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RADIOACTIVE SEALED SOURCES PRODUCTION PROCESS FOR INDUSTRIAL RADIOGRAPHY

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ABSTRACT

Since 1983, the Sealed Source Production Laboratory at the Nuclear and Energy Research Institute has been providing products and services to the private and governmental Brazilian users of industrial radiography and nucleonic control systems. Radioactive sealed sources are commonly used in nondestructive tests as radiography to make inspections and verify the internal structure and integrity of materials and in nucleonic gauges to control level, density, viscosity, etc. in on-line industrial processes. One of the most important activities carried out by this laboratory is related to the inspection of source projectors devices used in industrial radiography and its constituent parts as well as remote handle control assembly drive cable and guide tube systems. The laboratory also provide for the users iridium-192, cobalt-60 and selenium-75 sealed sources and performs quality control tests replacing spent or contaminated radiative sources. All discard of radioactive source is treated as radioactive waste. Additionally, administrative and commercial processes and protocols for exportation and transport of radioactive material are developed by specialized departments. In this work are presented the mean processes and procedures used by the Sealed Source Production Laboratory such as the arrival of the radioactive material to the laboratory and the source projectors, mechanical inspections, source loading, source leaking tests, etc.

1. INTRODUCTION

The radioactive sealed sources production for industrial applications started at IPEN in 1965 in the IEA-R1 Nuclear Reactor Department. The line was built focusing on production of iridium-192 (Ir-192) and cobalt-60 (Co-60) radioactive sources to supply the Brazilian market demand. For most radiography and industrial applications, usually low activity radiation sources are necessary. Ir-192 sources were built around 0.74GBq (20mCi) and the Co-60 sources around 3.70GBq (100mCi). At this moment, radioactive sources were sealed using a riveting mechanical system, leakage tests were not preformed [1], [2].

In 1983, the Sealed Sources Production Laboratory (LPFS) was formally founded by the Nuclear Physics Division (TFF) in the IEA-R1 building, aiming the production Ir-192 with activities around 0.74-3.70GBq (20-100mCi) useful for most models of source projector devices for industrial radiography. Co-60 sources were also built with activities around 19.5GBq (500mCi) for industrial nucleonic level and density gauges [1], [2].

The LPFS started to be managed by the Radiation Technology Center (CTR) in 1986 thus remaining until the present day. The mean activities of the LPFS are related to consulting services and production of radioactive sealed sources. Consulting services are associated to survey of the sources projector devices including shielding maintenance and the disposal of depleted radioactive sources [2] [3]. A typical Ir-192 source and a source holder are shown in Fig. 1.

Figure 1: Ir-192 radioactive source and source holder produced at LPFS

Nowadays, the LPFS has more than twenty six customers/users. Trading and source production for industrial radiography applications in Brazil can only be performed by national governmental approved laboratories. The final users of the sealed radioactive sources (e.g. nondestructive services companies or laboratories) need to be authorized by the national regulatory authority, the Nuclear Energy National Commission (CNEN) to minimize and avoid radioactive accidents and incidents in the country.

2. LABORATORY DESCRIPTION

The LPFS is operating using four hot-cells for handling the radioactive sealed sources as shown in Fig.2. One hot-cell is classified as primary and the other three hot-cells as secondary [1]. Several air filter systems worked to prevent possible radioactive leakage to environment.

Fig. 2: Hot-cells inside the LPFS -Zone 1

The LPFS has three delimited confinement working zones as shown in the ground floor map in Fig. 3 [1]. Zone details are showed below:

- Zone 1: primary and secondary hot-cells.
- Zone 2: pre-processing room, glove-boxes, shielding maintenance.
- Zone 3: administrative office, workshop, packaging and shipping area.

