in our experience at IPEN, in which this requirement was interpreted by the Radiation Protection Service as an isolated building, at least some tens of meters distant from the laboratories where the wastes were generated and from other buildings.

   In a NMS, experience shows that the waste storage space should be located as close as possible to the isotope manipulation room, to avoid frequent transportation of waste packages through crowded passageways in hospitals.

   Consequently, ‘far from normal working areas’ should be interpreted here as an exclusive locked room for storage of wastes, preferably next to the manipulation room, access to which is restricted to authorized personnel only. Additional aspects must be observed such as shielding, containment, and ventilation.

b. The storage capacity must be sufficient to accommodate all wastes generated during the decay period.

   The storage capacity depends on the size of the NMS, i.e. number of procedures realized daily, and on half-life of the radioisotopes – longer half-lives require longer decay periods. Experience shows that storage capacity in Class 2 NMS varies between two and five square meters, but larger rooms may be required depending on specific demands of a particular NMS.

c. The storage room must provide security for the wastes.

   This requirement is intended to prevent inadvertent or intentional withdrawal of any contaminated part of the wastes by people searching for usable goods. Examples of materials that could have potential to attract this kind of action in the radioactive waste storage of a NMS are packages and lead castles.

   However, the radiological risk associated with theses wastes are not too high nor the potential to be target to stealing is high enough to justify the investment in security officers or alarm systems and video cameras. Locked doors and signs of radiological risk will suffice.

d. The floor and walls of the storage room must be coated with easily decontaminable, nonporous surfaces.

   This requirement points to the use of some seamless poured epoxy floor coating and an epoxy or acrylic polymer paint for the walls. Epoxy floor coatings are widely used in the industry and health care facilities. Epoxy floor coatings have mechanical resistance to shocks and abrasion, provide non-porous, seamless and smooth surfaces that are chemically resistant to most acids, alkalis and organic solvents. Nevertheless, CNEN has licensed NMS with vinyl tiles flooring and ceramic wall tiles. Vinyl tiles are commonly used for interior flooring in commercial buildings in Brazil, including hospitals, but they are particularly difficult to decontaminate in the seams.

e. The storage room shall have features that help avoiding dispersion of the wastes by animals.

   Rodents, pigeons, cockroaches, termites and the like are the sort of animals that can cause problems, according to our experience in radioactive waste storage. Damaged packages that cause local contamination is the main danger with animals in the storage room. The impact of any contamination transported outside the storage is too small to deserve more attention. So, the intent of the requirement, as should be its wording, is to avoid intrusion of animals into the storage rather than avoiding them to disperse the wastes after having contact with the wastes. Although the radioactive wastes in a NMS are not particularly attractive to most of those pests and storage rooms are usually sited in clean areas, to dismiss this precaution can cause problems of contamination in the storage room.

f. The storage room shall have ventilation, exhaust and filtration system.

   Radioactive wastes from NMS can produce gases and aerosols, mainly in services where radioiodine is used in diagnostic or therapeutic procedures. The CNEN's regulations require that the storage room be fitted out with an exhaust and filtration system. However, NMS visited in connection with this research were licensed without these features. It seems that this requirement is not always necessary and that the enforcement is left to discretion of the official in charge of analyzing the license submissions and inspectors.

The last question raised here is that of fire protection in the radioactive waste storage room. It is not foreseen in the waste regulation except, perhaps, indirectly, in the item that requires that the facility have an emergency preparedness plan. This point is discussed below.

g. The facility shall have an emergency preparedness plan.

   In respect to fire protection, it can not be precluded that a fire evolves in the stored wastes. So, fire extinguishers must be select carefully. Class A extinguishers are for ordinary combustible materials such as paper, wood, cardboard, and most plastics, materials that will certainly be present in the waste storage and probably involved in the fire. For Class A, fire brigades recommend water extinguishers and air-pressurized water extinguishers or dry chemical extinguishers, filled with sodium bicarbonate, potassium bicarbonate, or monoammonium phosphate. However, water extinguishers are not recommended for a radioactive waste storage because they can further damage packages and spread contamination. Dry chemical extinguishers are not recommended too because they leave residues that can make it hard to decontaminate the place. On the other hand, Carbon Dioxide (CO_2) extinguishers, containing highly pressurized carbon dioxide, that are not usually recommended for class A fires because are not able to displace enough oxygen to put the fire out, causing it to re-ignite, should be considered here because leave no residues, do not damage packages and can be effective in putting the fire out if the storage room is an enclosed and limited space. This point merits a discussion with fire department officials in the licensing process of the facility.

3. CONCLUSIONS

Many other aspects of the regulations could be discussed here too but it is clear from the above examples that a thorough reading of the Brazilian regulations applied to radioactive waste storage facilities is not enough to – and do not guarantee success in – designing, constructing, licensing, and starting up the facility according to accepted practices. Differences between what is written down in the regulations and what is actually done at licensed installations shows that enforcement of some vague and doubtful requirements are left to the discretion of CNEN officials during the licensing process. This is further confirmed by the lack of a published standard format and review plan which could guide applicants in designing the facilities and providing the necessary information in application forms to justify their choices before the regulatory body.

The aspects of CNEN requirements that are discussed above can give some insight into what features should a storage room for radioactive wastes have in order to be well designed and safely operated, complying with regulations and good practices.

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