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IEN LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT

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Abstract

The low-level radioactive waste produced in Instituto de Engenharia Nuclear is generated basically from three distinct modes: a particle accelerator (CV-28 Cyclotron), radiochemistry laboratories and the operation of a nuclear research reactor (Argonaut type).

In the Cyclotron unit, all water flow from hot labs as well as from the deconcamiantion laundry is retained in special tank with homogenizing system and a remote control, that signalizes when the tank gets a pre-specified level. Samples homogenized from the tank are colected for previous analysis. They are analised and the possibility of sewerage disposal is evaluated. In the radiochemistry labs the radiological protection service maintains recipients for collecting the radioactive wastes which are mainly low-level alpha radioactive wastes.

In the reactor unit some radioactive material generated by fission migrates from the fuel to the coolant system and is retained in a filtration and ion-exchange resin system. Noble gases which migrates to air from cooling water is measured and exhausted from the building reactor in a very low concentration.

This work presents in details the control, treatment and disposal of the radioactive waste of above units.

1. INTRODUCTION

The Instituto de Engenharia Nuclear - IEN (Nuclear Engineering Institute), is a CNEN-owned research institution. Radioactive waste management at IEN is under the responsability of Seção de Proteção Radiológica (Radiological Protection Service) and the overall practices adopted is oriented for the preparing of the wastes for storage or final disposal. The wastes is mainly due to the works develcped in Radiochemistry Laboratories, operation of CV-28 Cyclotron, a Research Nuclear Reactor and wastes coming from other institutions under CNEN's inspections.

The liquid radioactive wastes coming from the Cyclotron unity are drained to retention tanks and those from Radiochemistry Laboratories are colected by means of appropriated recipients. After qualitative and quantitative analysis, the possibility of the wastes being disposed by release into sanitary sewerage system is evaluated. The liquid radioactive wastes which may not be released in a short time are treated with the objective of volume reduction, imobilization and are conditioning at a small installation at IEN site. The release of these wastes is made in accordance with national and international standards.

The solid radioactive wastes are segregated, conditioned and storaged for some time at the same installation above mentioned.

This work presents the steps of radioactive waste management at IEN, such as its segregation, treatment and disposal.

2. SOURCES OF RADIOACTIVE WASTES

The wastes produced by different works at IEN come from the three distincts areas already mentioned: Cyclotron unity, Radiochemistry Laboratories and a Research Reactor.

2.1. Liquid Radioactive Wastes

2.1.1. Cyclotron Unity

At Cyclotron unity the wastes are produced by activation of the accelerator components when targets are irradiated for radioisotopes production and by research works.

During the production of particles beans for targets activation, components parts of the accelerator are activated producing a variety of radionuclides. Since the accelerator generally needs some maintenance once in a week which includes cleaning of some of its parts by abrasion under running water, the wastes produced by this mean is drained to retention tanks. Some wastes originated from research activities are drained from the laboratories to the retention tanks as well. The radioisotopes produced are processed in hot cells and all remaining radioactive waste is retained inside the cells into appropriated recipients. Samples of all wastes are collected for analysis to verify the radioactive content and the viability of disposal into sanitary sewerage system. If the concentration of radionuclides present are large and the dilution to permissible levels for release is not viable, the waste is retained for treatment (see item 3) or storaged for decay.

The wastes produced generally present the following radionuclides: Zn-65, Ga-67, Br-77, In-111, I-123, I-124 and Tl-201. Some others radionuclides, due to research activities are less commonly found in the waste |1|.

2.1.2. Radiochemistry Laboratories

In these laboratories the wastes are basically constituted by uranium compounds, mainly due to researchs on isotopic separation. Chloridic solutions (UO_2Cl_2) are the major part of wastes produced by these laboratories.

Nitric solutions and others uranium and thorium wastes are produced in a smaller scale. These wastes are collected in appropriated recipients, in the laboratories and sent to Radiological Protection Service for analysis and treatment, storage or release, as the case may be.

Wastes containing others radionuclides are produced occasionally due to specific works.

2.1.3. Reactor Unity

In this unity a very small quantity of liquid waste comes from ion-exchange resin regeneration that contains some fission products that migrates out of the fuel elements to reactor moderation water, and activation products.

