Minimizing the Radiation Exposure Risk of First Responders during Emergency Situation Management

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Abstract. This paper will set out the radiation protection strategy envisaged by the Federal Office for Radiation Protection in Germany in cases where the Federal Support Group for serious incidents involving radioactive materials is called upon to support regional police operations. A description of the central radiation protection role of the Federal Office for Radiation Protection within the infrastructure of the Federal Support Group, which enables the minimization of the radiation exposure of deployed forces, will be given, along with an overview of the training and exercise regimes which are considered an essential part of the operation. Lessons learned from the deployment of the Federal Support Group for serious incidents involving radioactive materials in the Polonium-210 case in Hamburg in 2006 show that the perceived harm caused by radioactive materials can be much greater than the actual harm caused. The paper will include examples of the lessons learned from the deployment in Hamburg in this respect.

1. Introduction

Radiation protection for first responders to incidents which comprise malevolent acts involving radioactive materials is of utmost importance. The integration of radiation protection into the response to such an incident is central to its success. In Germany, the defence against nuclear hazards is normally the responsibility of the state ("Bundesland") in which an incident occurs. Each German Bundesland has its own police force, criminal police office and radiation protection authority who are all equipped to deal with small to medium-scale incidents involving radioactive materials. However, if the incident is of a serious and/or criminal nature, for instance an emergency with nuclear material or an attack with a radiological weapon, the Bundesland can call on the federal government for additional forces from a unit known as the "Federal Support Group for serious incidents involving radioactive materials" (abbreviated to ZUB from the German). The ZUB includes specialists from the Federal Criminal Police Office (BKA), the Federal Office for Radiation Protection (BfS) and the Federal Police (BPol) [1].

When called upon, the ZUB is integrated into the local task force dealing with the threat. The control of the operation remains in the hands of the local Bundesland police administration. As every Bundesland has different ways of dealing with nuclear hazards, different regulations and specialists, it is crucial for the federal forces to remain flexible, whilst still allowing for the radiation protection to take a central role in the deployment. To ensure that this is the case, the organisational structure of the ZUB is designed such that the BfS plays a central role in its organisation, the details of which will be set out in Section 2 of this article.

The aim of this article is to demonstrate how the radiation exposure risk of first responders can be minimised during emergency situation management, by giving an overview of the strategy in place at the federal level in Germany (in Section 3).

Training and exercises are an essential part of the defence against nuclear hazards and the German approach will be described in detail in Section 4. Another aim of the article is to show that communication is central to the success of a deployment of this nature and should be treated as a priority. Lessons learned from the deployment of the ZUB in the Polonium-210 case in Hamburg in 2006 show that the perceived harm caused by radioactive materials can be much greater than the actual harm caused. Section 5 includes examples of the lessons learned from the deployment in Hamburg in this respect.

2. Role of the Federal Office for Radiation Protection in the ZUB

Due to the high importance of radiation protection during ZUB deployments, the ZUB structure is designed such that the BfS takes a central role. During a deployment, the leader of the BfS unit will be in continuous contact with the leader of the ZUB (from the Federal Criminal Police Office (BKA)) and the leader of the operation in the local police force. The BfS unit and a core team from the BKA are always deployed with the ZUB; other forces from the Federal Police (BPol) and the BKA will join the deployment if necessary.

The leader of the BfS unit, a senior radiation protection expert, advises the operations leaders directly in all aspects of radioactivity and radiation protection. The topics could include, for instance, possible medical measures, protective measures for the deployed forces and the public, the transport of radioactive materials and informing the press and public. The BfS unit has measurement teams on the ground which can be deployed to detect radioactive material, make radionuclide determinations, estimate the activity levels and carry out contamination measurements. These teams can then remove radioactive sources or materials safely from the scene or deploy shielding if the radiation fields are affecting rescue operations. BfS experts either in the field, or in the operations centre, can carry out the evaluation of radioactive materials and estimate criticality risks. Similarly, these experts are on hand to estimate the radiological consequences following a detonation or dispersion of radioactive material and to make predictions for radioactive contaminations and radiation exposures.

