Experience in Environmental Remediation of Radioactively Contaminated Site in Waste Disposal Area in Istanbul – 15011

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ABSTRACT

In this paper specific environmental remediation examples of method applications are given. Radiological contaminated site was created by non-nuclear industry in Turkey. This is designated as a contaminated site and can ultimately lead to undesired health effects for residents. Appropriate actions have been taken to protect human and environment from contaminated site. As every site has its own characteristics, contaminated area was examined by sampling and surveying works. Before taken into action, remediation actions need to be justified and optimized. Radiation levels and homogeneity of contamination was investigated. Remediation program was established and taken into action in parallel two main works. First one covers all actions to the contamination itself. The site was isolated properly and all equipment was deployed. Working methods for segregation of contaminated material from the soil were determined. Besides, risk evaluation was carried out. Pathways between the contaminated soil and people were taken into account. Groundwater samples were taken and analyzed. According to these results, evacuation, area isolation or changing land use options were evaluated. Isolation of the site and removal of radioactive materials were determined as appropriate actions.

INTRODUCTION

A variety of environmental remediation techniques have been used at various hazardous waste sites. Classical environmental remediation methods are categorized as; biological, chemical or physical for contaminated soils and environmental waters. Basically treatment methods are divided into soil remediation and surface or groundwater remediation. A variety of activities and accidents may result in dispersed (non-point) sources of radioactive contamination. For the purpose of this report, dispersed contamination refers to the occurrence of concentrations of radioactive isotopes distributed over a wide area, where complete removal and disposal of the source is not practicable. Such contamination may present a hazard to humans and the environment. In this paper examples of sources include inadequate practices for the disposal of radioactive waste and radioactive contamination releases to the environment are presented.

METHODS

Generally one of the two approaches is applied for setting cleanup standards at contaminated sites. First one includes standards, which are set equal to country concentration limits. Other is a site-specific standard, which based on evaluations of factors such as human health and ecological risk, technical feasibility and cost. In Turkey, we have not any consistent decision-making strategy for determining which approaches should be used to set cleanup standards at this type of sites. Because of the lack of a consistent approach for setting cleanup standards, site-specific standards were developed according to international radiation protection limits. Uniform cleanup standards may be desirable because they can obviate the need for conducting costly site-specific analyses such as human health risk assessments. In addition, they provide a higher degree of consistency and predictability for site managers. However, there is a risk that uniform cleanup standards will be applied inappropriately, resulting in cleanup actions that are either overprotective or not protective enough. Site-specific standards may be desirable because they can be tailored to be responsive to unique site requirements and conditions [1].

The objective of any technique used in a remediation project is either to remove or reduce the source term or to block the exposure pathways. This can be achieved in a variety of ways and needs to be tailored to the contaminants and pathways of interest. It may be necessary to use a suite of techniques to achieve the remediation objectives, especially for source term isolation or removal [2]. Initially, one has to determine whether a condition exists that needs remediation considering factors such as the actual and/or foreseeable future use of the site, and regulatory advice or requirements (e.g. dose and risk criteria). In other words, is there a problem, and does it need fixing? There will be a need to compare with appropriate criteria, e.g. activity concentrations, and these will be established on a case-by-case basis [3]. The selection of appropriate remediation techniques will depend on the characteristics of the contaminated site and the potential pathways. Therefore, the choice will be, in most cases, site specific [4].

Some short half-life wastes, e.g. those at medical facilities, may be disposed of as nonradioactive waste if the waste is allowed to decay for a sufficient period, e.g. 10 half-lives, and all radiation labels and markings removed or obliterated. In 2004 a national regulation was published which covers solid wastes containing radioisotopes with half-lives smaller than 100 days are collected in hospitals for decay storage. After storage period these types of wastes are classified as medical waste. However the regulation is available related to decay storage of medical radioactive waste in hospitals since 2004, before of time all solid radioactive wastes had been sent to waste management facility as radioactive waste. During this term medical iodine (I-131) waste from hospitals had been collected and compacted into drums by waste management facility. Although most of these wastes have very low-level activities and very short half-lives, waste drums had been disposed inadequately in the field in 2005 due to limited storage capacity.

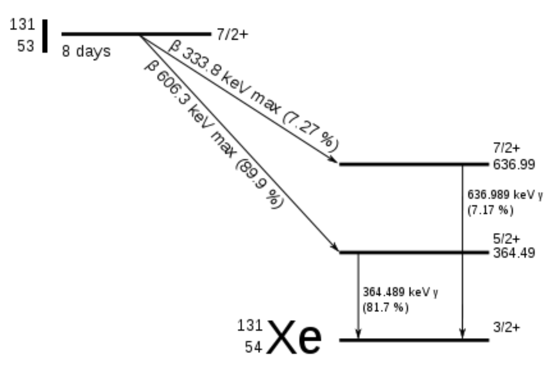

Fig.1. Decay of I-131.

