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SEALED SOURCE DISMANTLING HOT CELL - STARTUP

José Claudio Dellamano, Robson de Jesus Ferreira

Gerência de Rejeitos Radioativos - GRR
Instituto de Pesquisas Energéticas e Nucleares – IPEN-CNEN/SP
Av. Prof. Lineu Prestes, 2242
05508-000 São Paulo, SP
jcdellam@ipen.br; rojefer@ipen.br

ABSTRACT

Sealed radioactive sources are widely used in many applications of nuclear technology and at the end of the useful life, most sources become radioactive waste. In Brazil, this waste is received by the Institutes of the National Nuclear Energy Commission and kept under centralized storage. The Waste Management Department at the Nuclear and Energy Research Institute is the main storage center, having received around 20,000 disused sources. A hot cell was designed and constructed to manage Co-60 spent sealed sources with activity up to $3.7\ 10^{10}$ Bq and other sources with equivalent activities. In the hot cell the sources are withdraw from their original shielding and transferred to a standard shielding for further disposal off. The original shielding disassembling is made outside the hot cell and after opening, it is transferred inside the hot cell and the sealed source is removed remotely. The source is checked in relation to external contamination and its activity is checked. After this, the source is positioned in the standard shielding located inside an overpack at the bottom of the hot cell. This paper describes some pre-operational tests carried out in it, that include: opening and closing doors and locks, checking of all electrical and pneumatic controls, the original shielding movement inside the hot-cell, dose rate measurements outside the hot-cell, insertion of the sealed sources inside the activity meter chamber, transferring the sealed source to the standard shielding, movement of the overpack with the standard shielding to outside of the hot-cell and plugging of the standard shielding.

1. INTRODUCTION

Sealed radioactive source, SRS, is defined by National Nuclear Energy Commission (CNEN) as “encapsulated radioactive material designed to maintain leak tightness under conditions of specific application” [1].

SRS are widely used in many applications of nuclear technology in industry, medicine, research and others. According International Atomic Energy Agency (IAEA) the number of SRS worldwide is estimated to be in the millions [2]. In Brazil, considering radioactive sources from lightning rods and smoke detectors, this number is approximately 500,000 [3].

The main reasons to make a SRS useless are technical substitution, decay and malfunction [4, 5]. IAEA recommends that when a SRS is no longer to be used for its dedicated purpose, three options can be adopted for its management: transfer to another user for application elsewhere; return to the manufacturer/supplier; treatment as radioactive waste [2]. A small number of manufacturers around the world had foreseen the SRS return as part of the commercial process [5].

In Brazil, the two former options are not adopted for spent SRS and the management proposed is its treatment as radioactive waste [6, 7]. After used, the spent SRS are sent to one of the CNEN's Institutes for interim storage, further treatment and disposal.

Gerência de Rejeitos Radioativos (GRR) of the Instituto de Pesquisas Energéticas e Nucleares (IPEN) is the main center in the country dedicated to the management of non-fuel cycle radioactive wastes and it had received until the beginning of 2013 around 18,000 spent SRS [8], excluding Am-241radioactive sources from smoke detectors and lightning rods. Almost all spent SRS remain stored at GR in their original shielding. Table 1 presents the inventory and quantities of the spent SRS received and stored at GRR.

Table 1 – Spent SRR stored at Waste Management Department [8]

Radioisotope	Quantity	Emission type
^{192}Ir	7,084	β^-, γ
^{226}Ra	3,071	α, β^-, γ
^{137}Cs	2,190	β^-, γ
^{60}Co	1,883	β^-, γ
Unknown RI / Activity (1)	1,408	α, β-, γ
^{210}Po	349	α, γ
^{85}Kr	247	β^-, γ
^{90}Sr	203	β^-
^{147}Pm	153	β^-, γ
^{241}Am	174	α, γ
^{63}Ni, ^{204}Tl, ^{244}Cm, ^{22}Na, ^{55}Fe, ^{109}Cd, ^{133}Ba and others (2)	388	α, β^-, β^+ and γ
Total (3)	17,150	

(1) – Spent SRS without information – either unknown radioisotope or unknown activity.
(2) – Spent SRS of other miscellaneous radioisotopes.
(3) – Total excluding Am-241radioactive sources from smoke detectors and lightning rods.