The waste, in this case, has very low activity and for this reason does not need specific treatment for disposal |2|. Noble gases are detected in the reactor water and in the air of the reactor building, in very low concentrations.

2.2. Solid Radioactive Wastes

Solid radioactive wastes are also produced at the mentioned unities. These wastes are formed basically by a large variety of contaminated materials such as: laboratory glasses, gloves, absorvent papers, metal pieces, etc.

These wastes are collected and submited to procedures explained on item 3.

2.3. Others Sources of Radioactive Wastes

The Instituto de Engenharia Nuclear receives radioactive wastes from others institution due to CNEN's inspections activities. These wastes are comprised mainly of materials having Co-60, Am-241, Ra-226, Uranium, etc. That is managed as the same way of the wastes generated at IEN.

3. RADIOACTIVE WASTE TREATMENT

The radioactive waste management at IEN is showed schematically in figure 1. The solid wastes are identified at its source and segregated in accordance with its half-lives. The short-lived wastes are storaged for decay and subsequent disposal while the wastes with intermediate and long half-lives area separated into compactible and noncompactible, conditioned and sent to CNEN's storage installations.

With respect to liquid radioactive wastes treatment, IEN adopts the method of concentrating radioativity in volumes as small as possible, by means of chemical and physical processes with the objective of getting a final product that is safer to handle, transport and storage |3|.

3.1. Cyclotron Unity

The wastes that come from the Cyclotron Unity present several concentrations of radionuclides. Those wastes of low concentration in aqueous solutions has pH near to 5.0 and are drained to the retention tanks for further release into sanitary sewerage system. The aqueous wastes of higher concentrations are retained for cementation and the organic wastes are absorbed and the solidified product is conditioned afterwards.

3.2. Radiochemistry Laboratories

The wastes coming from Radiochemistry Laboratories are mainly chloridric solutions of uranium having pH near to 0 (zero). The treatment adopted for this type of waste is to precipitate uranium with sodium hydroxide at ambient temperature.

It has been observed experimentally that at pH near to 4.0 occurs the precipitation of the major part of uranium. The precipitate obtained is impure sodium diuranate that is dried for conditioning. This process of waste treatment has an efficiency of about 95%.

Figure 2 shows the influence of pH on uranium precipitation in this type of waste (chloridrics), where is observed the variation of the quantity of uranium in the solution after addition of sodium hydroxide |4|.

The treatment of organic solutions consists mainly in solidificating the wastes by means of absortion in differents materials.