Particularly 1-131, waste producers may store short-lived waste for decay before disposal by sewer distribution or incinerator. National or local rules define a maximum of half-life for radionuclides, which may be treated in that manner (for example in Turkey up to 100 days) and give rules for the storage time as 10 times the half-life. 10 half-lives will reduce the specific activity by a factor of 1024. The most used radionuclides, Tc-99m and 1-131, will have reached concentrations (with some exemption in human treatment at high concentration), which are in line with exemption limits. Nevertheless, uncontrolled release through urine and faeces of patients will occur much earlier than 10 times of half-life.

In our case, the site has already been designated for temporary storage area for radioactive waste packages since 1989. For this reason the site is in controlled zone. Disposal area is about 1 acre and there was not any inventory about the disposal. More than hundred drums were removed from this disposal area. Most of drums had been corroded and damaged. During operation potential hazards and risks to workers involved in implementing the remediation technique were evaluated and occupational safety was taken into consideration. On site measurements showed that there was not any health risks may result from workers being exposed to radionuclides. Some other long-lived sealed sources have been determined. Most of them were lightning rods in the form of multiple alpha-emitting sources of either Am-241 or Ra-226. The amount of radioactivity in these devices has varied, from less than 37 MBq (1 mCi) to 370 MBq (10 mCi). In addition, smoke detectors, iridium sources and neutron sources (troxler) were found in the area. These radionuclides are presented in Table 1.

TABLE I. Detected radioactive sources.

Radionuclide	**Amount**	**Activity**	**Usage purpose**
Ra-226	12	1-5 mCi	Lightning rods
Am-241	25	0.3 – 3 mCi	Lightning rods
Am-241	33	0.5-1 μCi	Smoke detectors
Am-241/Be	2	(Neutron source)	Density gauge
Ir-192	6	1-30 mCi	Portable Radiography

Fig. 2. Removal of radioactive waste from inadequate disposal area.

We have retrieved all these drums from the disposal area and segregated by using sensitive detection equipment (e.g. Sodium Iodide crystal detectors) to survey shipment of waste to be processed as medical waste. Most of the waste was not radioactive any more because of long decay period. These wastes have been sent to municipal incineration facility as an ordinary medical waste. Others were classified and taken into inventory as radioactive waste. These wastes have been processed and taken into interim storage for radiological safety.

Fig. 3. Inadequately buried radioactive wastes.

Removed soil was checked by visual and spectrometric measurement. Majority of the waste separated from soil and collected in piles for further checking. Soil screening process has been carried out. Spent sealed sources have been found and potential contamination has been checked. These plastic wastes were sent to incineration facility. But majority of the waste was mixed with soil. Appropriate survey instruments and techniques have been determined. Soil samples have been taken from surface and subsurface from predetermined locations. Although there was not any contamination determined in the soil, mixed soil with plastic materials had been removed from site. This soil was loaded to trucks and sent to municipal waste field. During this operation radiological survey was applied on the field. Smoke detectors and lightning rods were found and separated as radioactive waste. Fortunately there was not any contamination.

All of the waste was very short-lived contaminated plastic material. Smoke detectors and lightning rods have sealed sources. In addition TENORM metal particles had been found and separated. These wastes were taken into waste processing and storage facility for further processing as long-lived radionuclide. Mixed soil carrying trucks were passed through the panel detectors for final check. (Fig 4).

Fig. 4. Panel detectors.

After the remediation has been completed, the degree, extent and duration of control, if any (ranging from monitoring and surveillance to restriction of access) shall be reviewed and formalized with due consideration of the residual risk [5]. After remediation works, water samples were taken from water wells nearby the disposal area and detailed monitoring was applied on the remediation site. There was not any contamination caused by inadequate disposal of radioactive waste. TENORM wastes were taken into containers for interim storage (Fig 5).

Fig. 5. TENORM Containers

CONCLUSIONS

As a result of the cleanup standards review, it is concluded that no single approach is sufficient to regulate all contaminants of concern. In this case, techniques based on assessments of human health and detection of radioactive sources. Non-radioactive materials from the old disposal area have been removed from the site. Spent sealed sources have been detected and retrieved from the site to safe storage. The remediation works based on safety regulations. For surface and subsurface soils, screen out of exposure areas have been carried out. The highest average soil core concentration does not exceed the background level.

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