ABSTRACT

The paper reports about the 1994 accident in Estonia: looters of a depository of radioactive waste laid their hands on a source containing Cs-137 and received dangerous doses of radiation. One of the involved persons died, others suffered minor burns. The other incident (early 1995) was not a tragic one, an abandoned source containing Cs-137 was found in the vicinity of the Tallinn-Narva road and was disposed of safely. Both these accidents turn attention to the potential dangers caused by insufficient survey of the territory, radiation protection structures not yet fully operable, and lack of equipment and know-how. The lessons taught by the incidents are considered on the basis of the chronologies and factual data. The report contains concise descriptions of the incidents, a medical overview of the fate of injured persons and lessons taught by the accidents/incidents.

Key words: Cs-137, radiological accident, Estonia

INTRODUCTION

Two radiological accidents/incidents happened in Estonia. The first – 21 October 1994, three brothers entered the Tammiku repository and stole a radioactive Cs-137 source. One of the brothers died two weeks later. The second incident - 14 January 1995, members of the commission investigating the first accident detected abnormally high radiation level at a point along the Tallinn-Narva highway while travelling in a car. The source of the radiation was investigated and identified as a discarded metal cylinder containing Cs-137. The incident did not cause casualties.

CHRONICLE OF ACCIDENTS

The first accident

14 January 1994 a highly radioactive source was found in a batch of scrap metal which had been delivered to the Estonian Metal Export Company (EMEX) in Tallinn. The batch was routinely checked for abnormal radioactivity, a high level of radiation was discovered and the specialists of the Estonian Rescue Board were summoned. The source of the radiation was a metal holder containing Co-60 of 7 TBq activity (first preliminary estimates), while the dose rate close to the holder was 2 Gy/h. The holder was placed in the Tammiku national waste disposal facility.

21 October 1994 three brothers (B1, B2 and B3) entered the disposal facility in early hours by overriding the alarms, climbing a fence and breaking padlocks. B1 picked up a 18 cm long and 1.5 cm diameter holder which was the source and placed it in his coat pocket. Later he kept only the metal cylinder of 3 cm length which fell out of the holder. B1 started to feel ill in a few hours after the entry and vomited repeatedly.
25 October B1 was hospitalized and he died subsequently 2 November, his death was not associated with radiation exposure suspicion at the time.

The source was in the house of the family, it was kept in a toolbox in the kitchen.

8 November the next disposal of radioactive waste was carried out in Tammiku. The broken padlocks and decrease of dose rate (two orders of magnitude) were noticed but not reported.

9 November the stepson of the family (S1) handled the source briefly.

16 November the family's pet dog which had slept in the kitchen, died.

17 November S1 was admitted to the hospital with severe burns on his hands. These were diagnosed as radiation induced and the police were notified. The police summoned the Estonian Rescue Board which measured high dose rates in the vicinity of the house and during the same night evacuated the inhabitants from the neighbourhood. The source was located and shipped to the waste disposal facility. The source was identified by gamma spectrometry containing not Co-60 (newspaper reports), but Cs-137.

The members of the family were hospitalized.

A Government Commission to investigate the accident, draw conclusions and make recommendations was established 13 December.

**The second incident**

The Government Commission commenced its work after the New Year and was travelling on a routine inspection trip from Tallinn to a company in Narva 14 January 1995. At a point along the highway abnormal radiation (2 μGy/h) was detected. On the following day the source of the radiation was located under the snow. It was a metal holder which was transported to the Tammiku repository, and subsequently placed into a special container. The source contained accordingly to estimations Cs-137 of 1.6 TBq activity. The incident did not involve any casualties. No information has ever been obtained in regard to the origin of the source.

During the summer of 1995 a radiation survey of the territory of Estonia was carried out through cooperation between Estonia, Sweden and Finland. 20,000 km of Estonian roads were surveyed from a car equipped with meters and sensors. No radioactive sources were found by the team.

**THE BACKGROUND**

The described above accidents/incidents have their roots in the historical background of Estonia. During the years 1940-1991 the territory of Estonia was a part of the territory of the former Soviet Union, and the nuclear programme of the Soviet Union was carried out also in Estonia. The regulations governing handling, shipping and inventory of radioactive materials were established and implemented, but during the turbulent transformation years the system fell apart with grave consequences for the safety regime. Withdrawal of Russian military bases from Estonia was a gradual process spread over the period 1992-1994 (1995 for the military nuclear installations at Paldiski) and not easily observable because of military secrets involved, real or imaginable. During this withdrawal process a multitude of breaches of safety regulations were observed (oil spillage at airfields, burnings of rocket fuel, haphazard handling of radioactive materials).

