

RADIOLOGICAL ACCIDENTS/INCIDENTS WITH CAESIUM-137 IN ESTONIA



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Abstract

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A report is provided of an accident and an incident involving radioactive sources in Estonia. In the 1994 occurrence, looters of a depository of radioactive waste manipulated a source containing ^{137}Cs and received dangerous doses of radiation. One of the persons involved died, others suffered minor burns. Another event, which occurred in early 1995, did not have a tragic outcome: an abandoned ^{137}Cs source was found in the vicinity of the highway linking Tallinn and Narva and was disposed of safely. Both these accidents draw attention to the potential dangers caused by the insufficient survey of the territory, radiation protection structures not yet fully operable, and the lack of equipment and know-how. The lessons to be drawn from these events are considered on the basis of the chronologies and factual data. The report contains concise descriptions of the accidents, a medical overview of the fate of the injured persons and the lessons learned from these accidents.

1. INTRODUCTION

A radiological accident and a radiological incident occurred in Estonia. In the first occurrence, which took place on 21 October 1994, three brothers entered the Tammiku repository and stole a radioactive ^{137}Cs source. One of the brothers died two weeks later. In the second, which happened on 14 January 1995, members of the commission investigating the accident detected an abnormally high level of radiation at a point along the Tallinn-Narva highway while travelling in a car. The origin of the radiation was looked into and found to be a discarded metal cylinder containing ^{137}Cs with an activity of 2.2 TBq. This incident did not cause any casualties.

2. THE EVENTS

2.1. The accident

On 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 stainless steel box measuring $5 \times 20 \times 45$ cm, which upon initial estimate apparently contained ^{60}Co with an activity of 7 TBq, while the dose rate close to the holder was 2 Gy/h. The holder was placed in the Tammiku national waste disposal facility.

Early in the morning of 21 October 1994, three brothers (hereinafter designated as B1, B2 and B3) entered the disposal facility by overriding the alarms, climbing over a fence and breaking padlocks. B1 picked up a holder 18 cm long and 1.5 cm in diameter, which was a source, and placed it in his coat pocket. He later kept only the metal cylinder of a length of 3 cm which had fallen out of the holder. B1 started to feel ill a few hours after the entry and vomited repeatedly. On 25 October, B1 was taken to hospital. He died on 2 November. His death was not associated with radiation exposure at the time. Meanwhile, the source had been taken to the family house, where it had been placed in a toolbox in the kitchen.

On 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.

On 9 November, the stepson of the family (S1) handled the source briefly. On 16 November, the family's pet dog, which slept in the kitchen, died.

On 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 ^{60}Co (as reported in the newspaper), but ^{137}Cs . The members of the family were hospitalized.

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

2.2. The incident

The Government Commission commenced its work after the New Year. On 14 January 1995, members of the Commission were travelling on a routine inspection trip from Tallinn to a company in Narva. At a point along the highway, abnormal radiation ($2\ \mu\text{Gy/h}$) 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. According to estimations, the source contained ^{137}Cs with an activity of 1.6 TBq. The incident did not involve any casualties. The origin of the source is unknown.

During the summer of 1995, a radiation survey covering all of Estonia was initiated through a co-operation between Estonia, the Swedish Radiation Protection Institute and the Finnish Radiation Protection Centre. Under the project, 20 000 km of Estonian roads were surveyed from a car equipped with meters and sensors. No radioactive sources were found by the team.

3. DISCUSSION

The above-mentioned accident and incident have their roots in the historical background of Estonia. Between 1940 and 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 also carried out in Estonia. Regulations governing the handling, shipping and inventory of radioactive materials were established and implemented, but during the years of transition between the old structure and the new one, the system fell apart, with grave consequences for the safety regime. The withdrawal of the Soviet military bases from Estonia was a gradual process spread over the period between 1992 and 1994 (1995 for the military nuclear installations at Paldiski) and not easily observable because of the military secrets involved, real or imaginable. During this withdrawal process, a multitude of breaches of safety regulations were observed (oil spillage at airfields, burning of rocket fuel, haphazard handling of radioactive materials).

The resulting situation was not always clear cut for the Estonian authorities and the structures were not mature for handling critical situations. The abundant transit flow of scrap metal from Russia to the West placed a monitoring burden on the export companies, which had been small and numerous prior to the monopolization of the scrap metal trade by the state. Furthermore, knowledge of the hazards of radioactivity had been disseminated among

the population by the Soviet military authorities solely from the perspective of civil defence. The repository was subordinated to the city landfill management, in accordance with the former Soviet model. This fact no doubt bore a relation to the neglect of all the safety precautions by the three brothers looting the depository in the hope of obtaining valuable scrap metal for resale.

4. THE AFTERMATH

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

The Governmental Commission was charged with:

- analyzing the environmental aspects of the accident;
- updating the inventory of radioactive sources and equipment;
- inspecting the storage conditions of radiation sources and radioactive substances;
- developing guidelines for radioactive waste management.

Acting on the recommendations of the Commission, the Government established AS ALARA Ltd., a state-owned company to act as the radioactive waste management operator, additionally responsible for decommissioning the former Paldiski nuclear facility and Tammiku waste depository. Measures were taken to speed up the adoption of the Radiation Act by the Parliament. Due to the lengthy lawmaking process and a multitude of revisions to the draft law, the Radiation Act was passed in late April 1997. This legislation led to the establishment of the Radiation Protection Centre, reporting to the Ministry of Environment, and the strengthening of the security of the Tammiku depository.

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.

The above-mentioned co-operation with Sweden and Finland for the search for radioactive sources abandoned at the roadside was continued during the summer of 1996 and extended to the roads on Estonian islands. No radioactive material 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 were detected, with the exception of the military nuclear facility in Paldiski.

International co-operation played a vital role in the remediation of the post-accident situation. While medical assistance was made available from Sweden and Russia, monitoring of the family house and its immediate surroundings was carried out with the help of the Finnish experts. An IAEA expert group also travelled to the scene of the accident and provided valuable know-how. An IAEA report concerning the Tammiku accident is to be issued soon.

5. THE VICTIMS OF THE ACCIDENT TODAY

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

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

B3 (male, aged 13) suffered from a severe and prolonged bone marrow aplasia complicated by radiation burns on his left hand which later required amputation of his left thumb. He was hospitalized in Tallinn and examined by Swedish and Estonian physicians. Electron paramagnetic resonance measurement of his tooth enamel gave 2 Gy as his possible tooth dose and 2.7 Gy for the whole body by cytogenetic estimate. His condition is relatively good with cause for some concern.

GGM (female, aged 78) developed a moderate bone marrow syndrome from which she recovered. She died on 31 December 1995 from cardiovascular failure unrelated to exposure.

M (female, aged 35) received whole body doses of 0.5 Gy. No clinical effects were observed.

Six other persons (whose identities were not disclosed) received whole body doses in the order of 0.1–0.13 Gy each. No clinical effects were observed.

6. LESSONS AND CONCLUSION

The events described have given a clear warning that abandoned radioactive sources constitute a serious danger to the uninformed and unprepared members of the population. The measures to be taken to avoid the recurrence of such events must be preventive (thorough check 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 through a corresponding infrastructure, with the relevant regulations enforced by an effective rapid response system. Development of the infrastructure and legal framework is currently well in progress. After 1995, no incidents have occurred involving radioactive materials and sources.

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