RADIOACTIVE LIGHTNING RODS - PRESENT SITUATION

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ABSTRACT

Radioactive lightning rods are being replaced since the National Commission on Nuclear Energy lifted the authorization to use radioactive sources in these consumer products. Most of the rods containing Ra-226 or Am-241 are being sent to the Institute of Energy and Nuclear Research, IPEN, where a facility for the disassembling and decontamination of this radioactive waste was commissioned. A description of the facility and the process of extraction of the radioactive sources is given. The problems associated to the management of this waste are also presented.

I. INTRODUCTION

The use of radioactive sources in lightning rods in Brazil was reviewed by Heilbron Filho and Xavier (1) in a paper presented at the 1992 Brazilian General Congress on Nuclear Energy. It is interesting to summarize some points of that article:

- radioactive lightning rods (RLR) were manufactured in Brazil between 1970 and 1989,
- contrary to manufacturers claims as regards to the safety of the practice, the rods were installed without the required control,
- the number of RLR installed is unknown and it is only possible to estimate that figure by dividing the total activity of imported americium by the rod average activity,
- increased protection by use of radioactive sources is scientifically unsound and so CNEN lifted the authorization to the manufacture, trade and installation of RLR in Brazil, through the Resolution CNEN No. 4/89 based, among other reasons, on the application of the "principle of justification",
- CNEN determined that replaced RLR should be transferred to CNEN control,
- CNEN, through simplifications on the requirements to packages and to transportation conditions, made accessible for the public instructions on how to pack and to transport safely the replaced RLR.

These points make a good picture of the situation of RLR in Brazil but experience, five years later, shows that some points can be added.

According to CNEN instructions, RLR must be handled with gloves which are put together with the rod inside a plastic bag, surrounded by shock absorbing material into a 40 L metallic drum. This package was chosen as the standard package for RLR because, conservative assumptions about total enclosed activity and surface exposure rates allowed to classify the package as excepted package. Though simple, only recently these instructions were followed by most of the RLR owners.

The CNEN Resolution No. 4/89 (2) lifted the authorization to use radioactive sources in lightning rods but it did not set forth a deadline for the replacement of RLR installed before the issuance of that Resolution. On the other hand, the standard No. NBR 5419, for protection of structures against lightning, issued by the Brazilian Association for Standardization (ABNT) (3), does not foresee the use of RLR in the protection systems. Many local authorities used these two documents to determine the immediate replacement of the RLR and adherence to ABNT standards for buildings under their jurisdiction. The Municipal Decree No. 33132, of April, 23rd, 1993, of São Paulo City (4) is an example.

Before those decrees started to affect the rate of RLR replacement, the Goiânia accident in 1987 drew the attention of the people to the risks of radioactivity, as observed by Heilbron Fo. and Xavier (1), raising the quantities of sealed sources being put out of service and being sent to CNEN as waste, among them, the RLR. This increase can be observed in the table 1 which shows data from Waste Management Department of IPEN .

IPEN is the main reception center for radioactive wastes generated in Brazil and most of the replaced RLR has been collected there.

TABLE 1. Amount of RLR Received by IPEN

YEAR	Am-241 RLR	Ra-226 RLR
1983-1986	0	0
1987	9	0
1988	11	0
1989	52	3
1990	632	13
1991	815	17
1992	1210	19
1993	1208	8
1994	755	37
1995	1406	22
1996	983	10

Until 1990, the RLR collected at IPEN were repacked and sent to the Institute of Nuclear Engineering (IEN) in Rio de Janeiro, whose staff were carrying out a project aiming at reprocessing the Am-241 extracted from the rods. However, in August 1990, an accident that resulted in contamination of a technician and that made the headlines while the Goiânia accident was still fresh in people's minds, led the project to an end. Consequently IPEN started to store the RLR on site.

The storage of the RLR in 200 liters drums without any treatment would require about 3000 drums and 1000 m^3 of storage room. Therefore, the decision was to disassembling the rods and to extracting the sources, achieving around 3000 fold volume reduction.

Soon after this work started, it was found that about 10% of the rods were contaminated, as detected when the metal scrap underwent radiological control before discharge. The level of contamination was well above the concentration limits established by CNEN (5) and was due to source leakage while the RLR were still in use.

This contamination was unexpected since the sources had been certified by the supplier, the Amershan Co. (6) and independently by the Institute of Atomic Energy (IEA) (7). The sources were constructed and assembled in such a way as to prevent leakage. A gold-palladium alloy, a very corrosion resistant material, was used to seal the active americium layer. A reasonable explanation is that both Amershan and IEA tested the sources before use and the dust laden urban atmosphere opened the seal, by wind action, exposing the active material.

