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SAFE MANAGEMENT OF SMOKE DETECTORS CONTAINING RADIOACTIVE SOURCES

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ABSTRACT

Ionic smoke detectors contain radioactive sources that could be of Am-241, Pu-238, Pu-239, Kr-85, or other radionuclides. Although the activity of these devices is very low, their distribution and use is under regulatory control, and when become disused, should be managed as radioactive waste. More than 25 000 smoke detectors have been collected and stored at the Centralized Waste Management Facility in Cuba.
The safe management of ionic smoke detectors consists in dismantling the devices, recovering the radioactive sources and conditioning them for long term storage and future disposal. Most of smoke detectors contain long lived radioactive sources (Am-241, Pu-238 and Pu-239), therefore especial attention is given to the management of these sources. The rest of non-radioactive materials are segregated (plastic, metal and electronic components) for recycling. A technical manual with specific instructions for all operations, including dismantling of detectors, segregation and management of non-active parts, recovering and conditioning of radioactive sources, has been developed.

1. INTRODUCTION

Ionic smoke detectors contain very low activity radioactive sources, close to the exemption values established in Cuban Regulations [1]. However, due to the large number of these devices collected together and the long half-life of the sources, special attention should be paid to the safe management of these devices when become disused.

According to Cuban regulations [2], smoke detectors, once declared disused, should be managed as radioactive waste. For this reason, disused smoke detectors should be transferred to the Centre for Radiation Protection and Hygiene (CPHR), the organization responsible for radioactive waste management in the country. The CPHR have been collected over 25 000 smoke detectors in the past 10 years and stored at the Centralized Waste Management Facility.

Hundreds of containers with different models of smoke detectors are stored in the facility (fig.1). In order to improve the safety and security of the long lived sources and minimize the volume of waste in the storage facility, it is recommended to dismantle those devices, remove and consolidate the sources and condition for long term storage. The rest of non-radioactive materials should be segregated (plastic, metal and electronic components) for recycling.

Fig.1. Smoke detectors stored in the waste management facility

2. INVENTORY OF SMOKE DETECTORS IN THE STORAGE FACILITY

Smoke detectors have been collected from different institutions around the country. The information regarding the radionuclide contained in the source and the activity was unknown for some models of these devices.

Before starting the detectors dismantling and source recovery operations, the detail inventory of smoke detectors stored in the facility was revised and updated. The relevant information was obtained and updated from: (a) the waste collection formularies with information provided by the users, (b) the registry (database) of disused radioactive sources in the storage facility, (c) commercial catalogues from manufacturers and distributors, (d) labels contained on some devices, and (e) other international references [3]. Some measurements have been carried out, using a gamma spectrometric system, to corroborate the available information.

Thereby, 28 different models of smoke detectors have been identified from different origin. They contain between 18 to 37 kBq of Am-241 or between 0.37 and 37 MBq of Plutonium or around 37 MBq of Kr-85. This information has been updated in the corresponding registry for disused radioactive source stored in the facility.

3. DISMANTLING OF SMOKE DETECTORS AND RECOVERING THE RADIOACTIVE SOURCES

The safe management of ionic smoke detectors involves the device dismantling, and the recovering and conditioning of the associated radioactive sources for long term storage and disposal. A technical manual has been developed with specific instructions for dismantling each model of smoke detector and recovering the radioactive sources. Plastic covers, electronic and metallic components are removed until the source holder is reached. The next step involves the source removal from the holder and the corresponding conditioning operations.

Examples of dismantling operations for similar types of smoke detectors: System Sensor (different models), Notifier CPX 551, EST 1551F and Ademco 4192 are shown in fig. 2. Those devices contain an Am-241 radioactive source with activity less than 18.5 or 37 kBq (0.5 – 1 µCi).

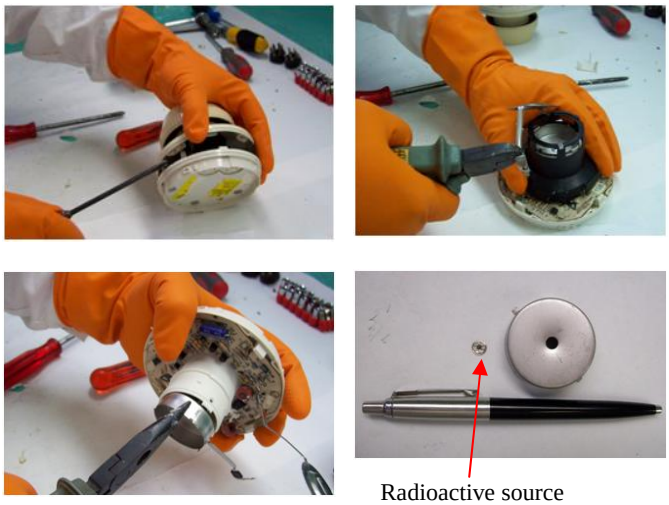

Fig.2. Dismantling smoke detectors and recovering the radioactive sources

Smoke detectors RID-I and RID-6M, of Russian origin, contain Pu-238 and Pu-239 radioactive sources type “ADI”. These devices generally have two sources, with an individual activity of 18.5 MBq (0.5 mCi). Specific instructions for dismantling these models of smoke detectors are also included in the manual (fig.3).