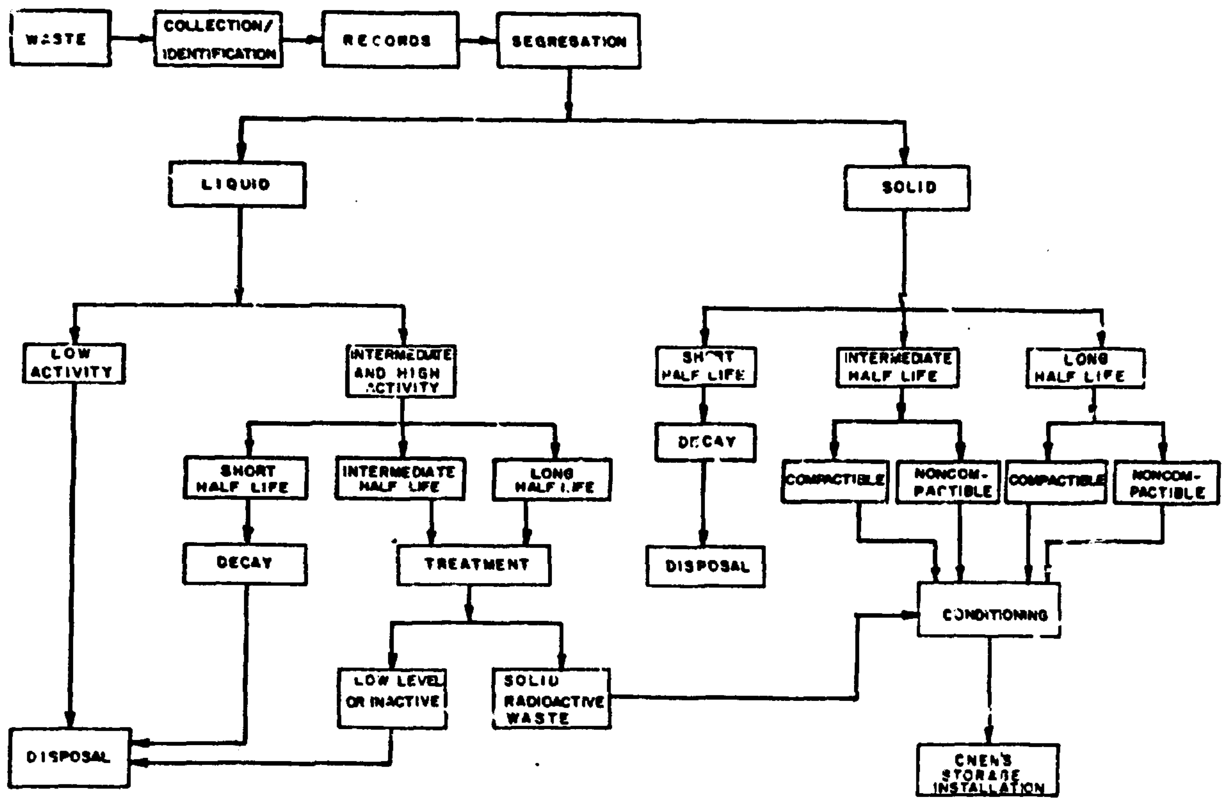

Fig. 01 Radioactive Wastes Management Steps

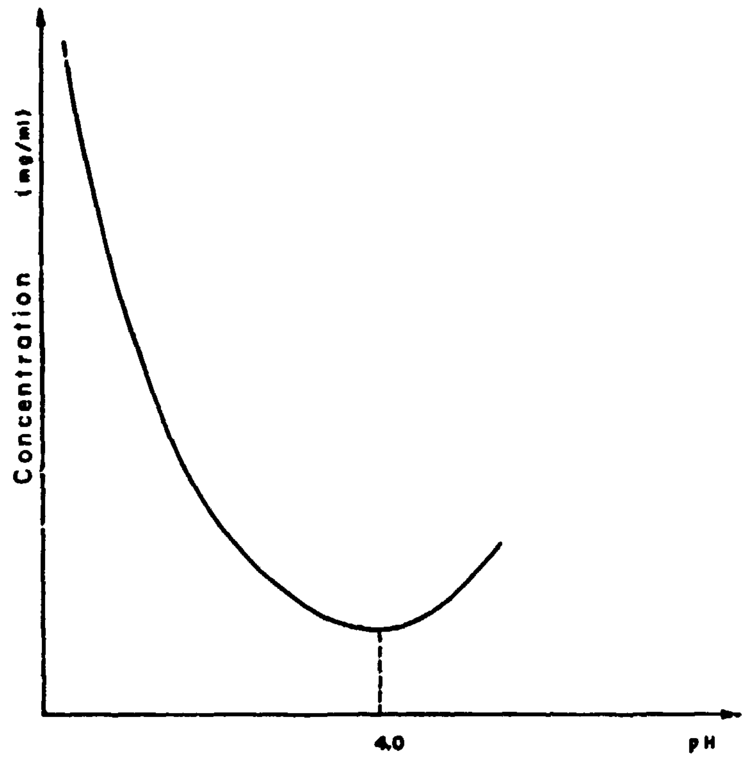

Fig.02 · Uranium Concentration in Solution as a Function of pH of the Solution, After Addition of NaOH.

4. RADIOACTIVE LIQUID WASTES RELEASE CRITERIA

IEN radioactive liquid wastes release criteria (see figure 3) obey national |5| and international |6| standards for releases into sanitary sewerage and are such that concentration of radionuclides in released wastes are kept below the permited limits (as low as possible). As generally, the operation of particles accelerators produces several radionuclides not mentioned in waste releases standard guides, a study has been developed at IEN |7| that become the releases of such radionuclides not so restrictive but still safe.

