Safety Systems of Radioactive Sources in Atomic Energy Centre Dhaka, Bangladesh and its Implication on Public Health

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1. Background and Objective of the present study

Radioactive sources are being extensively used in medicine, agriculture, industry, research & education, etc. in Bangladesh and its usage increasing with the socio-economic development of the country. Atomic Energy Centre Dhaka (AECD) was established in 1964 at University of Dhaka campus and it is the oldest radioactive sources R & D institute of the country. Various types of radioactive sources (high & low activities) are used for training, services, research & education purposes and radioactive wastes storage room available in AECD.

This paper gives an outline of the latest safety systems for radioactive sources in AECD. Bangladesh Atomic Energy Regulatory (BAER) Act-2012 & Nuclear Safety and Radiation Control (NSRC) Rules-1997 mentioned that radioactive sources to be managed during usage or storage at the facility in such a way that minimize the harmful effects from ionizing radiation on radiation worker, public and the environment.

The objective of the present study is to ensure the safe handling or storage of the radioactive sources in a facility that is very important for protection of the people and the environment from unnecessary radiation hazard now and future.

2. Materials and Methods

BAER Act-2012 incorporated the 10 fundamental safety principles of radioactive sources [1]. Safety report has to submit to the regulatory body in order to renew the license of the AECD in every year as per NSRC Rules-1997 of Bangladesh. Radiation Protection Officer (RPO) of AECD (two personnel) have been approved from the regulatory body in order to ensure the safety of the radiation worker, public & the environment. Security and access control has been maintained at radioactive source rooms and disused radioactive sources storage room to avoid the unauthorized access of workers, public and the unauthorized removal of radioactive sources. Radioactive sources of AECD were kept in the lead & concrete shielding structures for minimizing hazard to radiation worker, public and the environment. RPOs of AECD used to train the personnel through training course, on the job training, seminars, etc., for safe handling of radioactive sources so that AECD staff maintain ALARA principle.

2.1. Concrete structure for shielding

- Various kinds of low & high activities radioactive sources were kept in the shielding structures
- Various kinds of low activity radioactive wastes were stored in the special concrete holes of a large room (L-shape) of the AECD
- High activity radioactive wastes were buried at the shallow land in the special concrete structures of a large room (L-shape) of the AECD
- Most important approach for pre-disposal management of radioactive sources is delay & decay process.

2.2. Emergency preparedness and response

Emergency preparedness and response has been implemented as per National Nuclear and Radiological Emergency Preparedness and Response Plan-2020. The emergency plan of AECD includes the training of staff to be capable to identify and response to an unusual event or emergency, the assignment of each member of the team and appropriate arrangement of personal protective equipments to ensure the protection of the emergency workers. For instance, in case of unusual events such as spill in a laboratory, loss of radioisotopes, or fire, AECD has trained staff to response and restore the situation.

- Proper fire protection systems (smoke detectors, fire extinguishers) have been installed
- Entry & exit gates have 24/7 security personnel to control unauthorized access.

2.3. Spent sealed sources

Sealed radioactive sources after its useful experimental life are categorized as waste which requires be appropriately conditioning and managing safely. Spent radioactive sources are divided into the following categories [2]:

- Radioactive sources with half-life less than 100 days and high activity, namely ^{192}Ir (200-1500 MBq)
- Radioactive sources of low activity used for equipments calibration
- Radioactive sources with a potential discharge and contamination hazard. Special safety and radiological preventive measures to be taken for handling and storage of spent radium sources and radioactive sources which has the probability of leaking
- Radioactive sources with half-life greater than 100 days for low or high activity.

2.4. Decay storage

Radioactive waste is stored for decay and mostly important for the clearance of radioactive waste containing short lived radioisotopes. Clearance is the elimination of the radioactive substances from the regulatory control. It is proven that radioactive substances storage for decay is appropriate for waste contaminated by radioisotopes with half-life of less than about 100 days [3]. The radioactive sources were stored at AECD in the special concrete holes. The height of the concrete wall was 85 cm and depth is 64 cm.