It was realized that the disassembling and extraction of the sources posed a significant risk of contamination of the work place. For this reason, the workers wore protection suit and these operations were performed inside a box with easily decontaminable surfaces. However, after sometime of operation, it was detected widespread contamination in the room, indicating that americium contaminated particles were suspended forming an aerosol by an as yet unknown process. So, it became clear that this work could only be done safely inside an alpha-tight glove-box because of the high activity handled compared to the low annual limit on intake (ALI) for Am-241, 200 Bq for inhalation (5).

II. RLR DISMANTLING FACILITY

The concept of the facility was based on the following assumptions:

- all operations that could generate aerosols should be done inside the glove-box. These include the unpacking of the RLR, the disassembling of rod parts, the extraction of riveted sources, and the packing of them all for further management.
- the facility should be designed for handling Am-241 RLR only, the received Ra-226 RLR being stored without any treatment for future management.
- the facility should be constructed as to allow the segregation and separate collection of wrapping plastic sheets or bags, shock absorbing materials, the disassembled parts of the RLR and the extracted sources.
- all parts that are deemed to be contaminated should be packed for future treatment.
- the design of the facility should take into account that the amount of RLR to be processed is considerably large and so operations time should be as short as possible as well the workers physical force requirements should be maintained at adequate levels.
- the facility should be as flexible as possible allowing operation by varying number of workers, treatment of the different types of existing Am-241 RLR and future use for the treatment of Ra-226 RLR.

The IPEN personnel made the basic engineering project and purchased the detailed project and the construction of the glove-box from a laboratory equipment supplier. Internal parts, tools and ancillary systems were designed and constructed by IPEN personnel. The schematic flowsheet of the process is presented in Fig.1 and the main steps of the process are:

- to unpack the RLR.
- to segregate the shock absorbing material and dispose it of as non radioactive waste. Experience has shown that this material is contamination free.
- to transfer the bag containing the RLR to the glove-box.
- to remove the plastic bag and dispose it of as compressible radioactive waste in one collecting drum. Experience has shown that most plastic bags and the gloves used to replace the RLR are contamination free but the decision was to classify this waste as radioactive to avoid the worthless monitoring work.
- to disassemble the rods by unscrewing the nut that

fasten the entire assemble and to separate the parts.

- to collect all parts into a second collecting drum, except the dish-like disks to which the sources are fixed. Experience has shown that about 5 % of these parts are contaminated and so they are stored to be surveyed later, decontaminated and discharged as metal scrap.
- to extract the sources from the discs by removing the rivets that fix the sources.
- to collect the discs in a third collecting drum for further scanning, decontamination and discharge as metal scrap. Experience has shown that about 10 % of the discs are contaminated.
- to collect the sources in a metal can inside the glove-box for further management as radioactive waste or for recycling of the americium and the gold alloy.

