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THE WASTE MANAGEMENT EXPERIENCE AT THE CENTRO DE DESENVOLVIMENTO DA TECNOLOGIA NUCLEAR

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1. INTRODUCTION

Radioactive waste is generated from R&D activities of nuclear science and technology, from different applications in medicine, agriculture, industries and in generation of electricity. Radioactive waste can also come from the processing of raw matrials that contain naturally occurring radionuclides. Like other human activities, these practice produce waste that requires management to ensure the protection of human health and the environment, and to limit the burden on future generations.

In several laboratories and pilot plants at the Centro de Desenvolvimento da Tecnologia Nuclear - CDTN - Brazil, generated low level solid and liquid radioactive wastes coming from nuclear fuel cycle activities, radioisotopes application, R&D and routine works. CDTN also receives spent sources from radioisotopes users. These wastes are effectively and systematically managed to achieve the safe radioactive management requirements. This paper presents an overview of the waste management at the CDTN, some results of research and development tasks and the technical support given to the community, as well as dealing with the emergency caused by the radiological accident that occurred in Goiânia.

2. CDTN WASTE MANAGEMENT STRATEGY

Low level solid and liquid wastes are generated in several laboratories and pilot plants at the Centro de Desenvolvimento da Tecnologia Nuclear - CDTN. As support to the community, CDTN also collects spent sources, smoke detectors, lightning rods and Ra-needles for further treatment. CDTN waste management strategy (Figure 1) is based on the Brazilian standards and the infrastructure available at the Center such as results from R&D, developed treatment processes, equipment and installations and supporting laboratories.

All contaminated material is segregated at its origin according to the physical-chemical and radiological characteristics. These types of wastes are mainly contaminated liquid solutions and solid materials. The liquid waste is collected separately, as aqueous and organic wastes. The solid waste is segregated as compactable and non-compactable. After the collection, all data applicable to the waste, like its origin, composition, volume, weight, chemical and radiological contaminants and exposure rates are recorded in a data bank. After monitoring and classification, radioactive waste is stored for further treatment.

Non-compactable waste such as rubbish and scrap are immobilized in a cement and bentonite matrix. The damaged contaminated polyethylene flasks and the small irradiation flasks are reduced in volume by a 130 kg/h throughput shredder. Compactable waste is directly pressed in 200 l drums using a 16,000 kgf compactor. Non-reusable spent sources are stored for further treatment. They will be conditioned in qualified packagings and immobilized in a cement matrix according to the kind of source, its activity and physical condition. Smoke detectors and lightning rods will be dismantled and the source will be conditioned. The liquid aqueous waste is treated by chemical precipitation. The radionuclides are concentrated in an insoluble form, reducing greatly the activity of the overflow that is released according to the standards. The sludge is cemented. The organic waste is absorbed in vermiculite and also cemented. For the cemented waste product, quality control samples are taken. The liquid effluent from the

laboratories is collected in tanks, analyzed and discharged according to the release limits, otherwise the dilution is carried out.

