The Litvinenko Polonium-210 case – German experiences.

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Abstract. This paper brings together the measurement results taken and the lessons learned by the German Federal Office for Radiation Protection during the polonium-210 incident in Hamburg in late 2006. The incident was pivotal in confirming the importance of the defence against nuclear hazards in Germany and for highlighting the role of communication in the success of a deployment. The background of the case is reviewed and an overview of the German defence against nuclear hazards is given. The various measurement tasks, both at the scene and in the laboratory, and their results are summarized along with the communication challenges experienced. The main conclusions are that the traces of polonium-210 found at the sites were of little radiological consequence and the German defence against nuclear hazards in Germany delivered an excellent and measured response to the incident. However, communication challenges still exist and communication with the public and the emergency responders has to be given high priority during future deployments in order to ensure their success.

KEYWORDS: polonium-210, detection, response, communication

1. Introduction

In late 2006, Alexander Litvinenko died as a result of a poisoning with a highly-radiotoxic alpha-emitter, polonium-210 (Po-210), which allegedly occurred at a meeting in London. Media reports at the time linked Dimitri Kovtun to this meeting and to the German city of Hamburg. An investigation was started by Hamburg Police into Kovtun's movements during a visit to Hamburg in the week directly before the alleged poisoning. The presence of Po-210 at the sites visited by Kovtun in Hamburg was uncertain, but at the same time the British authorities were dealing with a hazardous amount of Po-210, leading to the closure of several venues. As the presence or magnitude of the radiation hazard in Hamburg was unclear, the Hamburg Police called on the federal defence against nuclear hazards in Germany, which includes the Federal Office for Radiation Protection (Bundesamt für Strahlenschutz, BfS).

BfS was responsible for the measurement of Po-210 at the sites visited by Kovtun, the radiological evaluation of the measurements and the radiation protection recommendations. Following a measurement for airborne contamination at the sites involved, both field and laboratory techniques (e.g., hand-held alpha detectors and grid ionisation chambers) were used to monitor the Po-210 contamination. A summary of the measurement tasks and the results of a selection of the measurements are presented in Section 3.1.

The traces of Po-210 found by BfS were of little radiological consequence and the radiation protection measures taken by BfS reflected this fact. However, neither the radiation protection measures taken by the emergency workers nor the reaction of the general public and press reflected the actual level of danger all of the time. Examples of the situations faced during the deployment in Hamburg are given in Section 3.2. The discrepancy between the actual and perceived level of danger must be taken very seriously by those responsible for giving radiation protection recommendations, as it will affect aspects of all incidents involving radioactive materials. It follows that strategies must be developed and implemented to deal with both the real and the perceived threats that occur during such an incident. Suggestions for these strategies are outlined in Section 5.

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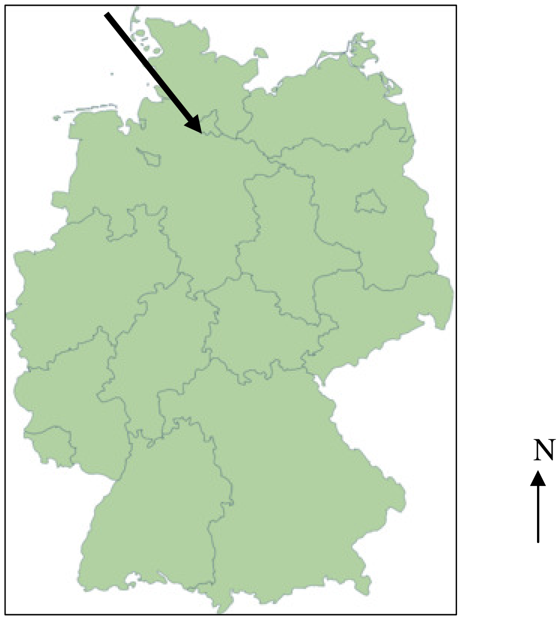
2. Overview of the German defence against nuclear hazards

Germany has a federal system which includes 16 states, which are known as "Bundesländer" (singular "Bundesland" and referred to as such in the following). Fig. 1 shows a map of Germany with the Bundesländer borders. The city of Hamburg is one of the German Bundesländer, marked with an arrow in Fig. 1.

Figure 1: Map of Germany showing the sixteen Bundesländer. The city of Hamburg (HH, one of the German Bundesländer) is marked with an arrow. Directly to the north of Hamburg is the Bundesland of Schleswig-Holstein (S-H), where sites were also investigated.



