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WASTE MANAGEMENT IN THE GOIANIA ACCIDENT - CONTRIBUTION OF THE WASTE TREATMENT DIVISION OF THE NUCLEAR TECHNOLOGY DEVELOPMENT CENTER

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ABSTRACT

Radioactive wastes were generated in Goiania, Brazil, by an accidental breakage of a cesium 137 radiotherapy source (50.9 TBq) in September 1987. The Divisão de Tratamento de Rejeitos Radioativos (Waste Treatment Division) of the Centro de Desenvolvimento da Tecnologia Nuclear - CDTN (Nuclear Technology Development Center) was requested to perform tasks on the general planning, establishment of waste management and specific procedures, identification of national infrastructure, installation of treatment systems, decontamination of the critical areas and operation of the interim storage. Of great value were the experience of the staff on waste management and the results obtained from R&D carried out by the Division.

1. INTRODUCTION

A vast amount of radioactive contaminated material was generated in Goiania, Brazil in September 1987, by an accidental breakage of a cesium 137 radiotherapy source (50.9 TBq). It has given rise to an unprecedented health risk to the population in the area and created an unusual radioactive decontamination problem.

Upon the request of the Comissão Nacional de Energia Nuclear - CNEN (National Nuclear Energy Commission), the Divisão de Tratamento de Rejeitos Radioativos (Waste Treatment Division) of the Centro de Desenvolvimento da Tecnologia Nuclear - CDTN (Nuclear Technology Development Center) participated in general planning, establishment of waste management and specific procedures, identification of the available infrastructure in Brazil, installation of waste treatment systems, decontamination of the critical areas, and operation of the interim storage. The main objectives were to decontaminate the areas, and to obtain waste products that would best meet the transportation and storage criteria set by the standards of Comissão Nacional de Energia Nuclear, considering the limitations in Brazilian infrastructure. All the tasks were performed under CNEN supervision.

The experiences gathered by the Division has enabled its staff to provide an efficient and prompt assistance in Goiania. The main R&D programs carried out by the Division is comprised of the CDTN's waste management, development and operation of different waste treatment facilities, qualification of final waste products, development and testing of packages for storage, and transportation of radioactive materials [1].

2. EXPERIENCES OF THE WASTE TREATMENT DIVISION USED IN GOIANIA

2.1. Waste Management

Based on the infrastructure available in Brazil, the following waste management strategy was suggested:

. to segregate the waste as far as possible;
. to condition/treat the waste according to its type and activity and packages available;
. to obtain final products suitable for transportation and storage.

These measures were all very important, mainly on account of the uncertainties of further treatment and of the characteristics and location of the repository. The factors associated to the quality of the final product would influence the cost-benefit analysis and the impact on the environment.

A waste control form was specially adopted, based on CDTN experience, to record all the information related to the conditioned waste. These data made the inventory estimation possible. The block diagram (Fig. 1) shows the steps on decontamination and the responsibilities of the different groups involved in the process.

2.2. Packages

The characteristics and location of the repository are very important in establishing the criteria that must be adopted for conditioning the waste. The decision for a transitory storage implies having suitable products for transportation to the final disposal.

Considering the packages available in Brazil within a short term, three types were selected:

. 200 liter drums tested and qualified for low specific activity waste, having good corrosion resistance, and available commercially. All the drums were inspected according to procedures established for their acceptance.
. Metallic containers tested, qualified and designed by FURNAS (utility owner of Angra N.P.Ps.) for contaminated steel components. This design was adapted to Goiania's waste conditions. Local industries manufactured the containers under technical supervision of the waste treatment staff.
. One-way concrete containers (shielding), type A, from FURNAS. By that time they were only preliminarily tested for qualification.