Table 1. List of few radioactive sources and activities in AECD

Name of radioactive source	Activity	Name of radioactive source	Activity
^{137}Cs	0.5 mCi, 1-58μCi	^{60}Co	5-48 mCi
^{60}Co	1-10 μCi	Am-Be	300 mCi
^{226}Ra	0.9 μCi	^{113m}In	54 mCi
^{90}Y	0.89 mCi	^{109}Cd	20-30 mCi
^{90}Sr	5 mCi, 10 mCi	**^{192}Ir**	**106.6 Ci, 104Ci**
Am-Be	**5 Ci**	^{137}Cs	8 mCi
Am-Be	40 mCi	^{54}Mn	0.97-11.42 μCi

2.5. Radiation monitoring

Continuous radiation monitoring is performed using thermoluminescent dosimeter (TLD) in & around the AECD campus. Real-time radiation monitoring is performed using digital portable radiation monitoring devices in & around the AECD campus for detection of abnormal situation.

3. Results and Discussion

AECD is the first radioactive sources R & D institute of the country and running more than fifty years in a safe and secure manner. AECD situated in the University of Dhaka campus where more than 37,000 students studying. This is the busiest place of the capital city. So, proper management of radioactive sources is vital for safety of the people and the environment now and future.

3.1. Radiation monitoring

The calculated mean annual effective dose to the public in & around the AECD campus was 0.256 ± 0.042 mSv, which is lower than the annual dose limit (1 mSv). Excess life-time cancer risk (ELCR) on public health around the AECD campus was estimated based on the radiation monitoring data and mean was 1.060 X 10^{-3} [4, 5]. The average ELCR on public at outdoor locations of the AECD campus is 3 times higher than that of the worldwide average value of 0.29 X 10^{-3}.

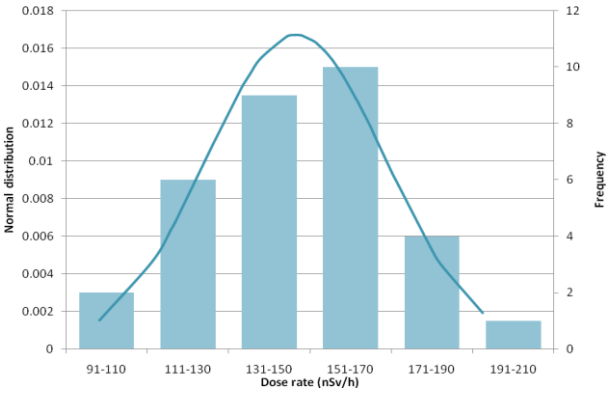

Fig.1.Frequency distribution of dose rate (nSv/h) in & around the AECD campus.

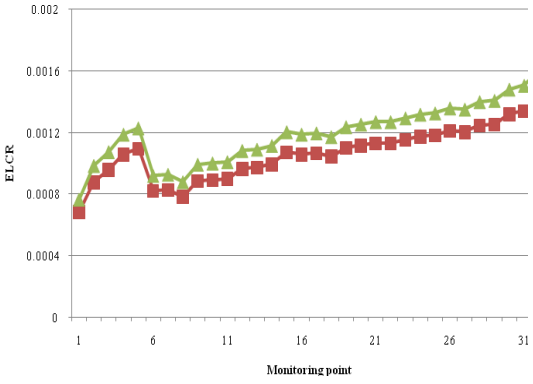

Fig.2.ELCR on public health in & around the AECD campus (green is ICRP recommendation & red is BEIR recommendation).

4. Conclusions

- The real-time radiation dose rate in & around the AECD campus is comparable to the other parts of the Dhaka city which ensure the safety of the radiation worker, public and the environment. So, it is observed from the study that impact of radioactive sources to the surrounding environment & public health is negligible.