Each individual Bundesland in Germany has its own government, which includes a radiation protection authority. For cases that it is able to deal with effectively, a given Bundesland is responsible for the defence against nuclear hazards, the response to incidents involving radioactive materials and decontamination. The Bundesländer also bear the costs of these operations. The vast majority of operations involving radioactive materials are dealt with by the Bundesländer themselves, with no extra resources from the federal government.

Germany also has federal forces that are trained for dealing with emergencies involving radioactive or nuclear materials. The unit responsible for the defence against nuclear hazards at the Federal level in Germany is known as the ZUB ("Zentrale Unterstützungsgruppe des Bundes für gravierende Fälle der nuklearspezifischen Gefahrenabwehr", which may be translated as the "central federal support group for the defence against serious nuclear hazards"). The ZUB is a collaboration between the Federal Office for Radiation Protection (BfS), the Federal Police (BPol) and the Federal Criminal Police Office (BKA) [1]. This unit has unique strengths, as it incorporates the expertise of three separate Federal institutions and can be called upon by a Bundesland to lend support during a serious incident involving radioactive or nuclear materials. The forces from the Bundesland remain in charge at all times when the ZUB is deployed, to provide continuity and allow local knowledge to be exploited.

Besides its role in the ZUB, the BfS is required by law to help the authorities from the Bundesland if they request support when a find or a discovery of radioactive materials is made, or if there is the suspicion of a crime involving radioactive materials. The BfS will lend support to the investigations, to the analysis of the radioactive materials and to the protective measures in securing the radioactive materials, as long as a serious danger to life, health and possessions is feared and the authority in charge cannot actually, or only with great difficulty, undertake these tasks itself. Some possible examples of requests are listed below:

- A Bundesland makes a request to the federal government for support following a threat (for example search, analysis).
- The federal government becomes active under its own juristriction (for example the federal public prosecutor is investigating).
- A Bundesland makes a request to the federal government for support after a release of radioactive materials (for example, measurements, calculations).

Once such a request is made, the BfS responds in a suitable way, taking a tailored approach to the situation in which the BfS calls on specially-trained staff from across its departments. For instance, if the situation demands on-site measurements and dose calculations, then the BfS can deploy mobile measurement units and a group of experts with daily experience in dose calculations. Part of the approach of the BfS to the defence against nuclear hazards is to exploit the experience gained in the day-to-day work of its staff for use in a deployment situation. This approach helps to prevent experts being faced with completely unfamiliar tasks during the pressure of a deployment. Of course, all deployments will be pressurized and unfamiliar situations for BfS staff and for this reason a central working group for the defence against nuclear hazards organises regular training exercises with a cross-section of BfS staff together with staff from the other institutions involved in the ZUB.

3. Measurement tasks and communication challenges

It must be mentioned at the beginning of this account that the deployment of the BfS as part of the ZUB and the deployment of the ZUB itself in Hamburg from 8th to 22nd December 2006 were successful and that at no time were any members of the emergency services or the public at risk from the health effects of radiation [2]. The fact that only trace amounts of Po-210 were present at the sites investigated was only apparent after the deployment was already in full-swing, so the deployment serves as a good example of how the German defence against nuclear hazards functions. Due to its serious nature and the resulting public interest, the deployment in Hamburg was not purely a measurement and evaluation task for the BfS, but also a major communication challenge. Details of the measurement tasks undertaken and the communication challenges brought to light as a result of the deployment are presented in Sections 3.1 and 3.2 below.

3.1 Measurement tasks

The ability of the BfS to provide continuous radiation protection advice to those in charge of a deployment is only possible due to the wide-ranging expertise in radiation measurement and evaluation that exists within the departments of the BfS. In the case of this deployment, the measurements of the trace quantities of Po-210 also assisted the police investigation into Kovtun's movements over the days he spent in Hamburg at the end of October 2006. Of course, the police investigation was also vital for pin-pointing and prioritising the radiation search, as the task of measuring an entire city for alpha radiation is almost impossible. The authorities in charge relied on teams of BfS measurement experts being available to deploy at all times of the day and night, over two weeks, in order to make measurements in various selected locations using hand-held alpha detectors and to take samples for further analysis in the laboratory. The following bullet points list some of the locations where measurements were made and some of the items found which gave an above-background alpha signal. The locations are all in the northern Bundesländer of the City of Hamburg (HH) and Schleswig-Holstein (S-H, see Fig.1).

