STATUS OF RADIOACTIVE WASTE MANAGEMENT AND DISPOSAL IN BRAZIL

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ABSTRACT

An important condition to attend the energy demand of the next millenium is certainly the expansion of electricity generation from nuclear power plants and consequently to have a complete control of the nuclear fuel cycle. A quite important branch of this cycle is played by the management of radioactive wastes.

In Brazil the principal objectives of radioactive waste management are to assure that workers and the public are not harmed now or in the future by the effects of radiation from the wastes, that the environment is not adversely affected, and that the finantial cost of handling and disposing of wastes is not excessive. An additional goal is to make sure that public concerns about waste generation and disposal do not foreclose the nation's option to utilize the benefits of nuclear energy for electric power or for radiation applications in medicine, research and industry.

In Brazil there are one nuclear power plant in operation(626 MWe); mining and milling industry; a fuel fabrication plant; some accelerators and about 2000 institutions (medicine, industry, agriculture, research centers etc) widespread through out the country utilizing radionuclides on a large scale. There is not yet an operating final repository to receive the radioactive waste produced in the country. Instead, all radioactive wastes produced must be treated in such a way that:

- the volume of the waste is minimized as much as possible
- the handling and treatment of wastes are carried out with due regard to environmental considerations
- the radioactive materials are immobilized for storage over long periods safely and preventing them to reenter man's environment
- wastes are immobilized and stored safely for as long as necessary pending the development of disposal facilities

Discussions are made concerning the brazilian policy and the research and development program undertaked by Instituto de Pesquisas Energéticas e Nucleares (IPEN), at São Paulo to the treatment and conditioning of nuclear wastes.

INTRODUCTION

Production of radioisotopes for medical and industrial purposes as well studies in reactor physics, nuclear physics etc and personnel training was initiated in Brazil in the mid-fifties using the experimental swimming pool reactor IEAR-1-5MW located in São Paulo.

The quantity of liquid and solid radioactive waste resulting from those activities were rather small. No special waste treatment method was used since most of the waste involved radioisotopes with relatively short half-lives. After a short storage period most liquid and solid wastes could be released directly into the environment without any harm to the public or environment. After the installation of the brazilian nuclear power program and the increase in the use of radioisotopes in industry, medicine and other fields and with the responsibility of protect public health and ensure safety it was created a brazilian regulation covering all aspects of the use of radioactive materials either from the nuclear fuel cycle as well from the nuclear activities resulting from non nuclear fuel cycle.

In Brazil the main sources of radioactive wastes belong to the category of low-level wastes (LLW) and only in few cases intermediate-level wastes (ILW).

As until the moment there is not a permanent site to receive the radioactive waste produced in the country, the LLW and ILW must be treated and stored, in appropriated ways, under the supervision of CNEN, by the producers or sent to IPEN which is in charge of receive those wastes when the radioisotope utilizer does not have ways to do it.

CLASSIFICATION OF WASTES

The official classification of wastes in Brazil is originated from the IAEA Standards and is entitled "Gerência de Rejeitos Radioativos em Instalações Radioativas - CNEN-NE-6.05-Nov/1985". The classification is based on health and safety requirements according to pratical experiences at waste treatment plants from other countries and applies to existing national and international regulations for the safe transport of radioactive materials.

The wastes are classified according to their physical state, radiation nature, concentration and exposure rate.

Primarily the wastes are classified on the basis of their physical state of aggregation i.e.

- liquid waste
- solid waste
- gaseous waste

Another very important distinction is the presence or absence of alpha emitters in the waste stream. According to this classification a more appropriate treatment method can be assigned to the waste. In addition to those classifications there is another more detailed classification on the basis of radiological properties of wastes.

For liquid and gaseous wastes this classification is characterized by their specific activity while for solid wastes the classification is based on the exposure rate. The classification used in Brazil for solid, liquid and gaseous wastes according to their radiation contents are presented in Table I.

The elimination of certain amounts of wastes from any installation is conditioned to particular authorization to be obtained from the National Commission of Nuclear Energy. The upper limit for the specific activity of solid wastes permited to be disposed in the urban collection system is 74 Bq/g (2 nCi/g) while for liquid and gaseous wastes allowed to be eliminated in sewage or atmosphere a specific table containing those informations for each radionuclide is provided in the regulation.

According to these regulation persons engaged in activities utilizing radioactive materials must provide complete informations and technical data on training, personnel experience, safety procedures, operation system of interim storage, disposal of efluents and detailed analysis of this proposed operation.

The applicant to use of radioisotopes may request to CNEN for specific approval of proposed procedure to dispose of licensed radioactive material in a manner other than as generaly authorized in the regulation. If necessary, meetings are held between the CNEN staff and the applicant staff in order to solve specific questions.

To assure compliance with the approved conditions all licensees are subject to periodic inspection. Radioactive waste, which is not more possible to be under responsibility of the applicant are collected by the CNEN inspectors and sent to IPEN for the necessary treatment, conditioning and intermediate storage.

RADIOACTIVE WASTES IN BRAZIL

For wastes coming from the nuclear fuel cycle great emphasis is given for volume reduction while for those from industry, medicine and research outside the nuclear fuel cycle the volume reduction is not so critical because the volumes generated are so small that they do not justify the investment in a volume reduction facility except when they are sent for treatment in institutions which possess such facilities.

