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MANAGEMENT OF RADIOACTIVE DISUSED LIGHTNING RODS

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ABSTRACT

The manufacture of radioactive lightning rod was allowed from 1970 to 1989. This authorization was based on state-of-the art science of that time that verified that radioactive lightning rods had efficiency superior to the conventional lightning rods, denominated Franklin. However, the experience showed that their efficiency was not superior enough to justify the use of radioactive sources. Consequently, in 1989, the National Commission for Nuclear Energy - CNEN, issued the Resolution 04/89 from 04-19-1989, that forbidden the importation of ^{241}Am tapes, assembling and commercialization of radioactive lightning-rods. The institutes of CNEN are responsible for receiving these lightning-rods and sending to the users procedures for removing and dispatch to the institutes. Therewith, these devices are kept away from the human being and environment. The Nuclear Technology Development Center - CDTN and Institute for Energy and Nuclear Research - IPEN of CNEN, has built laboratories appropriate for dismantling such devices and store the ^{241}Am tapes safely. Nowadays are being researched methodologies to evaluate the contamination levels of the frame for possible recycling and become better the management of these devices.

1. INTRODUCTION

The production and commercialization of radioactive lightning rods in Brazil started in 1970. In 1989, through Resolution CNEN-04/89 of 19/04/1989, the National Commission for Nuclear Energy-CNEN established the suspension of the grant of authorization for use of radioactive materials in radioactive lightning rods because it was proven that their efficiency is not so superior to the conventional lightning rods [1], so does not justify the use of radioactive sources.

The radioactive materials from this devices can be released to the environment due to natural phenomena (rain, heat, wind, etc.) and small amounts are sufficient to cause cancer to the human being if inhaled or ingested, since the radiotoxicity of ^{241}Am is very high, and the critical organs are kidneys, lungs, and bone [2].

Another aspect relates to the aspect of safety is that the useful life of components of the radioactive lightning rods (about 10-30 years), be much shorter than the half-life of the isotope fixed on them (for americium 241, 432, years) [3].

For proper storage of radioactive lightning rods that are being phased in Brazil, CNEN has instructed its Institutes to receive these devices. It is made segregation of metallic components and the tapes of ^{241}Am to optimize the space occupied in storage, and also facilitate the packaging of the radioactive material that is collected.

The Center for Development of Nuclear Technology CDTN and Institute for Energy and Nuclear Research - IPEN research institutes of CNEN, has been receiving these devices. These institutes built laboratories appropriated for dismantling these lightning rods, and the ^{241}Am tapes are stored securely on their respective storage buildings.
Institute for Energy and Nuclear Research - IPEN is developing physical and chemical methods for decontamination of metallic components of the radioactive lightning rods, with the goals of recycling them to better management this problem [4, 5].

2. USES OF ^{241}Am

The ^{241}Am was obtained in 1944 by bombarding neutrons on isotopes of plutonium in a nuclear reactor at the University of Chicago, according to the following scheme:

$$^{239}\text{Pu}(n,\gamma)..> {}^{240}\text{Pu}(n,\gamma)..{}^{241}\text{Pu}.. > {}^{241}\text{Am}$$

The ^{241}Am, whose half-life is 432 years, decays by emitting particles α (alpha) which is the nucleus of the chemical element Helium. These particles are responsible for the ionization of air having the purpose to improve the flow of atmospheric electrical discharges [3], but it was contested by tests.
The radioactive lighting rods consist of metal discs or metal rings on where are fixed the ^{241}Am, spindle and cramps iron. Each lightning have a maximum of 212 MBq (5.6 mCi). The most common model of radioactive lightning rod shown in Figure 1.

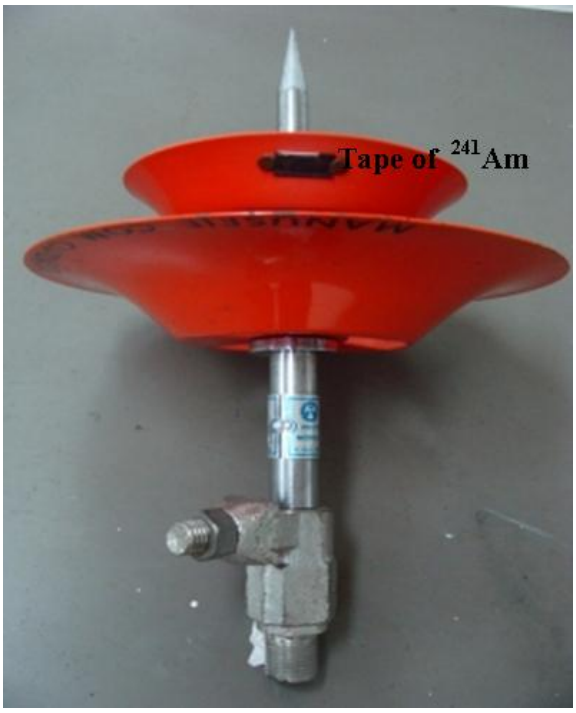

Figure 1: Model radioactive lighting-rod sold in Brazil

The ^{241}Am is also used in smoke detectors. In combination with beryllium is used as a neutron source for nondestructive testing of machinery and equipment, and as a thickness gauge in glass industry [6].