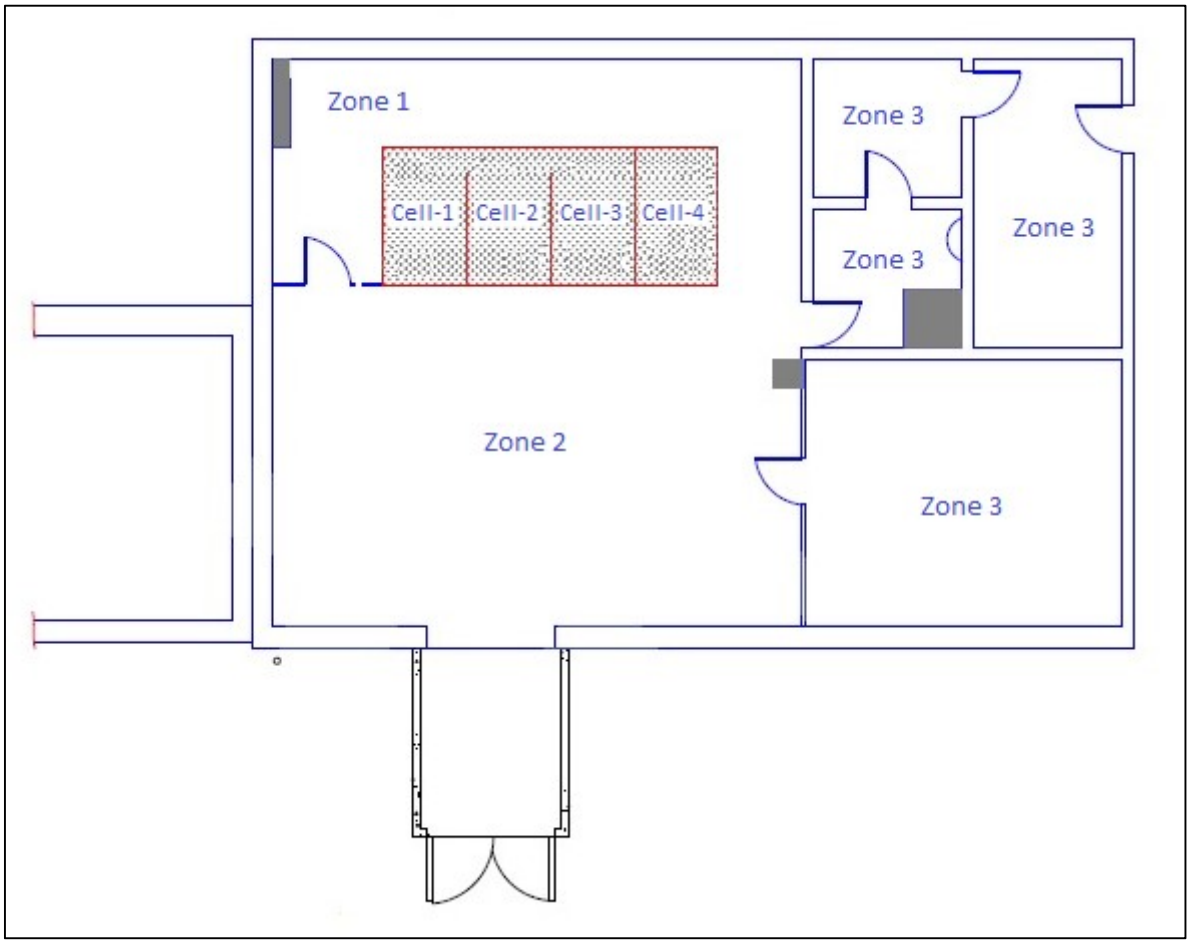

Fig. 3: LFPS ground floor map

Additional LPFS supporting systems can include air exhaustion (activated charcoal and absolute filters), vacuum, air compressor and power generation.

3. HOT-CELLS SPECIFIC OPERATIONS

The hot-cells are shielded nuclear radiation containment metal boxes used for radioactive material handling without human exposure. Hot-cells are commonly composed by lead shielding at least 100 mm of thickness, lead glass to watch the handling, remote manipulators (telemanipulators or tongs) and command panel.