Low-level waste includes solid and liquid wastes which may be slightly contaminated with traces of radioactive materials. Examples are worn-out or damaged equipments, crushed glassware and protective clothing from research laboratories, air filters, chemicals used to treat low-level radioactive liquids before discharge into the environment, and ash from the burning of the low-level combustible wastes.

Very low-level liquid and gaseous wastes can be diluted and discharged into the environment with negligible risk to the public. These discharges are controled by strict regulations covering their maximum permissible radioactive content. Besides, the radioactivity associated with LLW and some ILW is dominated by short-lived species.

ILW covers solid and liquid materials from the nuclear power stations and the radioisotope industry. This category includes fuel cladding, used reactor components and equipment, gas filters, and the sludges and resins used in effluent treatment systems.

The wastes arising from the application of radioisotopes in medical and biomedical research fields as well in the clinical area, together with the wastes resulting from the application of radioactive material in industrial processes are treated as follow:

- for short half-lived radionuclides, the majority originated from medical and research institutions is employed a decay treatment method followed of disposal by release to the sanitary sewage.
- solid wastes contaminated by traces of short-lived radioisotopes with a specific activity not exceeding 74 Bq/g (2 nCi/g) can be sent to a municipal refuse disposal plant.
- the excretion (faeces, urine, vomite) of patients who have received therapeutic doses in excess of 555 MBq (15 mCi) has to be collected in bags and, after decay, emptied into a sink for excreta.
- sources of radiotherapy must be returned to the country of origin as well the sources used in sterilization.

- those sources generally used in industrial equipments as for foil thickness measurements, level detection, gauging, quality control, smoke detectors etc are generally sent to IPEN for treatment.
- exausted ^{60}Co or ^{192}Ir sources mostly used in non-destructive testing are sent also to IPEN for recovery or conditioning.

The operation of nuclear power plants does not produce excessive amounts of waste if one considers the total fuel cycle; most of the waste produced by them fall exclusively under the low and intermediate level waste categories. In spite of this in Brazil the nuclear power plant Angra I is the most important waste source.

Until now only contaminated trash, packaged in 200 L drums were generated in the fuel fabrication plant. At moment there are only four drums at the interim storage area in the facility.

WASTE MANAGEMENT AT NUCLEAR AND ENERGY RESEARCH INSTITUTE (IPEN)

As a consequence of the small amount of waste generate till recently in Brazil, the function of waste management at IPEN was performed mostly by the health physics personnel. After 1983 a Department was established with the following functions:
- to process and treat all kind of waste generated by IPEN and from some smaller producers
- to develop new processes or implement processes for treatment of all kinds of radwastes produced in Brazil
- to realize an extensive research, development and demonstration program, RD&D, in the field of radioactive waste treatment and disposal.

That department has two branches:one responsible for the treatment, conditioning, transport and interim storage and the other responsible for the RD&D program devoted to make available the techniques for the treatment of all kinds of waste as well to implement a quality assurance program and realize some activities in the field of waste disposal.

The radwaste generated at the institute as well the waste received from medical applications, industry or other institutions are treated at IPEN using either compaction, cementation , incineration or any other technique specially developed for the specific waste.

The solid waste produced at IPEN or arriving from other institutions is mostly reduced in volume by simple compacting directly in the waste drums with a press strength of 10 ton. Although compaction results in average volume reduction factors of only 4:1 it is characterized by low operating costs.

A small parcel of non compactible long lived wastes are also produced and received for treatment. These wastes usually are put in 200 L drums and immobilized by pouring cement paste into the voids.

A relatively long list of sealed radioactive sources is usually sent to IPEN for treatment. Usually the sources are immobilized in concreted drums with their original container. For those gaseous or radium sources specially developed packages were prepared.

A system for incinerating combustible solid wastes has been developed in order to achieve higher mass and volume reduction of the wastes generated at IPEN or received from other institutions. The facility is not yet in normal operation due to some drastic changes in the off-gas system intended to eliminate some flaws. It is expected that it can be operating by the end of this year.

Limited volumes of liquid wastes containing small quantities of radionuclides are produced at IPEN as a result of research or radioisotope production activities. This reduced volume of liquid wastes results from the optimization of processes in order to keep to a minimum the wastes generated. Even more, since most of the radioisotopes handled at IPEN are short-lived the delay and decay technique is still valid.

As cementation was considered a reliable process for immobilization of several waste streams in Brazil some effort has been devoted to establish criteria to control the quality of waste forms. The parameters considered for quality control of the immobilized waste were+ homogeneity, salt content, compressive strength, setting time, leaching rate, porosity, radiation damage, thermal conductivity etc. It was considered also the addition of special additives to improve the degree of fixation and the mechanical properties of the solidified products.

Some studies are been realized in cooperation with CNEN to establish criteria for the land disposal of LLW and ILW.Laboratory measurements of radionuclide sorption and migration by using batch and column techniques are in progress in order to support the studies for site selection.

Special developed concrete packages for final disposal are being studied concerning its long term integrity.