Occupational Doses Involved in a Radioactive Waste Management Laboratory

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Abstract. The Radioactive Waste Laboratory (RWL) of IPEN-CNEN/SP receives, treats, packs, characterizes and stores institutional radioactive wastes, in their physical forms solid, liquid or gaseous and sealed radioactive sources, with the objective to assure an adequate level of protection to the population and to future generations and the preservation of environment. Since its creation, RWL has already received and treated about one thousand cubic meter of solid waste, eight thousand spent sealed radioactive sources from practices in industry, medicine and research, totaling more than 100 TBq. In addition, fifteen thousand radioactive lightning rods and twenty two thousand radioactive smoke detectors were received. The activities accomplished in RWL, as dismantling of lightning rods, compaction of solid wastes, decontamination of objects, waste characterization, treated waste packages rearrangement, among others, cause risks of intake and/or external exposure of workers. Requirements of radiological safety established in the regulations of the nuclear authority and international recommendations are consolidated in the RWL radioprotection plan in order to ensure the safety and protection of workers. In this paper, it was evaluated if the procedures adopted were in accordance with the requirements established in the radioprotection plan. It was also studied which activities in the waste management had substantial contribution to the occupational doses of the RWL workers in the period from 2001 up to 2006. For that, the radioprotection plan, the operational and safety procedures, the records of workplace monitoring and the individual dose reports were analyzed. It was observed that the highest individual doses resulted from operations of treated waste packages rearrangement in the facility, and none of the workers received doses above the annual limit.

KEYWORDS: radiological protection, waste management, individual doses, occupational radiation exposure.

1. Introduction

Radioactive Waste Laboratory (RWL) of the Nuclear and Energy Research Institute, IPEN – CNEN/SP, receives, treats, packs, characterizes and stores institutional radioactive wastes from several radioactive facilities in the country, in order to assure an adequate level of protection to the population and to future generations and the preservation of environment. These wastes are in several forms solid, liquid or gaseous and sealed radioactive sources. Since its creation, RWL has already received and treated about one thousand cubic meters of solid waste and eight thousand spent sealed radioactive sources from practices in industry, medicine and research, totaling more than 100 TBq. There are also fifteen thousand radioactive lightning rods and twenty two thousand radioactive smoke detectors stored.

The RWL has four buildings. The main building is divided in two sectors; the first floor is the treatment area constituted by laboratories for characterization, decontamination, liquid waste treatment, cementing, compaction, spent sources dismantling, spent sources storage and lighting rods dismantling; on the second floor there are administrative rooms and research laboratories. In addition, the RWL has one building to store treated wastes, other to store radiotherapy spent sources and another to keep the resins and charcoal originated from the IEA-R1 research reactor.

The activities carried out at RWL, such as dismantling of lightning rods, compaction of solid waste, decontamination of objects, waste characterization, rearrangement of packages of treated waste, among others, cause risk of intake and/or external exposure of workers. The main goal of radioactive waste management has been to limit the exposure of individuals to acceptable levels with the spirit of the ALARA principle (As Low As Reasonably Achievable). The radiological safety requirements set

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out in the regulations of the nuclear authority and in the international recommendations are consolidated in the radioprotection program of RWL. The aim of this program is to ensure the radiation safety of workers, public and environment and, thereby, to encourage the use of nuclear technology. The objective of this study was to evaluate whether the adopted procedures were in accordance with the requirements established in the radioprotection plan. It was also studied which waste management activities had substantial contribution to the occupational doses of the RWL workers in the period from 2001 to 2006.

2. Methodology

The written procedures adopted for the various routines of the operational units were studied and their adherence to the radioprotection plan were analyzed. Routine monitoring of the workplace for dose rates and for surface contamination were held monthly. Thermoluminescent dosimeters (TLD) were also used for area monitoring and they were exchanged every three months.

The evaluation of personal occupational doses was made with TLD and had a monthly basis for exchange. Bioassay and whole body counting were made in an annual basis and in cases of suspected intake of radioactive material. The registered personal occupational dose distribution in the RWL are presented in Table 1. Most workers received annual individual doses lower than 2.0 mSv. Only one worker received annual dose above 5.0 mSv.

Table 1: Personal occupational dose distribution in the RWL.

