

STUDY CASE N° 12: CONTAMINATION OF WORKERS DURING DISMANTLING OF GLOVE BOXES IN THE CZECH REPUBLIC

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□ Description of the incident

During June and July 2001, three dry glove boxes, which served before as part of a line for manufacturing radioactive sources (smoke detectors) from pulverised 241-AmO, were dismantled and processed as radioactive waste. This operation was carried-out in the Nuclear Research Institute, plc at Rez (NRI), the Czech Republic. The manufacturing company declared the activities in glove boxes prepared for waste process as 150, 180 and 50 MBq of 241-Am respectively. Before the transport from the manufacturing factory in Prague to the NRI at Rez, where boxes were processed as radioactive waste, the contamination on the walls and the inside installation was fixed by lacquer. All dismantling procedures took place in the Fragmentation and Decontamination Centre (FDC) of NRI in three time periods; the data critical operations being June 21st, July 3rd and 10th of July 2001. On the beginning of the operations, the boxes were separated from each other and the external and internal surfaces were monitored. The operations comprised the removal of the covering foil, the opening of the box and its dismantling. The material was then fragmented, i.e. cut in pieces by hydraulic shears and saw machine. The fragmented radioactive waste was put into steel drums and conditioned by cementing as radioactive waste.

Before the daily operations started the system for monitoring the volume activity of air in the working area was switched on and the locally adaptable exhaustion for FDC area was put in operation. At particular steps the surface contamination was measured using both wipes and direct measurement. The workers should use the protective aids appropriate to the character and hazard of this working activity, including respirators.

In the course of dismantling operations the dust particles with 241-Am were incidentally released and due to violation of the radiation protection requirements (non-systematical use of personal protective aids, no full observance, keeping off approved radiation protection procedures) several workers were internally contaminated. Subsequently this contamination spread through the whole building. On 10th July after the dismantling operations concerning the third box and subsequent waste treatment were finished, the chief of the FDC was informed about the result of the evaluation of the filter of the device for volume activity measurement in air in the FDC. The value of filter activity exceeded the monitoring programme determined intervention level and the chief of the FDC ordered to immediately stop all the working activities in FDC area. On 11th July the measurement of respirators used by workers revealed a considerable contamination, reaching in the worst case 1 kBq of 241-Am (later amended to 2,7 kBq). The chief of the FDC evaluated the situation and declared at 16.30 an extraordinary event of the 1st grade (in the terms of the Decree of SUJB No. 219/1997 Coll.).

On 12th July the notification of an extraordinary event was transmitted to the State Office for Nuclear Safety (SUJB) and the media were informed. The worker suspected of the highest internal contamination (W1) was directed to the National Radiation Protection Institute (NRPI) for where the first in vivo investigation was performed and the data were reported as preliminary results to SUJB. The necessity for highly conservative estimate was considered because it should serve as a guide for possible remedial steps. From the first two in vivo measurements the body

burden of 241-Am was estimated at about 5 kBq and considering the date July 10th as the time of intake, the committed effective dose (E50) was assessed in the order of 1 Sv. The evaluation was based on the presumption that inhalation (with particles of AMAD 5 µm, class M) was the main mechanism of internal contamination and that the deposit was located in lungs only.

In addition in other seven people similar internal contamination of 241-Am was ascertained. It was, however, recognised that the first obtained results of measurements were overestimated due to the contamination which remained on the body surface in spite of thorough showering before measurements and absence of positive response of surface monitors. The collection of stool and urine was carried-out. The repeated in vivo investigations (WBC, head and knees) and evaluation of the first excreta results reduced the doses initially estimated, so that at the time of notification of the event to IAEA on 17th July the maximal committed effective dose was quantified as 350 mSv.

The follow-up of the workers with measurable contamination continued. The decrease of the results in vivo measurements below detection limits during several weeks confirmed the interference of early findings with surface body contamination. Eighteen other employees were screened on WBC. Whole body counting, measurement of head and also measurement of knee in some cases were performed. No measurable internal contamination was found in this screened group.

A final evaluation in January 2002 was based on excretion data and points to the committed effective dose (E50) of 50 mSv in W1, and to E50 in the range of 5 to 185 mSv in W3-W8. The excretion analysis suggested, that in some workers repeated intakes might occur, e.g. partly already on June 21st and July 3rd (in the two first operations). This uncertainty complicated the interpretation of excretion results. The worker W2 did not fit fully with the patterns typical for subjects presented above. In this case clearly measurable activity was found with lung measurement and this activity did not decrease considerably in the course of time so that it was supposed that no external contamination was present on the trunk. The committed effective dose in this case was calculated by combining the in vivo (lung) results and the excretion data. The estimated E50 of the worker W2 was 130 mSv. The whole body measurements in the event involved workers will be continue with the half year period to precise the present time obtained results.

On the basis of first results, some workers seemed to be qualified for treatment by DTPA infusions. The worker W1 was hospitalised on July 13th and was treated by two doses of 1 g Ca-DTPA. Five more workers (W2-W6) were given two doses of Ca-DTPA on 20th and 22nd July. The tolerance of the treatment was good, no adverse effects were observed. After the assessment of the intakes had been amended, no continuation of the treatment seemed to be justified.

□ Lessons learned

- After any hazardous operation with open sources it is necessary to control daily the personal clothing and protective aids, including respirators and change them as frequent as appropriate – the obligation to use such personal protection during hazardous operation is self evident.
- Very important input data on calculation of a possible release of radioactive material at the workplace could be obtained from the activity measurements of the filters of ventilation

system, together with the record of ventilation rate and precise intervals of collecting period. The results must be available before the next task at the workplace is started.

- Contamination of the body surface may considerably interfere with the in vivo measurements of alpha emitters. The sensitivity of a portable alpha monitor may be too low to detect any activity which is later ascertained with a long term whole body measurement in shielded conditions. In this respect the role for early onset of collecting stool and urine in suspected subjects could not be overlooked, as well as the preparedness to apply express methods which are able to differentiate surface and internal contamination in event involved workers.

□ Point of view of the State Office for Nuclear Safety

The inspection of SUJB concluded that the considerable underestimation of the hazard of the dismantling and fragmentation of dry glove boxes contaminated by ²⁴¹Am caused this extraordinary event first of all. This working task should have been prepared in more detail especially as radiation protection procedures were concerned. Besides some important elements of the periodic safety control were lacking including the thorough and regular documentation of all indices and circumstances important for protection. Some gaps in the responsibility of the Radiation Protection Officer of the plant could be identified. Based on these findings the SUJB decided to penalise the NRI by a fine amounting to 150,000 Czech Crowns (about 5000 US \$). SUJB preliminarily classified that event on the INES Scale at level 2 and notified it to IAEA. Final classification from the point of view of released activity should correctly correspond to level 1. The estimated effective dose in one radiation worker exceeded (more than two times) the annual dose limit and in some others reached just this level which corresponds to INES level 2. SUJB conservatively confirmed former event classification on the INES Scale at level 2.