2.3. The use of Brazilian bentonite

To improve the quality of solidified wastes, Brazilian additives has been investigated since 1980 at the Waste Treatment Division. Experimental work using bentonites for cementation of simulated wastes containing Cs 137 had presented good results. These data provided the establishment of some cementation parameters using bentonites for cesium retention. Under Goiania's conditions, the obtained products presented low leaching rate without jeopardizing their mechanical resistance.

2.4. Conditioning of contaminated animal carcasses

During the accident, there were a lot of contaminated animals which had to be sacrificed and conditioned as waste. Veterinary

professors suggested injecting formalin solution into the killed animals to avoid the generation and release of gases during biological degradation. Afterwards all these animal carcasses had to be immobilized using lime and charcoal.

2.5. Treatment of contaminated urine

It was planned to treat contaminated urine as waste. Several tests were performed at the CDTN in order to establish a decontamination method for such material. Chemical precipitation was the chosen process, based on the Division´s experience in this field, its simplicity, and its relatively low cost. By this means, the obtained slurry could easily be cemented. This process is also applicable to other generated liquid wastes. The method was tested with nitric acid and nickel ferrocyanate according to predeterminated operational conditions. The decontamination factor attained was about 97% .

2.6. Treatment systems

2.6.1. Compaction system

A great amount of solid waste was generated during the decontamination works and its volume could be reduced by compaction. A CDTN compactor press was transported to Goiania for this purpose. It was installed at Estadio Olimpico and a filtration system for contaminated aerosol retention was coupled to it.

2.6.2. Cementation System

On account of the unusual conditions of the accident it was impossible to install a radioactive waste cementation system in Goiania. A simple one was tested using a conventional concrete mixer that could easily be adapted to the actual situation. Some parameters such as mixing speed, residence time associated to the setting time were determined. The mixer capacity, performance, and its installation under radiological and operational conditions were evaluated.

3. DECONTAMINATION TASKS

The CDTN staff has worked on decontamination of all critical areas and in the storage facility. The name of the places mentioned below were given by the local people.

3.1 Estadio Olimpico (Olympic Stadium)

The first contaminated persons were isolated in the Estadio Olimpico. This place was also used to monitor the population. Until the establishment of the interim storage, collected wastes, including part of the source shielding, have been sent to the

Stadium. The compactable solid wastes were baled in 200 liter drums and the non-compactable ones were conditioned.

3.2. Ferro Velho I (Junkyard I)

The Ferro Velho I, located on 26-A Street was the name given to an old scrap yard. The area was about 800m², with some houses and a workshop. The contamination was caused by the disassembling of a piece of the capsule of the cesium source. Ferro Velho I was the first place where all the infrastructure was set-up, such as the lay-out of the control area, specification of the equipment and conditioning systems, and the logistics needed. All the measures applied were useful for the decontamination of other areas. The waste of Ferro Velho I consisted of compacted waste papers, rubbish, equipment, soil, domestic utensils, furniture, clothes and some left over food. The first decontamination step was the removal of high exposure rate wastes, which were conditioned in concrete containers.

3.3. Ferro Velho III (Junkyard III)

The Ferro Velho III was a covered junkyard for non-ferrous metals. It was located on P-19 Street with an area of about 400m². It has received all the scraps from other junkyards. The contamination had spread because of the manipulation of a piece of source shielding. It was verified that the main operational problem was related to the incorporation of contaminated dust but not to the exposure of the workers. The wastes consisted of cables, rubbish, metals, batteries, tools, a balance and two trucks. The waste volume reduction was done by using an acetylene cutting torch and an electric blade saw, followed by conditioning.

3.4. Rua 57 (57th Street)

The source was broken in the backyard of a house on 57th Street and the radioactive material spread out, contaminating persons, personal objects, furnitures, domestic utensils, animals, houses, soil, trees, and plants. During the emergency phase the more active waste had been collected in packages that later needed new conditioning in order to assure their transportation to the storage. A great amount of soil was removed and conditioned in metallic packages.