Specific operations are performed inside hot-cells, according to the line production. The attributions can be described below as [1]:

- Primary hot-cell: source activities measurements [4], stainless steel source encapsulation by TIG welding;
- Secondary hot-cell No.1: contamination and decontamination actions, leakage tests as well ISO 2919 and ISO 9978 following standard recommendations [4] [5];
- Secondary hot-cell No.2: lixiviation test [5] and fixing of the source holder parts (e.g. pigtail), as shown in Fig. 4;
- Secondary hot-cell No.3: source activity checking and source fixing in projector devices.

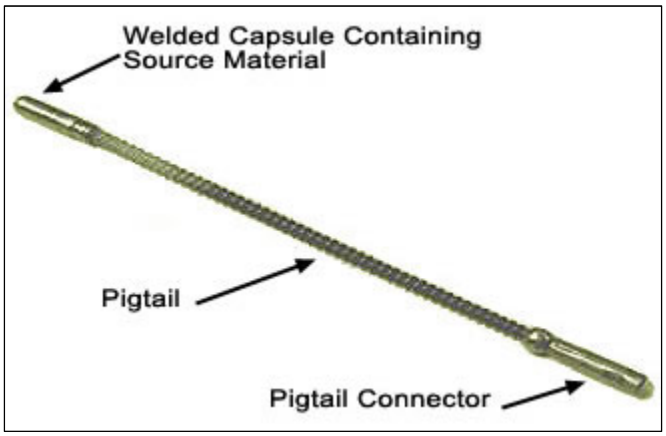

Fig. 4: Source holder: pigtail and pigtail connector.

In order to attend ALARA principles, radiation monitors and alarming systems are placed around the hot-cells. TLD dosimeters are using to monitoring workers and areas [1] [6].

4. DESCRIPTION OF THE ACTIVITIES

One of the most important activities developed at the LPFS is the action to open the containers with radioactive sealed sources (new sources batch) sent by the producers from outside of the country. Fig.5 shows the flowchart of this procedure following a specific steps sequence. Removing of the depleted radioactive sources from the projector devices and installation of fresh radioactive material is also a mean process as shown in Fig. 6.