The inherited situation was for the Estonian authorities not always surveyable and the structures for handling critical situations were not yet mature. The abundant transit flow of scrap metal from Russia to the West placed a monitoring burden on the export companies which before monopolization of the scrap metal trade by the state were small and numerous. Also the knowledge of the hazards of radioactivity was spread among the population by the Soviet military authorities solely from the civil defense aspect. The repository was subordinated (by the former
Soviet model) to the city landfill management. No doubt that this fact had a relevance to neglect of all safety precautions by the three brothers looting the depository in the hope to obtain and sell valuable scrap metal.

THE AFTERMATH

The follow-up activities after the October 1994 accident were administrative, medical and ecological.

The Governmental Commission had the task to:
- analyse the environmental aspects of the accident;
- update the inventory of radioactive sources and equipment;
- inspect the storage conditions of radiation sources and radioactive substances;
- develop guidelines for radioactive waste management.

Acting on recommendations of the Commission, the Government established the AS ALARA Ltd., a state-owned company to act as the operator of the Paldiski nuclear facility and the Tammiku waste depository. Measures were taken to speed the adoption of the Radiation Act by the parliament. Due to the lengthy lawmaking procedures and a multitude of revisions of the draft law, the Radiation Act was passed late April 1997. This resulted also in establishment of the Radiation Protection Centre reporting to the Ministry of Environment. Security of the Tammiku depository was strengthened.

In January 1995 the Estonian Medical Society circulated information to all medical personnel in Estonia about the characteristics of radiation-induced injuries and called for vigilance.

As mentioned above, in May and June 1995 the Estonian authorities in cooperation with the Finnish Radiation Protection Centre carried out a search for abandoned radioactive material in Estonia. 20,000 km of roads were inspected for wayside radioactive radiation level. Nothing was found. In June 1995 the U.S. Department of Energy conducted an airborne radiation survey of the Pakri Peninsula. The radiation levels were charted and no anomalies (exception: military nuclear facility in Paldiski) were detected.

International cooperation played a vital role in the remediation of the post-accident situation. Medical assistance was made available from Sweden and Russia, monitoring of the house and the vicinity of the house was carried out with the help of the Finnish side. An IAEA expert group also arrived at the scene and provided valuable know-how. The IAEA report concerning the Tammiku accident can be expected soon.

The victims of the accident today
B1 (male, 25 years) died 12 days after exposure before radiation injury was diagnosed and the radiation dose received by him can only be estimated post-factum. He received a dose exceeding 2000 Gy (several hours of 2000-3000 Gy/h dose rate at skin surface) and succumbed from acute radiation syndrome, grade V combined with grade IV local radiation injury.

B2 (male, 28 years) had been in the vicinity of the source for few hours and handled the source. He developed a moderate degree of radiation sickness (of grade I) combined with grade III local injuries. The received by him dose equalled to 2 Gy. He was hospitalized in Tallinn and his recovery was complete.

B3 (male, 13 years) suffered from a severe and prolonged bone marrow apalasia complicated by radiation burns on his left hand which later caused amputation of his left thumb. He was hospitalized in Tallinn and consulted by Swedish and Estonian physicians. Electron paramagnetic resonance measurement of his tooth enamel gave 2 Gy (2.7 Gy by other methods) as his possible dose of radiation. His condition is good.

GGM (female, 78 years) developed a moderate bone marrow syndrome from which she recovered. She died 31 December 1995 from cardio-vascular failure not to be connected to exposure.

M (female, 35 years) received a dose of 0.5 Gy. No clinical effects were observed.
Six other persons (identities not disclosed) received a dose of approx. 0.1 – 0.13 Gy each. No clinical effects were observed.

LESSONS AND CONCLUSION

The described above accidents/incidents gave a clear warning that abandoned radioactive sources constitute a serious danger to uninformed and unprepared population. The measures to be taken have to be preventive (thorough checking of transboundary shipments, routine survey of territory and strengthened security of depositories) and informative (dissemination of knowledge about dangers of radioactive substances and sources).

These measures can be implemented only by a corresponding infrastructure and the relevant regulations must be enforced by an effective swift-response system. Development of the infrastructure and legal framework is well in progress and after the year 1995 there have been no incidents involving radioactive material and sources.

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