3. LABORATORY FOR DISMANTLING IN CDTN

The laboratory was built according to the standards of licensing radioactive facilities.

3.1. Classification of the Laboratory

In accordance with Resolution 112/11 [7] - "Licensing of Radiative Facilities" and the Regulatory position - PR 3.01/001 [8] - "Criteria for Exclusion, Exemption and Exemption Requirements for Radiological Protection" this laboratory is classified as installation of the group 5, where are handled radioactive sources of ^{241}Am with activity of more than 30 MBq.

3.2. Constructive Aspects

The laboratory is designed according to the standards, the walls and floor painted with epoxy, there are places for decontamination and monitoring of people working in these tasks.
The main equipment for dismantling the radioactive the radioactive lightning rods is a glove box that is operated at negative pressure, so that no material is released to the environment (Figure 2). This glove box was built after technical visit performed at the laboratory of Management of Radioactive Waste from the Institute for Energy and Nuclear Research - IPEN of the CNEN.

Figure 2: Glove box for dismantling radioactive lighting rods

The glove box consists of a metal structure of stainless steel (ASTM A 276-TP-304) 1/8 "thick and upper and front panels made in transparent acrylic 10 mm thick. The box works under a constant negative pressure in relation to the environment, 40 mm of water column. To control the internal pressure, the box has a pressure gauge and an alarm system sound and light to alert operators in the event of any irregularity in their hermetic system. The indoor air is exhausted through the system constituted by the exhaust gas, HEPA filters and manual

valves for adjusting the negative pressure. HEPA filters are disposable and changes made as required. The seal between the metal structure and panels is done with acrylic neoprene rubber.
The glove is on a rigid metallic structure of 2.95 m long, 0.95 m wide and 1.05 m high. To perform the various operations of dismantling radioactive lightning rods, the glove is provided with the tool kit that includes instruments, drift, bench lathe, chisel, hammer, pliers, screwdriver, etc.

4. PLAN OF DISMANTLING OF RADIOACTIVE LIGHTING-RODS

The activities implemented in laboratory for dismantling, involving the use of ionizing radiation are subject to the regulations set forth in the Standards CNEN-NE-3.01: 2011 [9]- " Basic Guidelines on Radiological Protection", Resolution 112/11 [7] " Licensing of Radiative Facilities", CNEN-NE-3:02 [10] -" Radiation Protection Services" and CNEN-NE-6:05 [11] " Radioactive Waste Management in Radioactive Facilities".
The basic objective of this Plan is to meet these standards and ensure that the Laboratory be operated in a radiologically safe.
The basic objective of this Plan is to meet the standards and ensure that the laboratory be operated so radioagically safe. To this end, operational procedures are established to ensure that any unnecessary radiation is avoided.

5. STAFF INVOLVED

The staff working at the dismantling of radioactive lightning rod received training in radiation protection and also participates in refresher courses for servers CDTN who work with radioactive materials or equipment emitting radiation administered periodically by the radiological protection service.

6. PACKAGING OF STORAGE

Currently there is no provision for use of americium present in radioactive lightning rods. Therefore, Americium 241 tapes generated during disassembly are considered radioactive waste and must be packaging for storage for a long period.
The packaging for the storage of sources of ^{241}Am, shown in Figure 3, consists of a metal outer container 45 liters in which are housed four wood supports of 28 cm diameter by 16 cm long, with 37 positions for insertion of aluminum 3 cm diameter by 13 cm length for placing the tapes containing americium.

Figure 3: Packaging storage - left general view and right internal details

The packaging containing the tapes of ^{241}Am and 200 L metal drums containing metal skeletons are stored in the Deposit of Treated Waste and Disused Radioactive Sources -Building 33, seen in Figure 4.
The administrative control of radioactive lightning rods received, dismantled and ^{241}Am radioactive sources placed in the storage packaging are inserted in the database of the Waste management Service of the CDTN.

Figure 4: Storage Building of Treated Waste and Disused Sources

7. CONCLUSIONS

This article aims to show the presentation of reasons for the National Nuclear Energy Commission-CNEN prohibit the use of radioactive materials in lighting rods and manage radioactive disused lightning rods.

The constructive aspects of radioactive lightning show us that approximately 99% of the components may contain contaminants, due to damage from weathering. Thus, these lightning rods are dismantling to segregate the tapes where ^{241}Am are fixed, and these tapes are stored in the storage buildings

Methods to check for contamination on carcasses of lightning rods (plates, rods, clamps) are being studied with the objective of recycling and reducing waste sent to storage building.

The Institute of Energy and Nuclear Research - IPEN is in advanced stage of chemical and physical studies for the decontamination of carcasses and shows that the laser abrasion may be used, reducing the volume at low prices.

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