3.5. COPEL - Comercio de Aparas de Papel Ltda

COPEL is a company located in Goiania that deals with waste papers for recycling which are distributed to different regions of Brazil. Waste papers come from industries, banks, junkyards, etc. and are compacted and tied into 200 kg bales. COPEL has many storage places in the city and the biggest one is located in the district of Santa Genoveva on 21st Street. Probably the main contamination came from waste paper handling at Ferro Velho I and

was spread to the whole storage area, stackers, backyard, and trucks. The compacted waste paper bales were wrapped in plastic and conditioned in shipping containers; while rubbish, soil and scrap were conditioned in drums and metallic containers. After the decontamination, the floor of the storage was covered with a new concrete layer, and the ground of the backyard was filled with uncontaminated soil.

3.6. Casa da Fossa

"Casa da Fossa" was the name given to the house located on 17-A Street, where some source fragments were thrown out into the sewage. The contamination scattered from the sewage pipe into the soil. The soil was removed and conditioned in metallic containers and the area was refilled with stone and sand.

3.7. Residences

"Residences" was the name given to contaminated properties such as houses, workshops, bars, etc. detected by the group called "Denuncias e Buscas" (Denouncement and Search). The contamination was disseminated by persons and animals. For the decontamination work, the area was checked over and, if necessary, residents were removed from the area. The procedure consisted of decontamination of the structural parts and removal of dust from walls, floors, furnitures, etc. Contaminated objects were conditioned in plastic bags and then in drums or metallic containers. Surface chemical decontamination was applied, whenever possible. In some places, contaminated animals were found, such as dogs, pigs, rabbits, and birds. They were sacrificed and conditioned in drums with charcoal and lime.

4. WASTE IMOBILIZATION

In Goiania, the most active wastes were collected in drums and conditioned in concrete packages using mortar and concrete with bentonite. Drums containing organic material and/or with corrosion pits were conditioned in metallic containers previously prepared with a concrete layer at the bottom. Afterwards, the voids were filled with the same mixture. The liquid generated during the decontamination work was treated by chemical a precipitation process and the resulting slurry was solidified with cement and bentonite.

5. TRANSPORTATION AND STORAGE

Before the trucks were loaded for transportation, the waste packages were decontaminated, monitored, and identified. A special control form was filled up with all available information. Each transport was accompanied by radiation protection and waste

treatment supervisors.

6. WASTE STORAGE FACILITY IN ABADIA DE GOIANIA

The interim storage was specially constructed to receive waste generated during the decontamination work. It is located in Abadia, about 30 km from downtown Goiania. The facility, which is highly protected and guarded, constituted of a waste storage area, a control and utilities house and a natural dam. The storage area itself has six concrete platforms in a modular arrangement, and each one has 64 bases and six effluent control systems. Each base has the capacity of upto 32 drums or 8 metallic containers (storage in two decks). The packages were arranged in such a way that those with higher exposure rates were placed in the center of the base. The position of each one was recorded in a special form, through this, it is possible to get information about any package at any time.

7. GENERAL COMMENTS

The Waste Treatment R&D Program developed at CDTN and the experience from the Waste Treatment Division staff were very helpful and strongly contributed to the different tasks performed at Goiania. This Division is responsible for the waste management of the Center and for the development of waste treatment processes, with the purpose of obtaining a waste product suitable for transportation and storage. In this context, package projects were developed and qualification tests were performed.

Considering the emergency situation caused by the accident, parts of established procedures were not applied, specially those related to the waste segregation and conditioning. As a consequence, a substantial amount of uncontamined material was collected and conditioned.

Another aspect that has to be considered is the quality of the final product: the collected material was very heterogeneous and the quality control of the manufacturing of the packages was not efficient enough. This aspect is important for the future projects that should be developed for Abadia storage, with regards to the final disposal of the waste.

It was learned from the accident that the population must be aware of the risks involved in handling radioactive material. It is also important to have an adequate infrastructure and a well trained staff ready to conduct and to intervene efficiently in cases of emergency.