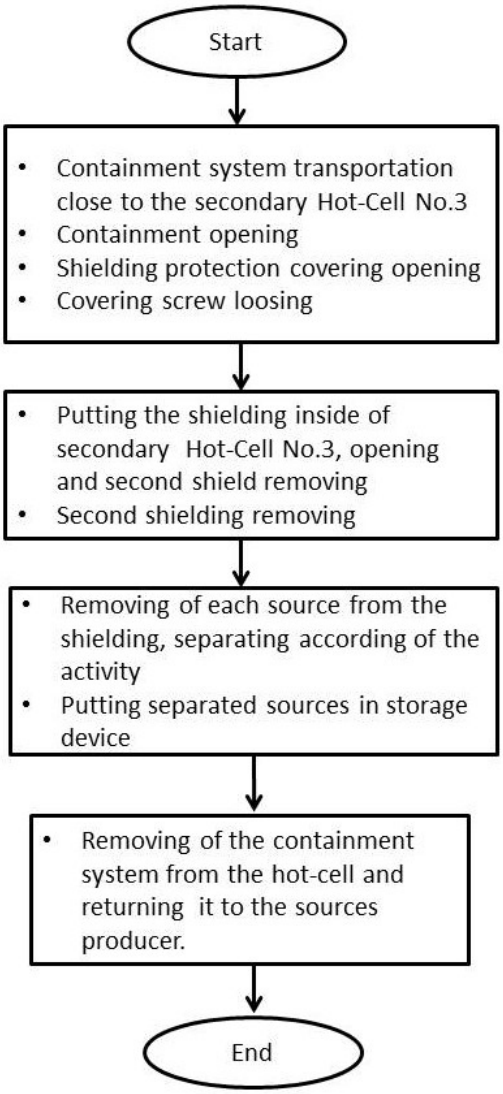

Fig.5: Opening a new radioactive sources batch

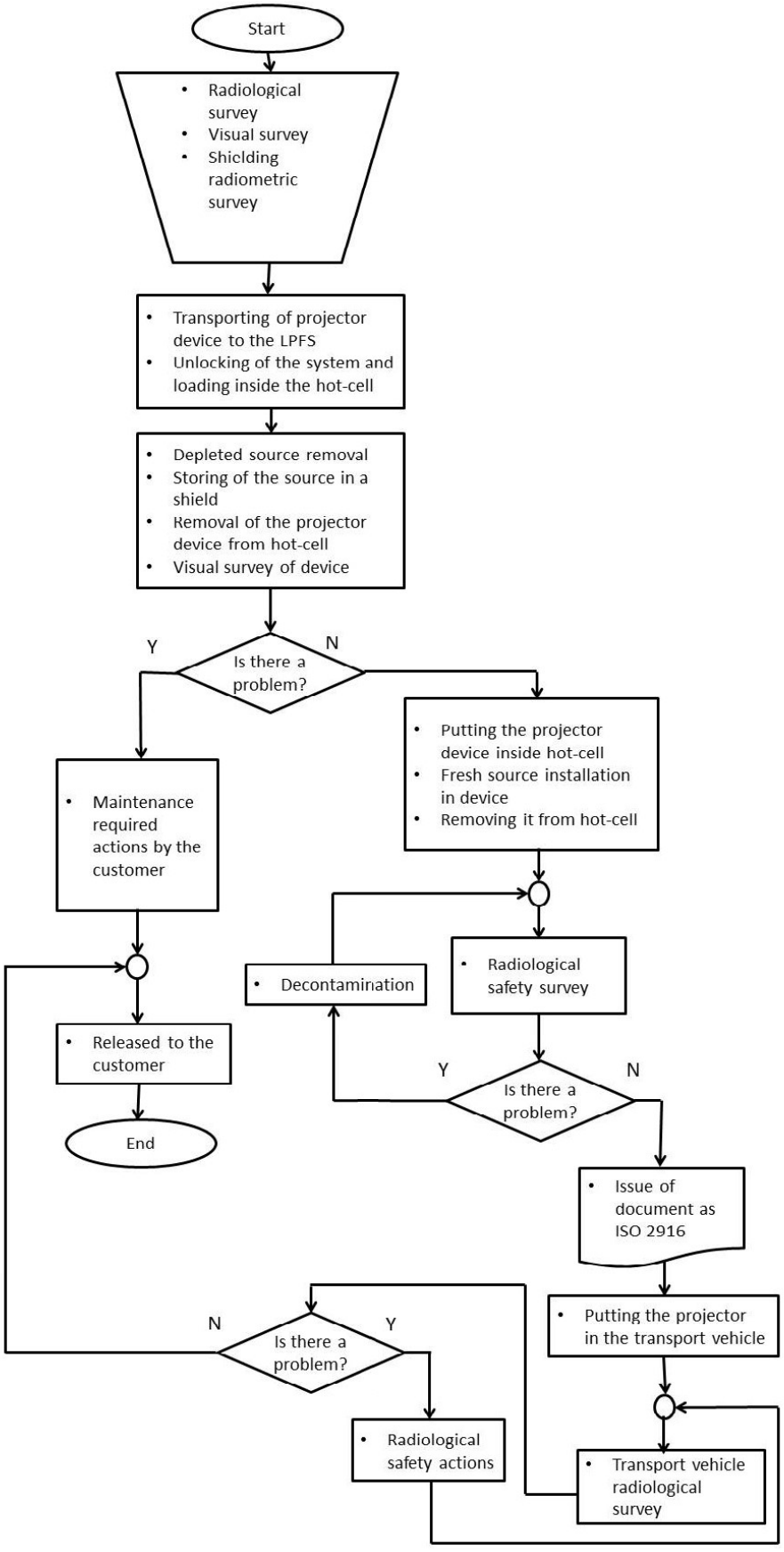

Fig. 6: Changing a source of exposure device

3. CONCLUSIONS

In this work, the means activities and procedures performed by the LPFS at IPEN-CNEN were described. LPFS has been supplying radioactive sealed sources for the industrial Brazilian market regarded to the industrial radiography applications. The developed flowcharts of the LPFS procedures helped to visualize and understand the complexity of the total system. Flowcharts of procedures could improve individual and total processes as such helping to apply correcting actions to avoid failures.

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