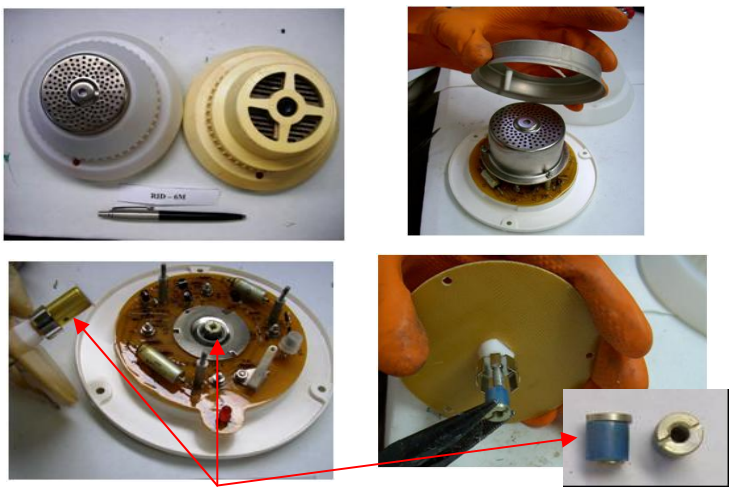

Fig.3. Dismantling smoke detectors (RID 6M) and recovering the radioactive sources

More than 2000 smoke detectors, models Robotron and RFT from Germany, containing Kr-85 radioactive sources are stored in the facility. Specific procedures for dismantling these devices and recovering the radioactive sources were developed and implemented (fig. 4).

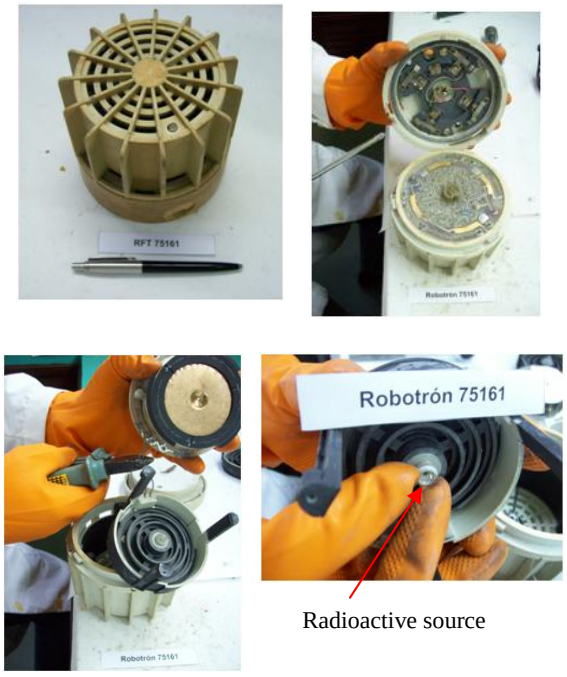

Fig.4. Dismantling smoke detectors (RFT and Robotron) and recovering the radioactive sources

Recovered radioactive sources are placed in small containers, depending on the radionuclide and individual source activities (fig. 5). More than 5300 smoke detectors have been dismantled following this methodology.

Fig.5. Radioactive sources recovered from smoke detectors awaiting conditioning

Non-radioactive components (metallic, plastic and electronic parts) are segregated and then recycled through appropriate organizations. Labels containing information regarding the radioactive sources as well as the ionizing radiation symbol are removed from these parts before taking them out from the Waste Management Facility.

4. CONDITIONING OF LONG LIVED RADIOACTIVE SOURCES

Most of smoke detectors contain long lived radioactive sources (Am-241, Pu-238 and Pu-239), and therefore especial attention is given to the management of these sources. A methodology has been developed for conditioning of radioactive sources, consisting in encapsulation for long term storage.

The long lived radioactive sources Am-241, Pu-238 and Pu-239 are placed in stainless steel capsules (fig. 6). Sources of the same radionuclide and individual activity are placed in a capsule. The number of sources and the total activity in the capsule is controlled and recorded. As the activity of a source is very low, the amount of sources to be placed in a capsule is limited by the source volume and the capacity of the capsule.

Fig.6. Long lived radioactive sources placed in a capsule for conditioning

Once loaded, the capsule is sealed by placing and welding the lid. Welded capsules are then submitted to leakage test, which is performed according to the International Standard ISO 9978 [5]. Sealed capsules are placed in a concrete-lined drum.

A package is being prepared with Am-241 radioactive sources recovered from smoke detectors. So far 5300 Am-241 sources, in 21 capsules, with a total activity of 160 MBq have been placed within the concrete lined drum. This package has not been completed yet. Other conditioned capsules containing long lived radioactive sources will be placed in it.

The compliance with the waste acceptance criteria for the storage facility is being controlled and recorded: identification of the waste package, radiation levels at the surface and 1 meter, radioactive content (radionuclides and activities) and the surface contamination. The

formulary for the waste package is completed with a detailed description of the package and the capsules with radioactive sources. The retrievability of the sources (sealed capsules with radioactive sources) for future disposal has carefully been considered.
The doses to be received by operators and by operations have been estimated and are controlled. All radiation protection measures are in place and all operations are approved/ authorized by the competent authority.

The activities described in this paper were carried out within the framework of a Bilateral Collaboration Project between the Centre for Radiation Protection and Hygiene of Cuba and the Atomic Centre Ezeiza from the National Commission of Atomic Energy of Argentina.

5. CONCLUSIONS

A methodology has been developed and implemented for dismantling 28 different models of smoke detectors and recovering the associated radioactive sources.

Most of smoke detectors contain long lived radioactive sources (Am-241, Pu-238 and Pu-239), therefore specific procedure were developed and implemented for the proper conditioning of the sources, guarantying the safe long term storage and retrievability for the final disposal.

6. ACKNOWLEDGMENTS

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7. REFERENCES

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