XA0054291

IAEA-CN-78/98

SAFE MANAGEMENT OF SEALED RADIOACTIVE SOURCES AT KARACHI NUCLEAR POWER COMPLEX

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Abstract

This paper describes the conditioning of sealed radioactive sources, carried out at the Karachi Nuclear Power Complex (KNPC) in co-operation with the IAEA. The radioactive sources were radium needles of various size, used by various radiotherapy units in different hospitals throughout the country. For some time the use of radium needles had been abandoned and they were stored in hospitals awaiting proper disposal. Since their storage conditions were not ideal and there was a potential of leakage of radioactive material into the environment, it was decided to condition and store them safely. A significant logistic effort was required to identify these sources, bring them to a central facility and condition them according to current international standards. Various steps were involved in conditioning the sources: place it in a stainless steel capsule, weld the capsule, test it for a leak, place the capsule in a lead shielded package, put and seal the shielded package in a concrete-lined steel drum and finally store it at the waste storage facility. A total amount of about 1500 mg of Radium needles were conditioned. Radiation exposure during the entire operation was within acceptable limits.

1. INTRODUCTION

The Karachi Nuclear Power Complex (KNPC) consists of a 137 MWe CANDU PHWR. It is located at Paradise Point on the Arabian Sea coast, 25 Km west of Karachi. The reactor has been generating power since October 1971. KNPC manages its own radioactive waste. A waste disposal area was designated near the plant. This area, measuring about 36m × 70m, is located approximately 1 km north of the plant, is within the plant's boundary and has been provided for long-term, retrievable storage of low level solid radioactive waste. Wastes are placed in concrete lined trenches and, when a trench is nearly full, it is filled with about 60cm of inert material to seal it off from the environment. Finally it is covered by a concrete lid. KNPC also makes this facility available to users of small amounts of radioactive material by receiving and safely managing their radioactive wastes. These wastes are mostly from hospitals or commercial sectors which do not have adequate means to dispose of them.

2. THE RADIUM CONDITIONING PROJECT

Radium-226 was one of the common radioactive source used in radiotherapy. After artificially produced radioactive sources became available, the use of radium declined and the radium needles became useless and were stored at various hospitals. In some cases they were not very safely managed. Since the half-life of radium-226 is quite long and these sealed sources still are highly radioactive, there was a danger of their leaking over time with a potential of causing serious danger. It was necessary to dispose of or store these sources in a safe manner.

The IAEA started the radium conditioning programme in 1990 and has been providing guidance and assistance to requesting countries. The programme offers a standard way to manage the sealed sources, especially to those countries which do not possess the technology and the means to adequately address this issue. The Project in Pakistan, which was completed in June 1999, was divided into three parts:

(i) to identify and locate all the sealed Radium sources throughout Pakistan;
(ii) to transport all the sources to KNPC;
(iii) to condition them in a safe manner for storage.

An expert mission was arranged by IAEA to develop a detailed plan and advise on training of the operation team.

The conditioning project was performed with the co-ordination of the regulatory body, the Directorate of Nuclear Safety and Radiation Protection (DNSRP) of the Pakistan Nuclear Regulatory Board (PNRB).

2.1 Logistics

One of the biggest challenges in the project was to locate and identify all radium sources at various places within the country. These radium sources were in the form of needles encapsulated in stainless steel. They were in various hospitals and radiotherapy units. The regulatory body collected information about the availability of radium sources at different medical centers in Pakistan. The radium sources from the northern part of Pakistan were first collected at Islamabad and they were later transported to KNPC by the members of the team responsible for this project. This team also brought the radium needles from the southern region of the country to KNPC.

The weight of Radium needles collected at KNPC ranged from 0.5 mg to 25 mg. These needles were segregated in batches according to the radium content. In total, 1500 mg of radium needles were collected.

KNPC fabricated the packages required for conditioning according to the IAEA specifications. This included 200 l stainless steel drums, shielding containers, stainless steel capsules (small and large). The IAEA also provided a welding turntable and vacuum pump, for leak test. Other items required for the shielding, transportation, transfer of radium sources, respiratory protection, contamination control, monitoring etc. were arranged by local utilities.

2.2 Preparation

The area selected for the operation, after consultation with the IAEA expert, was an isolated room, in radiological zone 3, with separate ventilation system; effluents are released through a stack after filtration and monitoring. Radium needles were temporarily stored in another room in the same building. The whole area was declared as "Controlled Area" to restrict entries. Other zones were established in the operation room for different tasks.

The conditioning room was declared as "Rubber Area" to prevent a release of any possible contamination. Floor and the shielding material were also covered with transparent foil. Persons working in the operation room were required to use proper protective clothing and respiratory protection. Radiation dose was monitored.

2.3 Execution

Radium conditioning at KNPC was performed, in the presence of an IAEA expert, by a KNPC team and no outside contractor had to be involved. The process of conditioning consisted of the following distinct steps:

(a) Encapsulation
About 50 mg of radium was transferred into each capsule using long handling tools in a well shielded space.

(b) Welding of Capsules
Capsules were then transferred for TIG welding to the shielded turntable installed in a welding zone with the help of a remotely handled tool. After welding, the capsules were cooled in shielded tray and then were transferred to dissector for the leak test.

(c) Leak Test
The dissector contained glycol and after inserting the welded capsule the pressure was reduced to 0.25 kPa (0.25 atm). A leakage from the welded capsule should be indicated by the appearance of bubbles in the glycol. None of the welded capsule failed the leak test. However, one empty capsule was deliberately welded poorly to observe the bubbles during testing.

(d) Placement in the Shielding
All capsules after passing leak test were dried and placed in shielded packages. Each shielded package contained 10 holes for 10 capsules containing a total of 500 mg of radium. After placement of the capsules, the shielding container was closed by a lid and sealed by welding it.

(e) Final Package
The shielding containers were placed in specially manufactured 200 litre concrete lined steel drums (one package per drum) and the drums stored in the Waste Storage Area of KNPC.

2.4 Dose Record

All persons involved in the work were provided with TLDs and Direct Reading Dosimeters (DRDs) for whole body dose measurement. Extremities dose measurement devices were also used where required. Results of the measurements of radiation dose received by the team members were:

(i) Radiation dose received during the transportation of the radium sources from northern and southern regions:

Total radiation dose received:	0.95 Man-mSv
Maximum dose received by any person:	0.50 mSv

(ii) Radiation dose received during the radium conditioning:

Total radiation dose received:	0.35 Man-mSv
Maximum dose received by any person:	0.09 mSv

(iii) Total dose received during the entire project: 1.30 Man-mSv.

2.5 Record Keeping.

For keeping the information on processed radiation sources, data have been recorded on IAEA prescribed forms provided for this purpose. They contain information mainly on the individual radium sources that were conditioned and link this to the capsules, shield and the final package. Once the conditioning operation was carried out the capsule, containing about 50 mg of radium, was considered as a new single radiation source. The capsule information, recorded on a Capsule Information Form, will be available for future processing or any additional management which is not foreseen today. The package information will serve as input for the surveillance and control as well as for any present or future operation or handling purpose.

3. CONCLUSION

The method and procedures applied in this project in Pakistan to safely manage existing radium sources are considered to having been very effective. The common effort of the IAEA expert and the KNPC team was successful. Experience gained could be very valuable in conditioning work of radium sources in other countries.