Since 2005, GRR has studied processes to treat the spent SRS stored at its installations, in order to reduce the radioactive waste volume and to provide requirements established for transport and disposal, in order to contribute to the national strategy for spent SRS management, to be adopted in Brazil.

The proposed solution is the spent SRS withdrawn from its original shielding and its transference to a standard shielding, inside a hot cell, in order to protect all workers.

The construction of the hot cell was concluded at the end of 2012 and some start up tests were carried out at the beginning of 2013. This paper describes these pre-operational tests and the startup of the facility.

2. TREATMENT PROCESS DESCRIPTION

The hot cell was constructed with stainless steel structure, in order to bear the weight of lead bricks that is 100 mm thickness in the walls and floor and 50 mm in the roof. It is 1.8 m long, 1.0 m depth and 1.3 m high, covered inside with stainless steel in order to facilitate cleaning and eventual contamination. It has lead windows and pincer in both side and a panel for electrical and pneumatic control.

The hot cell was designed to treat up to 3.7 10^{10} Bq of sealed sources with energies equal or below Co-60. More than 90% of the stored SRS at GRR are included in this group and can be treated in this facility.

Figure 1 shows a picture of the facility and can be used to follow the treatment process that will be described as follow.

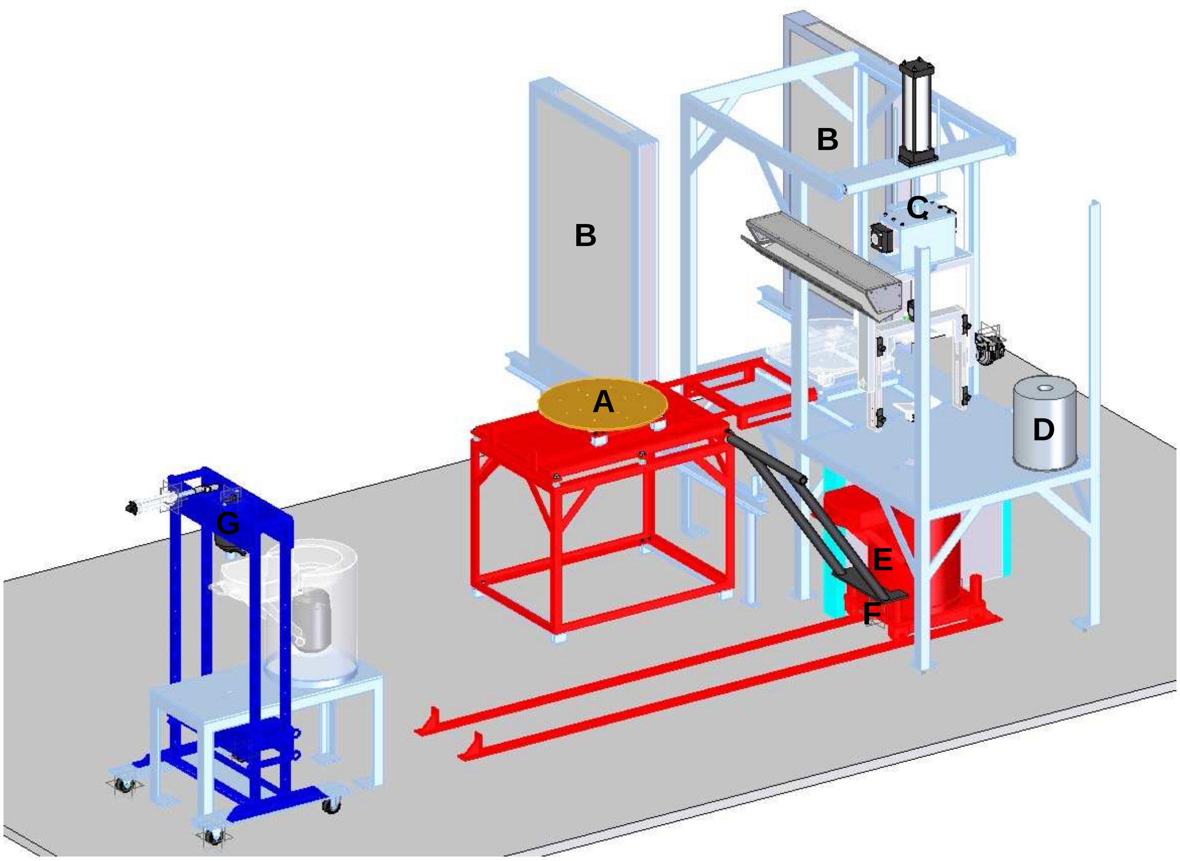

Figure 1 – Sealed radioactive source treatment facility

The opening and unlocking of the original shielding are carried out manually and outside of the hot cell, over a moving table (A). When the shielding is completely unlocking, contamination is evaluated by the wipe test and if there is no contamination it is transferred to inside. The doors (B) are closed and a rotation/elevation pneumatic system (C) allows the shielding to be positioned upside down and the SRS can “fall” on the floor of the hot-cell. The source is inserted inside the activimeter counting chamber (D) to certify the characterization and then transferred to the standard shielding (E) located at the bottom of the hot cell. After completely full, the over pack of the standard shielding is pulled using a barrow (F). The standard shielding is closed with a cap using a press (G). After closing it the standard shielding is transferred to the interim storage of the GRR.

3. STARTUP TESTS

The performance evaluation of the unity was carried out using SRS previously characterized, according procedures developed at GRR [9]. The main topics evaluated will be described as follow.