Year	Radiation workers monitored	Number of radiation workers and their dose distribution			
		0.00 to 1.00 (mSv)	1.01 to 2.00 (mSv)	2.01 to 5.00 (mSv)	5.01 to 10.00 (mSv)
2001	14	13	01	0	0
2002	14	12	03	0	0
2003	13	06	03	03	01
2004	14	12	02	0	0
2005	15	11	03	01	0
2006	15	14	0	01	0

The collective dose, the maximum personal dose and the maximum monthly personal dose are presented in Table 2.

Table 2: Dose records in the RWL workers.

Year	2001	2002	2003	2004	2005	2006
Number of radiation workers	14	14	13	13	15	15
Annual collective dose (person.mSv)	2.52	1.15	18.96	3.62	9.48	6.96
Maximum annual personal dose (mSv)	1.13	0.62	6.92	1.20	3.29	4.86
Maximum monthly personal dose (mSv)	1.13	0.41	2.38	0.62	1.55	1.34

The gamma dose rate monitoring performed in RWL showed that the highest doses rates are in the spent sources storage room. In this room, the activities are planned and supervised by the radioprotection team. The dose rates in other laboratories were smaller than 20 μGy/h. Average dose rate values for 2002 to 2006 are given in Table 3. An exception mean value of 799 μGy/h for the

liquid waste treatment room was detected in 2003, because of temporary storage of spent resins and charcoal filter originated from the IEA-R1 research reactor.

Table 3: Average gamma dose rate in the workplace.

	Average Dose Rate (μGy/h)			
Workplace	2003	2004	2005	2006
Decontamination	19.0	6.2	0.4	0.6
Liquid waste	799.0	14.7	2.5	5.0
Lighting rods	2.0	1.1	0.5	1.1
Compaction	39.0	9.8	9.5	9.8
Cementing	3.0	1.2	1.2	1.2
Spent sources storage	499.0	377.5	105.8	98.8

3. Discussion

The waste management practices and operations in the RWL have been accomplished in strict compliance with the IAEA guidelines [1] and the national nuclear authority regulations [2, 3].

The RWL is constituted by fours buildings, the first floor of the main building is the treatment area composed by characterization, decontamination, liquid waste treatment, compaction, cementing, spent sources dismantling, spent sources storage and lighting rods dismantling laboratories. This treatment area is designated as controlled area. The others three buildings are also controlled areas and in these buildings the treated wastes, radiotherapy spent sealed sources and resins and charcoal from the research reactor are stored.

TLD is used for personnel dosimetry and are evaluated on calendar monthly basis. The workers are continually monitored for occupational doses and their dose record is kept for 30 years after their retirement.

The number of records for monitored individuals is an indication of the size of a dosimetry program, but it is not necessarily an indicator of the size of the exposed workforce. This is because of the conservative practice at IPEN facilities of providing radiation dose monitoring to individuals for reasons other than the potential for exposure to radiation and/or radioactive materials exceeding the monitoring thresholds. Many individuals are monitored for reasons such as security, administrative convenience, and legal liability.

Analysis of dose record provides information about effectiveness of the radiological protection procedures and services. The annual average effective dose values are shown in the Table 1 for the six year reported period (2001 to 2006). Six consecutive years have been chosen in order to show compliance with the effective dose limit of 50 mSv during any single year, and that the total of 100 mSv in five consecutive years was not exceeded [1, 2].

No individuals received a dose in excess of the nuclear authority limits during the analyzed period. The annual personal doses were smaller than 5 mSv, with exception to one worker that received 6.93 mSv in 2003 year. The highest doses recorded were 6.93 mSv for only one worker and 4.86 mSv for another worker during 2003 and 2006, respectively. Bioassay and whole body counting for internal contamination of all the workers showed no case of internal contamination during the analyzed period.

In the year 2003, three workers received doses from 2.01 to 5.0 mSv, and one worker received 6.93 mSv. In this period the collective and individual doses were higher. This fact was consequence of receiving spent ion-exchange resins and charcoal filters originated from the IEA-R1 research reactor. In addition, in this operation there was rearrangement of treated waste drums to other building.

An improved working environment in the interim storage were observed, in spite of increased activity due to increasing of operation in time, as a result of good housekeeping, improved handling techniques, and shielding.

4. Conclusions

In conclusion, the assessment of occupational radiation exposure for 2001-2006 year showed that none of the workers received doses above the annual limit. It was observed that the highest individual doses resulted from operations of treated waste packages rearrangement in the facility.

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