- Hotel Elmshorn, positive measurements on a shopping bag (S-H)
- Home of ex-mother-in-law, positive measurements in BMW and Crysler cars (S-H)
- Hamburg Airport terminal and Hamburg Police station, measurements negative (HH)
- Private flat, home of ex-wife, positive measurements on various items(HH)
- Foreigners‘ registration office, positive measurements on one document (HH)
- Clothes shop, measurements negative (HH)
- Restaurant, measurements negative (HH)
- Private flat, measurements negative (HH)

Many other measurements were carried out, including additional measurements at the airport Cologne/Bonn in Nordrheinwestfalen, one of the westerly Bundesländer. The measurements at the airport were made on the aircraft used by Kovtun to fly to Britain and no traces of alpha emitters were found using handheld alpha detectors.

The very first measurement carried out by the BfS after arriving at a site was to ascertain if an alpha emitter was present using hand-held alpha detectors. The majority of the detectors used by BfS during the deployment were plastic scintillator detectors [3] which have an approximate counting efficiency of 10%. Bearing in mind the German legal limit for Po-210, which is set at 1 Bq/cm^2 [4], and the detector area of approximately 100 cm^2, the measurement results become significant upwards of count rates of approximately 10 counts per second. These results then have to be verified in the lab using alpha spectroscopy, for which samples of fabrics and swabs were taken.

The first time that the presence of an alpha emitter was confirmed, on the first day of the deployment, air filter samples were taken in order to check for airborne contamination. The filters were sent via helicopter to the BfS laboratory in Munich, where the filters were measured during the night using alpha spectroscopy. The result of the measurement was that there was no airborne contamination present, so the BfS team leaders decided to proceed with protective clothing suitable for preserving traditional forensic evidence (see Fig. 2). These suits were chosen in order to prevent contamination of the scene with hairs and clothing fibres, etc., in case of future prosecutions, and also to protect BfS staff against skin contamination from Po-210.

Figure 2: A BfS measurement expert at work at one of the sites investigated. Note that the clothing is appropriate for preserving traditional forensic evidence at the scene.

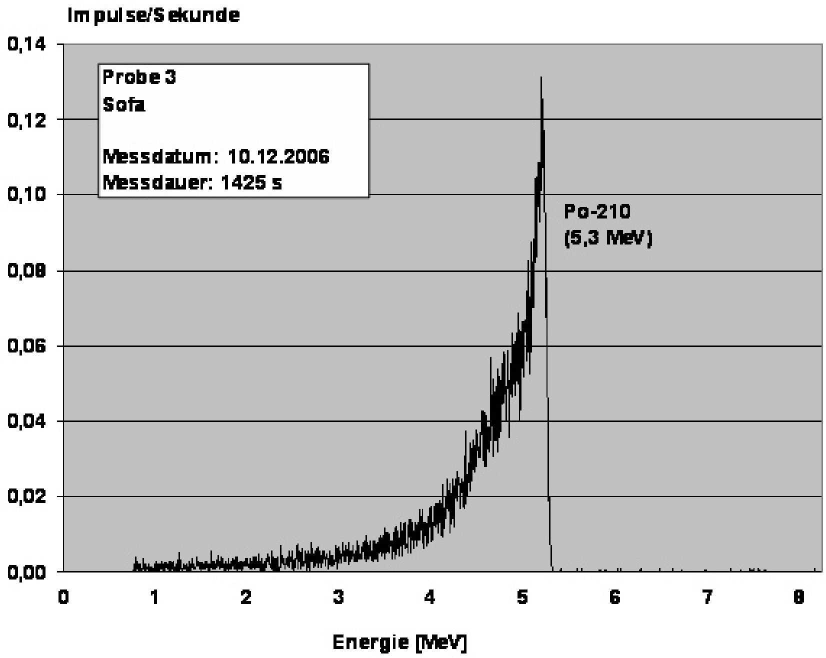
Table 1 shows three examples of measurements taken at the scene using a hand-held alpha detector and then confirmed as Po-210 in the laboratory using a grid ionisation chamber and radiochemistry techniques. In addition, gamma spectroscopy was used in order to rule out a significant presence of Pb-210. This confirmed the Po-210 as coming from a reactor-produced source rather than a source separated from uranium-238 daughter products.