- Doors closing/opening – The switches and the locking devices functioned in a satisfactory way;
- Pneumatic/electric system – All switches and pneumatic/electric controls were checked and some of them were replaced due to either operation failure, malfunction or leakage of compressed air;
- Rotation/elevation system – It was not possible work with shielding smaller than 20 cm diameter because the pneumatic valve that it is used to fix it has its course limited. It was used a filler material between the fork and the shielding;
- Radiation leakage – The leakage assays were carried out with the Radiation Protection staff and using a SRS of Co-60 with 1.8 10^{10} Bq. The SRS was positioned in the middle of the hot cell and the measurements were done around all external surface of the hot cell. Only the upside presented results higher than background level. It was expected since the thickness in the upside is half of those in the walls. The higher values measured were around 10 µSv/h (on the surface). Radiation measurements were also done in the Chemical Lab that is located over the hot cell and the level was the same of the background;
- SRS characterization – the insertion and withdrawing of the SRS in the counting chamber was done using a sample holder. These tasks are relatively easy even considering the handling by means of pincers;
- Transfer to the standard shielding – The SRS insertion in the standard shielding located under the hot cell was also relatively easy even considering the handling by means of pincers;
- Over pack of the standard shielding moving – The over pack moving is difficult at the beginning due to the heavy weight (400 kg);
- Standard shielding cap – There was no problems with the shielding closure, but the exact positioning of it under the press was done by two workers and demanded more time than it was foreseen.

3. DISCUSSION

The unit presented safety conditions to carry out all process steps including opening, unlocking, characterization, transference and closure.
Some modifications are being done in the rotation/elevation system in order to allow the work with shielding smaller than 20 cm diameter.
Some modifications are also being done in the press in order to facilitate the positioning of the standard shielding for closure.
Although all wipe tests had not indicated contamination (using 20 SRS), some studies are been carried out to evaluate the contamination due to SRS leakage, inside the hot cell. This modification will improve the safety for workers and will minimize risks in the facility.

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