Generally the concentration limits for releases of radioactive material into sanitary sewerage, is based in the old values |8| of maximum permissible concentration of radionuclides in water (MPC_w). With the introduction of the ALI concept |9, 10|, we are at IEN using this concept to calculate concentration limits for many radionuclides not mentioned on the standard guides.

Before each release, samples are taken for analysis. The total activity found is computed and compared with the annual limit of 40 GBq |7|. If a release will imply that the annual limit be exceeded, the waste will not be released and it will be storaged for the necessary time until it decay to a permissible levels. In fact even when the storage for decay is not necessary, the waste is retained some time to avoid that the accumalated released quantity stays near to the annual limit. This permits that subsequent releases may not become unviable.

Since the annual release limit is not achieved, it is verified if the permissible daily concentration is exceeded. If it is not, the volume will be released and the total quantity (activity) computed. If the daily concentration is exceeded, the volume of waste will be storaged for decay or will be released in small daily quantities if dilution at permissible levels is possible.

5. RADIOACTIVE LIQUID EFFLUENTS RETENTION - RELEASING SYSTEM

This system is comprised of two cilindrical tanks with 2.0 m^3 of capacity.

The tank number 1 receives continuously liquid wastes that come from the Cyclotron unity hot laboratories. The wastes coming from the others hot laboratories not directly connected to the tanks, are collected as described in item 2.

The tank number 2 is used for homgenizing the liquid wastes for sample collection, analysis and further release.