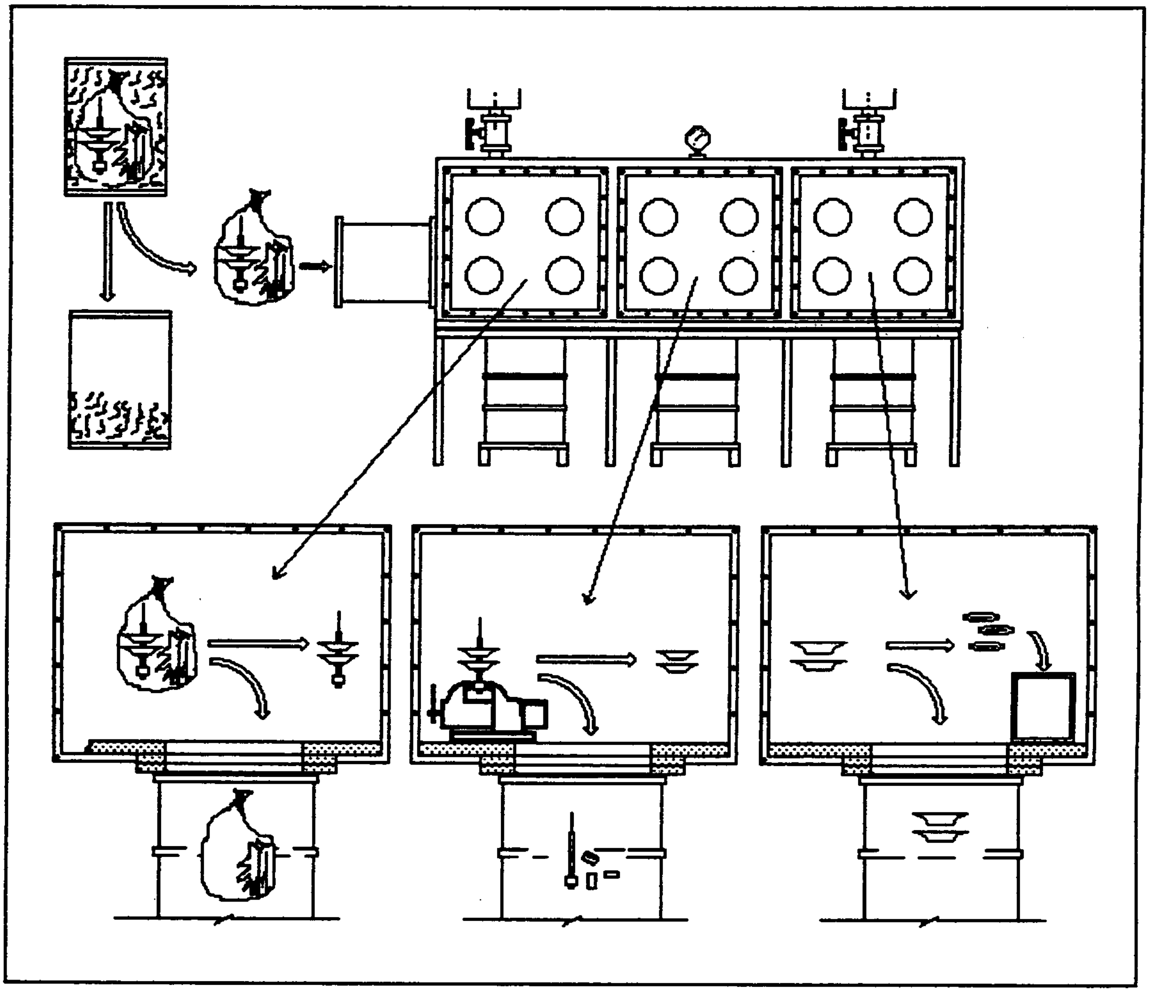

Figure 1. Schematic flow diagram of the process.

The facility is composed by:

1. glove-box with stainless-steel structure and Lucite panels, 3 meters long, 0,8 meters high and 1 meter wide.
   - one double-lid inlet door for admission of the RLR into the glove-box.
   - three outlet door with "bag in - bag out" coupling system to 100 L drums.
   - twenty glove ports for access from both sides.
2. ventilation system composed by
   - centrifugal exhausting fan with capacity to keep the glove-box internal pressure bellow 20 mm water gauge and a flowrate of 100 Nm3/h..
   - two sets of HEPA filters with two 50 Nm3/h cylindrical frame filters each.
   - two sets of check valves and pressure control valves.
3. air compressor capable of delivering 6 Bar, dry, lubricated compressed air for operation of a pneumatic screw driver and a pneumatic cylinder press.

4. set of special tools to disassemble the RLR, including a pneumatically driven punch with a laser pointer sighting guide, to extract the source rivets.
5. room for storing packages, drums and other ancillary equipment. The equipment and tools used were specially developed and are able to handle five different types of assembling nuts and rod geometries and are able to handle two different types of riveting, which covers all existent types of RLR.

A picture of the glove-box can be seen in Fig. 2.