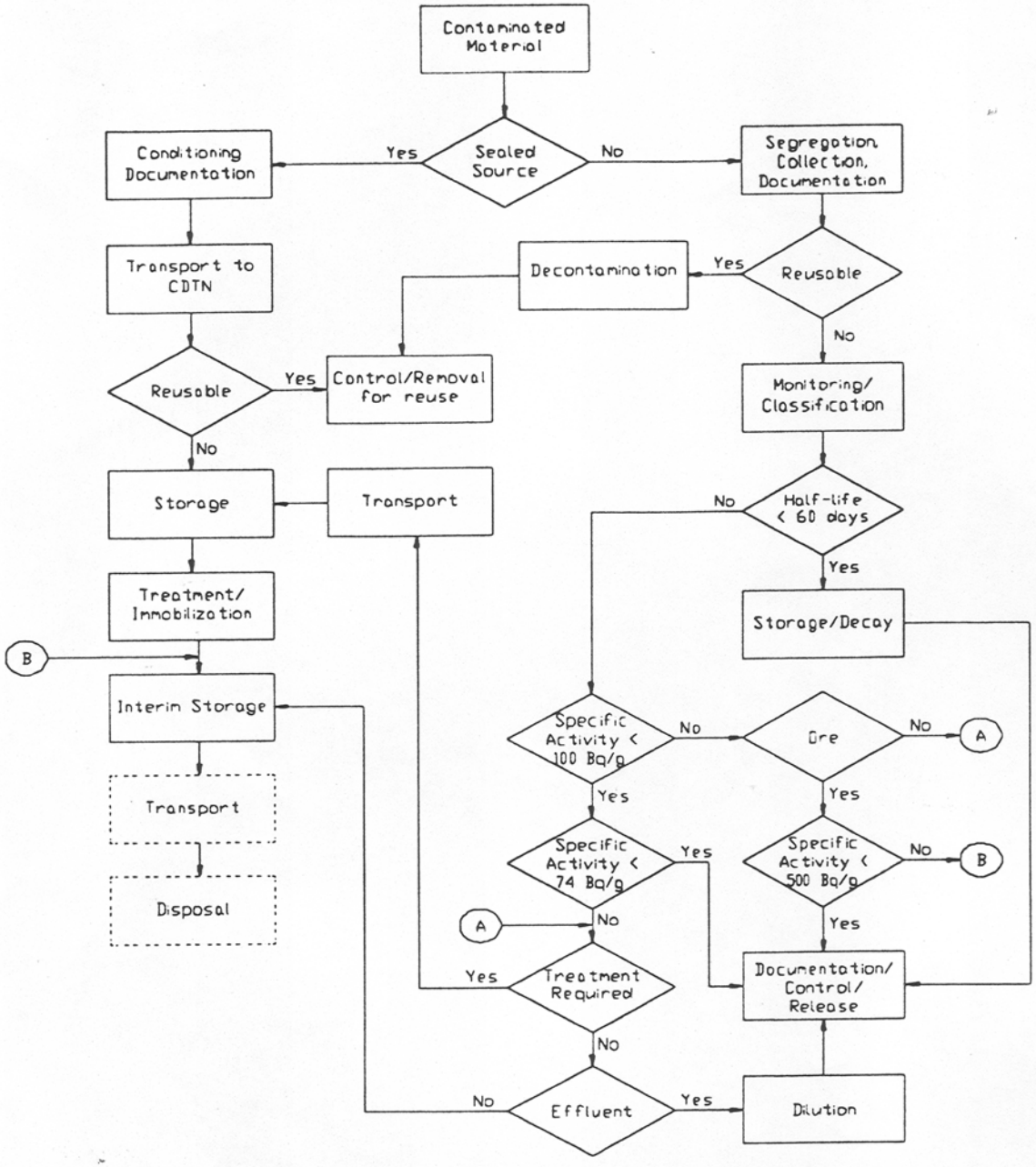

Fig 1 - Waste Management Strategy at the Centro de Desenvolvimento da Tecnologia Nuclear

3. RESEARCH AND DEVELOPMENT PROGRAMME

3.1 Immobilization

The immobilization process is based on the technology where the waste is fixed in a matrix and the obtained final product is a solid that presents good impermeability and restance characteristics. minimizing the contamination risks and is suitable for disposal. Research and development works for cementation and bituminization of wastes generated from the nuclear plants operation and radioisotopes

applications are carried out at the Center. The results from both studies are helpful to choose a more suitable process for a specific waste. They are also useful to give support to the nuclear power plants Angra I and Angra II or to the regulatory bodies on the establishment of the waste acceptance criteria.

Cementation - The cementation R&D works include the investigation of different kinds of matrix, equipment and methodologies in order to have a more efficient process and high quality products, the establishment of process control and procedures and tests for immobilized product characterization, the evaluation of the cement-waste compatibility and the establishment of cementation parameters in the real scale. To support these works there is a cementation laboratory and a 200 l batch cementation plant. Several Brazilian natural clays are evaluated, specially bentonite, vermiculite, kaolin and serpentine. Experiments were carried out with active and inactive wastes. The obtained results are applied to solve the CDTN waste cementation problems. Additionally, experiments with 3 types of chemical additives (retarding, accelerator and fluidization agents from different manufacturers) are in progress.

The investigation of different parameters that influence the final cemented products was done specially with the aim to solve Goiânia's accident waste problems. The developed methodology is also applied to treat hazardous wastes. Experiments were performed to evaluate the heavy metals retention in a cement/clay matrix. Some results showed that, using clays, the retention is higher than 99 % and the leached amount is lower than those recommended by environmental standards.