The results presented in Table 1 are of a magnitude typical for all samples taken during the deployment with positive measurement results. The activities are very small and in one case, the fabric sample from the sofa, under the German legal limit. However, the sample cut from the sofa at the home of Kovtun’s ex-wife is interesting, as it was the first laboratory result that showed that Po-210 was present in Hamburg. The alpha-spectrum is shown in Figure 3. The gamma spectroscopy result for this sample, Pb-210 < 0.0073 Bq/cm^2, was the first confirmation that the Po-210 in Hamburg came from a reactor-produced source.

Table 1: Results of measurements on objects collected at the sites.

Sample	**Sample size (cm^2)**	**Po-210 (grid ionisation chamber, Bq/cm^2)**	**Po-210 (Radiochemistry, Bq/cm^2)**	**Hand-held α-detector (cps)**
Sofa	180	0.23 ± 0.06	-	0.6
Car head-rest	130	3.1 ± 0.7	4.4 ± 1.1	9
Car neck-rest	200	1.5 ± 0.4	2.1 ± 0.7	0.78

Figure 3: An alpha-spectrum taken from a fabric sample from a sofa in the ex-wife's flat.



The car head-rest and neck-rest were also shown to contain small amounts of reactor-produced Po-210. This was particularly useful for the police investigation, because the car had been involved in an accident after Kovtun travelled in the front passenger seat, leaving the physical evidence in place until the time of the investigation.

In addition to the fabric, filter and swab samples, 24-hour urine samples were also taken. Table 2 shows the results of 59 urine sample measurements collected from 53 people during the deployment. The highest radiation dose (approximately 1 mSv) was received by the toddler in the family of Kovtun's ex-wife. This sample was difficult to collect, as the urine was extracted from the nappy. In all cases the BfS deemed that no further medical measures were necessary and that the people involved could be informed over the local authorities. Stochastic risks were discussed according to the dose.

Table 2: Results of urine sample measurements. 59 urine samples were collected from 53 people. The median activity in uncontaminated urine was 3.5 mBq/d.

Group tested	24h-activity (mBq/d)	Dose (mSv)
Toddler (urine from nappy)	106.0 / 156.0	0.84 / 1.25
Family of ex-wife	20.0 ± 4.8	0.03 ± 0.02
Special unit forces	4.4 ± 3.8	0.005 ± 0.004

3.2 Communication challenges

The communication challenges that have been brought to light as a result of the deployment can be split into two general categories, relating to internal and external communication. Internal communication in this context is taken to mean communication between members of and/or organisations belonging to the emergency services, some of which are not part of the ZUB. External communication is taken to mean the communication between the emergency services and the general public and the media, be this through the media images produced by the way the deployment is carried out or through official spokespeople. Discrepancies between the internal and external communication also present challenges and the coordination of the internal and external communication is a general theme.

A public example of the consequences of ineffective internal communication between the radiation protection authorities and the emergency services occurred when Kovtun's ex-wife's family was persuaded to take further medical tests after having already left their home for a hotel. The medical tests were planned as a precautionary measure and would give the family a chance to escape the media for a few days. There was no medical emergency and they had been living normally for several weeks at home before the deployment. There was no indication of radiation syndrome, nor were more than trace amounts of Po-210 found at the scene. One of the main reasons for recommending precautionary medical tests was to put to rest any doubts the family might have about their health. However, the fire brigade responsible for taking the family to the hospital arrived in full protective suits and with a kind of vehicle that is normally used to transport people under triage conditions, see Fig. 4. These measures were inappropriate and resulted in the family experiencing a large amount of unnecessary anxiety. As a further result, the family lost trust in the emergency responders and this made obtaining their continued cooperation in the operation more difficult.

Figure 4: Photos taken from outside a hotel in Hamburg, demonstrating an inappropriate response by the emergency services.

The pictures shown in Fig. 4 also had a negative affect on the external communication during the deployment, as they were in the public domain. Two press conferences were held during the first week of the deployment, one on the 10th and the other on the 11th December 2006. These press conferences were both broadcast live on German national television. During the first press conference a good dialogue was established with the press and the coverage and questions focussed on the story behind the alleged murder of Alexander Litvinenko. Between the first and the second press conference the pictures shown in Fig. 4 (plus some others) came into the public domain and changed the attitude of the press and public to the rest of the incident. Instead of listening to the message that there was no public health risk, the press and public began to speculate that the radiation hazard was perhaps much greater than the BfS was claiming in its statements, one newspaper asking "Does this look like the all clear?" [5] The leaders of the deployment and their spokespeople, especially those from the BfS, had to spend a long time explaining the discrepancies between the press statements and the pictures in the press conference and following interviews.