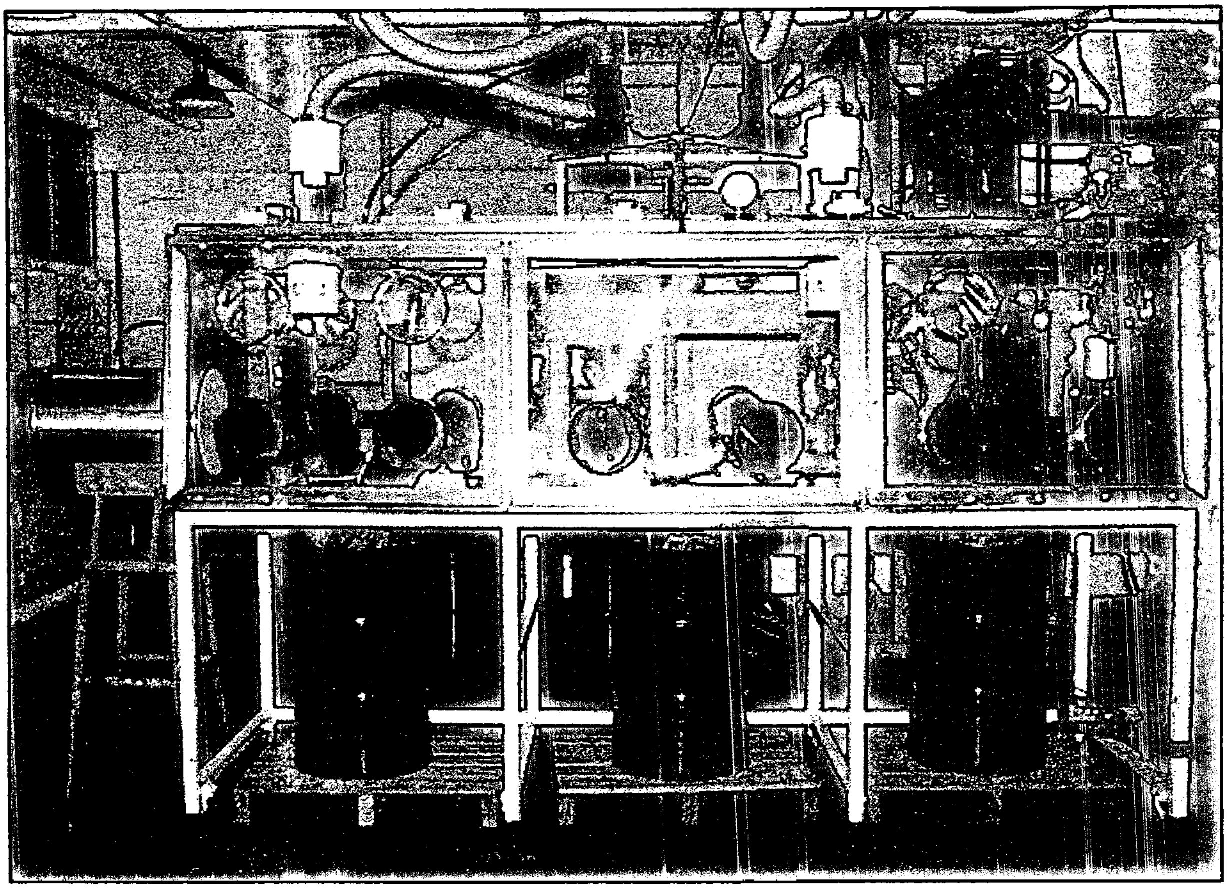

Figure 2. Glove-box for Disassembling of Radioactive Lightning Rods

The costs of the facility amounted to about US$ 60,000 including detailed project and construction of the glove-box, tools, expendable materials and ancillary equipment. The costs of IPEN personnel and buildings are not included.

The necessary infrastructure of radiation protection makes up a significant fraction of the investment and operation costs which are also not included in the figure above.

The monitoring program for this facility includes:

- monitoring of the work place: surface contamination and air contamination.
- monitoring of the discharge of gaseous effluents to the environment through the exhausting fan.
- personal dosimetry: external exposure, external and internal contamination.
- monitoring of metal scrap for recycle.

While external exposure dosimetry is routinely available and the monitoring of surface contamination, either work place, or worker skin, or protection suits can be done with the aid of a common portable monitor with pancake probe, the other topics of the monitoring program are not easily accomplished.

The control of the air contamination, $8x10^{-2}$ Bq/m^3 in the work place or $7,4x10^{-3}$ Bq/m^3 in the discharge duct requires high volume samplers and a very sensitive alpha or gamma spectrometers.

The routine work with large quantities of Am-241 requires preparedness to deal with accidents, that could result in internal contamination. The assessment of internal contamination due to Am-241 is a difficult task. Dosimetry by wholebody counter is made difficult by the weak gamma lines of Am-241 (0,06 MeV) and by very low ALI values; bioassay is also limited by the low ALI values and excretion function curve, requiring sensitive methods for detection.

The monitoring of the metal scrap requires an equipment capable of detecting 0,3 Bq/cm^2, in thousands of pieces with unfavorable geometry.

III. COMMENTS

Some questions about the number of RLR that IPEN is expected to receive have been raised. In the project of the facility it was used the evaluation made by CNEN which approach led to a number close to 75.000. It was also considerate that the two other Institutes of CNEN, namely the Center for the Development of Nuclear Technology (CDTN) and IEN, will share part of the responsibility to treat this waste. However, the CNEN assessment did not account for Ra-226 RLR that represents about 2 % of the amount received until now by IPEN. Furthermore, the number of rods reaching IPEN during the last years is nearly steady state and much bellow expectations. Reasons for this low flowrate are:

- Although the replacement of RLR by a Franklin Type Rod, according to CNEN instructions, can be performed by any person with a minimum skill, to rebuild the protection system and to turn it into one which complies with the new standards, requires the services of a licensed professional or company. The availability of such service to supply the increasing demand is limited and cost too high for most householders.
- Although the fee that CNEN started to ask for from October 1995 on to receive each RLR is a small fraction of the total replacement costs, it discouraged, at least during sometime, the replacement of the RLR.
- Most householders are unaware of the existence of the RLR in their buildings and are even more ignorant of the legal and technical questions involved with them.

The technology developed at IPEN to manage RLR is adequate to solve the problem from point of view of waste management, allowing to achieve high volume reduction factors and large decontamination factors and allowing the work to be done according to safety and radiological protection standards.

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