Bituminization - The investigation of bitumen product acceptance criteria is based on Brazilian hot climate conditions. For the first approach, Brazilian bitumen of a softening point in the range of 80-100^{o} C and penetration of 10-20 (1/10mm) were selected. Experiments with simulated evaporator concentrates which solid content incorporation varied from 27-40 wt % were performed. Product parameters such as softening point, flash point, penetration, water content, grain size/homogeneity, swelling and leaching were investigated. Experiments with simulated spent resins, loaded with lithium and boric acid, in bitumen were carried. The range of incorporated resins varied from 33-48 wt %, the product softening point from 113-124^{o} C, flash point from 205-224^{o} C and penetration around 0.4 mm. The water content in the product was less than 2 %. The leaching rate of borate and lithium ions was around 5.0 x 10^{-9} m/s and 1.0 x 10^{-10} m/s respectively for the anion and cation exchange resins incorporated in the bitumen. The swelling of the product was in the range of 10-30 %. The products appear to be in good physical condition after a year of leaching tests. The distribution of mixed resins in the bitumen phase and micro-structure of resin-bitumen products have been investigated by microscope. These experiments were performed by a pilot plant extruder with 1 kg/h product and 3-4 kg/h condensate throughput.

3.2 Packagings for radioactive material.

Since 1982 CDTN has designed, tested and qualified Type A packagings for radioactive materials. These packagings are used for the transport of radioisotopes, spent sealed sources and wastes from the nuclear fuel cycle, radioisotopes users and those generated during the radiological accident in Goiânia. For this purpose, facilities and equipment were developed, qualifying the Center as the Brazilian official packaging testing institute. Studies are done in order to create capability in qualifying intermediate and high level radioactive materials, using finite element computer codes for thermal-structural analysis and shielding calculations. This program has the aim to give support to the storage of spent fuels from Angra I NPP and solve the problems from the conditioning of higher activity spent sources. All the gained experiences can be also applied to deal with problems related to the transportation of hazardous/chemical materials that is very critical in Brazil.

In order to evaluate the durability of commercial drums, from two different manufactures, used for low and intermediate level wastes conditioning, CDTN has carried out a program since 1983. The results obtained show that the tested drums are not suitable for open storage, since they failed after an 8-year storage period. In the second phase of the study, one type of drum was tested. The purpose was to evaluate the long term influence of both the environment, externally, and the waste internally, upon the drums. This program has a duration of five years.

3.3 Repository safety assessment

Since November 1993, a multi-disciplinary group at CDTN was formed to deal with repositories safety assessment. This group is from different areas such as those with knowledge in source term, ground water flow, hydrology and dosimetry. The studies are conducted in an interactive manner by starting simple, and followed by calculations using computer codes. Experimental works will be determined along the studies. The purpose of this work is to create a national capability, within the three different Brazilian institutions in safety assessment analysis. All results applicable to waste characterization, packagings and backfill can be applied for this purpose.

3.4 Hazardous waste

At the Center a large amount of chemical/hazardous material is generated. The experience gained in the radioactive waste management is used to manage these hazardous wastes. After the waste qualification and quantification, a hazardous waste management program will be implemented. The strategy includes waste collection, recycling through a stock exchange data base and treatment for a safe storage. The developed methodology can also be extended to other institutions.

4. CONCLUSION

Based on experiences accumulated in R&D work and CDTN waste management, the Center was able to provide assistance and technical support to the fuel cycle industries, radioisotope users, hazardous waste management, as well as dealing with the emergency caused by the radiological accident that occurred in Goiânia. Studies were done to characterize the effluent stream from a monazite processing industry, establishment of the liquid waste treatment process for an uranium enrichment plant. Establishment of the waste management program for the nuclear fuel element manufacturing plant. evaluation of leaching resistance of cemented wastes from Angra I, establishment of procedures of the cementation process and obtained product qualification generated in hot cells and evaluation of packagings for the transport of non-irradiated fuel elements were carried out. Medical and industrial radioisotopes packagings were also tested and qualified.

The main important feature is that the gained experience allowed participation on the Goiânia radiological accident waste management in 1987. The staff worked on the establishment of the general planning, and the strategy adopted for these wastes management, definition of specific procedures and the identification of the short term available infrastructure such as packagings, treatment processes, definition and operation of the interim storage and also the decontamination works. Until now there is participation on the establishment of strategies for a safe interim and final disposal, definition and design of reconditioning packagings and the composition of the backfill for the drums immobilization and operation of the first Goiânia's waste repository. Support has also been given to several incidental situations with unsealed sources.

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