REFERENCE

[1] MIAW, S.T.W., KRAUSE, H., Status Report on the Waste Management Cooperation Programme Jointly Undertaken by KfK/INE-NUCLEBRAS/CDTN, Rep. KfK 4360, NUCLEBRAS/CDTN 594, Centro de Desenvolvimento da Tecnologia Nuclear, Belo Horizonte (1988).

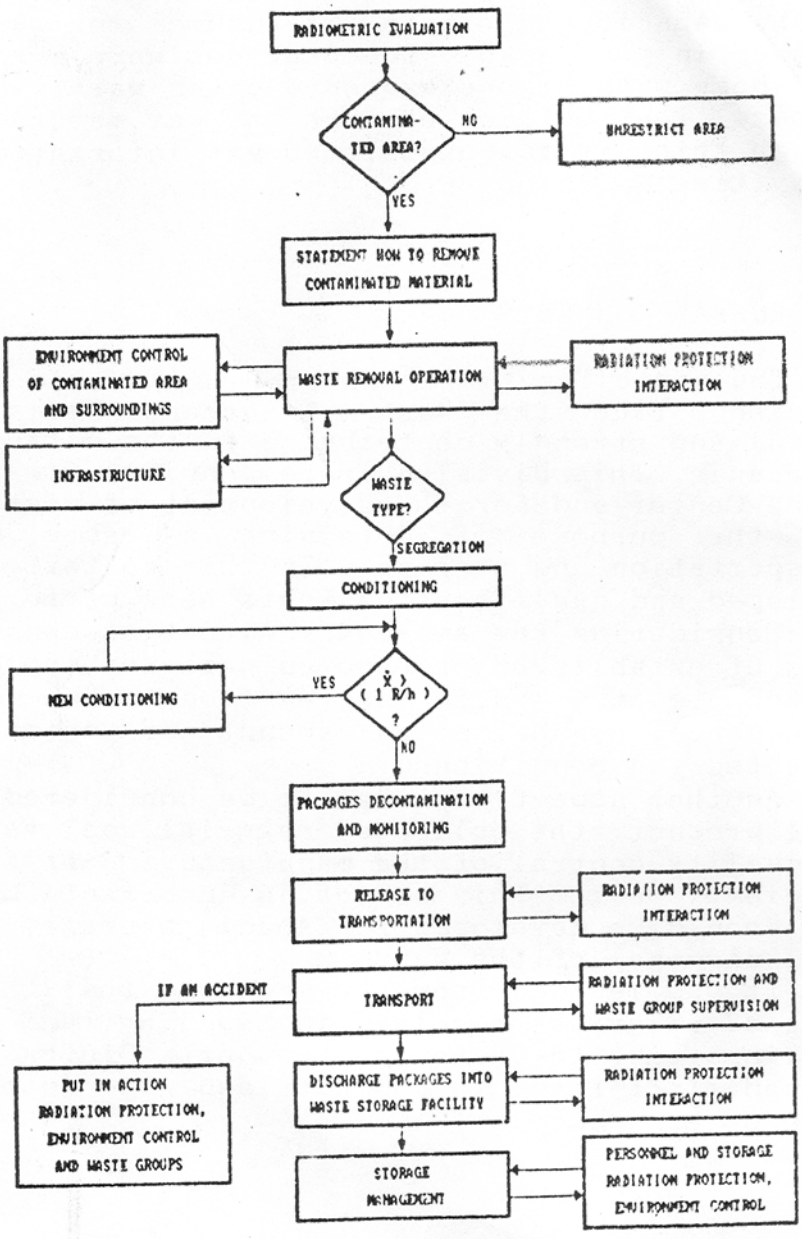

FIGURE 1 - BLOCK DIAGRAM FOR GOIANIA'S WASTE MANAGEMENT STRATEGY