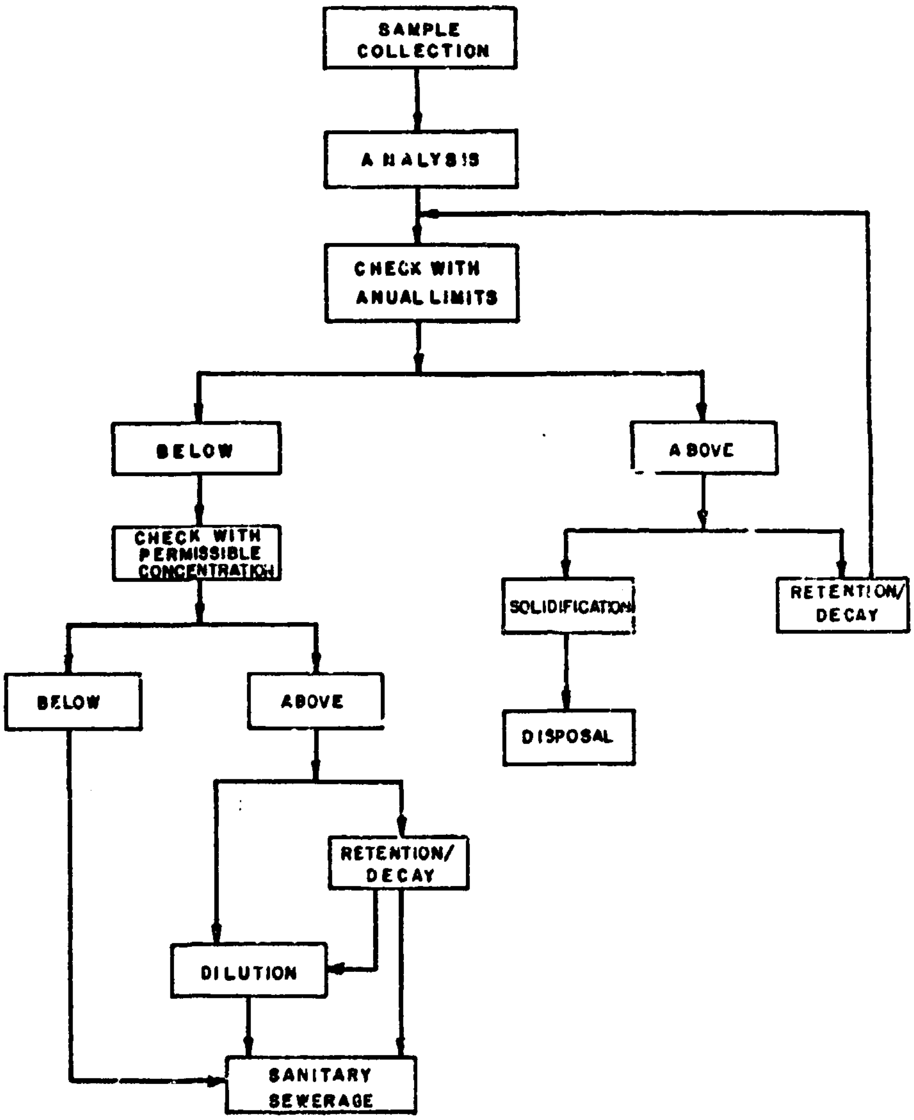

Fig.03 : Basic Steps for Liquid Wastes Diposal

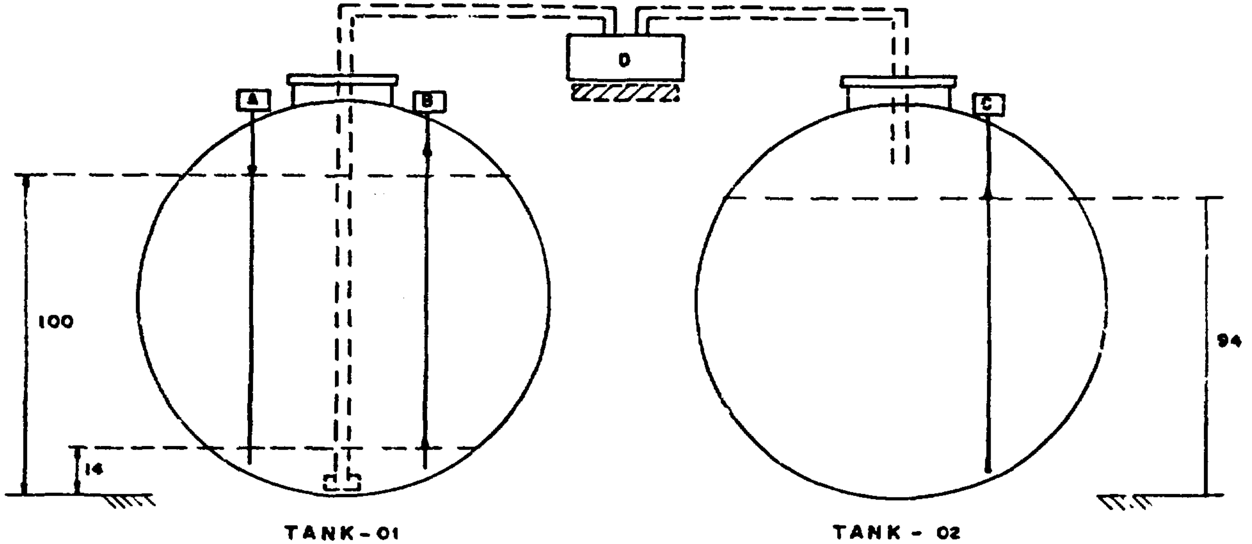

Fig.04 : FRONTAL VIEW OF THE TANKS (DIMENTIONS IN CENTIMETERS)

A - Device to start the remote alarm.

B - Device to transfer the effluent automatically.

C - Device to turn-of the effluent transference pumps.

D - Transference pumps.

Figure 4 shows the effluent transfering and level control system. When the volume of the effluent in the number 1 tank reaches a pre-set level, a remote alarm is activated. This alarm is situated at Radiological Protection Service Installations. Then, the transference system between the two tanks is turned-on manually and two pumps transfer the effluent in 4 minutes. The transference of the effluent stops when the volume in number 2 tank reaches 1.5 m^3 and samples are collected from the homogenized effluent in number 2 tank afterwards.

This system has two others controls devices to avoid overflowing of the number 1 tank. One device turns on automatically the pumps when a maximum level is reached. This device is necessary because a delay between the alarm actuation and the manually turning on the pumps could cause an overflowing of the tank. An other device located at number 2 tank do not permit an other transference of the effluents until the release is completed.

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