The effects of the change in the public perception of the deployment were also felt by the emergency workers and BfS staff involved in the deployment. People who had been at or near the scenes, or had been in contact with Kovtun or his ex-wife's family, but were in no danger of having become contaminated with Po-210, began to ask for radiation measurements to be made on their person and in their offices. In many cases the BfS staff obliged these so-called "worried well" and spent long hours measuring sites of little relevance to the police investigation. In addition, many people demanded urine tests to ensure that they had not incorporated Po-210, even when the chances of incorporation were very slim, resulting in a strain on health physics resources.

4. Conclusion

The high scientific standards of the BfS were necessary in order to characterise and evaluate the low activities of Po-210 found during the deployment in Hamburg. The evaluation of the measurements enabled the BfS to offer effective radiation protection advice and to assist the police investigation. The majority of the Po-210 traces were found in places that had been in skin contact with Kovtun, leading to the conclusion that Kovtun had most probably incorporated Po-210 *before* his visit to Hamburg in October 2006. As yet, no formal charges have been brought by the German authorities against Kovtun and the costs of the operation remain under discussion.

It is clear from the events reported in Section 3.2 that the internal and external communication is intrinsically linked to the efficiency of the measurement tasks of the BfS, as demands for excess measurements from the "worried well" of the emergency services and the public can be very time-consuming. Additional urine samples can also slow down the laboratory measurements considerably. This affect is also felt by the leaders of the deployment, who have to spend precious time at press conferences or giving interviews to explain any inconsistencies in the information shown in the press. A lack of trust between the public and the deployment leaders can in turn affect the attitude of the staff working on the deployment, as press interest and general heightened anxiety increase the stress on them considerably.

In this case, the press was very open to the statements given by BfS and a helpful dialogue was established early in the deployment, so that the problems caused by the inconsistencies in the press images could be explained by the BfS, along with other deployment leaders, in further press conferences. However, the explanations took an entire day's worth of time, which, in a more serious incident, would probably not have been available. The main conclusion that can be drawn from this is that consistent, open communication from the onset of a deployment, both between the institutions involved and between deployment leaders and the press, will save precious time and resources, lower anxiety in the public and emergency workers and could, in a culture of trust where radiation protection advice is listened to and followed, ultimately save lives.

5. Evaluation

Whilst the measurement tasks were completed and evaluated efficiently and the radiation protection advice for the public and the emergency workers was consistent and correct, some challenges with the internal and external communication came to light during the deployment. After the deployment it was quickly recognised that the problems in the communication have to be addressed across the ZUB as a whole in order to produce a customised, homogeneous and appropriate response to future incidents.

Internal communication between the ZUB, the State police forces and the other emergency services has been improved using two different methods. Firstly, the pre-emptive internal communication has been improved [6]. This is information that is available *before* an incident involving radioactive materials occurs. For example, detailed information about the ZUB, its aims and its internal structure is now available on secure police intranet sites for all police officers at both the Federal and State level. Secondly, the internal communication during the early stages of a deployment has been improved. For example, the police officers who are not members of the ZUB will receive a short training talk and a printed information sheet specific to their impending deployment under the supervision of BfS and BKA specialists directly *before* they deploy. The information will be partially drawn from selected pre-prepared teaching materials and partially from the sensitive information available about the situation at the deployment site. This is to ensure that the information given to emergency responders is of a specific nature, referring directly to the radionuclide present and its predicted health effects under the conditions used in the dispersal, along with specific radiation protection recommendations.

A further internal communication modification is the development of pre-printed information cards. These information cards are similar to those suggested in the IAEA Manual for First Responders [7], as they contain basic safety guidelines for deployments involving radioactive materials. However, the information cards contain additional information for emergency workers that is specific to the German radiation protection regulations [8]. The information cards have been prepared by the BfS and BKA together for distribution to all emergency responders at the scene and will be made available in a laminated pocket-size format.

It should be mentioned here that the external communication during an event involving radioactive materials can only be improved separately to the internal communication by providing the public with speedy and accurate official information about the incident via press conferences. An important part of the strategy will be to pass on as much information about the deployment as possible, including the information given to the State police before the deployment, if the situation allows. A major part of improving the external communication can be afforded by improving the internal communication, as this will give a more homogeneous response to the incident, which in turn will help to remove many of the doubts the public has about the emergency response.

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