Additionally, the BfS can undertake gamma-spectroscopy from the air for the determination of long-range contamination or for the search for sources. The lab-based capabilities of the BfS include incorporation measurements via body counters and the analysis of bodily waste, biological dosimetry and radiochemical analysis. The BfS can provide advice on transport (according to German law) and temporary and final storage of radioactive materials if required. The BfS has an on-call rota system, which ensures that sufficient forces (including leaders, experts and measurement teams) are available at all times to cover the initial phase of a deployment.

3. Radiation Protection Strategy

Although the exact deployment scenario is difficult to anticipate, the radiation protection strategy envisaged by the BfS in the case that the ZUB is called upon to support regional police operations follows the As Low As Reasonably Achievable (ALARA) principle. A team of radiation protection officers from the BfS act as first responders within the ZUB and are able to make on-site measurements, dose

estimates and immediate radiation protection recommendations. The measurement results are then relayed to the leader of the BfS deployment, a senior radiation protection expert who is in direct continuous contact to the police deployment leaders. This expert, together with his team can then check that the radiation protection measures are appropriate and decide on the next steps for optimising the radiation protection (e.g., if more measurements are necessary or if additional equipment is required). The operational structure ensures that the radiation protection advice is timely, deployment-specific and central to the operations plan. The structure also ensures that the advice is communicated to all deployed forces through police channels and to the public via press conferences and statements.

Dose limits will be observed during a deployment of the ZUB. The dose limit for the public and for other first responders who do not routinely work with radioactive materials is 1 mSv per year. First responders within the ZUB who do routinely work with radioactive materials, i.e. the radiation protection officers and measurement teams from BfS, are allowed to receive a dose of up to 20 mSv per year due to routine operations. Their dose will be overseen and minimized as far as reasonably possible by a senior member of the radiation protection team at the scene, who has access to radiation measurement data and who can make informed and timely dose estimates. The radiation dose for deployed forces will be estimated by a senior radiation protection expert from the on-site radiation measurements and overseen by film and electronic dose meters. The goal is as low a radiation dose as reasonably attainable under deployment conditions

In order to save lives (or to prevent serious harm to people or catastrophic events developing), an exceptional radiation dose of up to 250 mSv (once only, or 100 mSv in a year) as a reference level has to be observed, depending on the informed consent of the first responder involved and the permission of the senior radiation protection officer in charge. This implies that training and education about the effects and nature of radiation for first responders before an incident is imperative, so that each first responder can make a more informed decision about the radiation dose he or she might receive. This training and education is treated as a central task within the Federal Support Group for serious incidents involving radioactive materials and is dealt with in more detail in the next Section.

One additional point that must be mentioned is that, in certain scenarios, for example if the contents of a Cs-137 source were to be distributed around a populated area [2], or the terrorist use of a “dirty bomb” [3] [4] were to be realised, then, by the time the ZUB is deployed, it might be the case that radiation doses over these limits have already been received by the public and/or first responders. In this situation, the BfS could make estimates of the doses received and would advise on appropriate measures for surveying incorporated radiation doses (e.g. urine samples or full body counter measurements), if appropriate, or medical measures in the case that deterministic effects are expected**.**

4. Training and exercise activities of the ZUB

It is clear that trust must exist between the police forces and the radiation protection forces, as they must rely on one another to protect the team from police dangers (for example booby traps and gunfire) and from radiation protection dangers (for

example, open radioactivity at a crime scene). An effective way to build trust and good working relationships is training and exercises [5].

The ZUB has a training schedule that includes both training and exercises internally within the ZUB (between BPol, BKA and BfS) on two different levels. The first level is training and exercises within one of the partner institutions, organised by that institution for its employees alone. A good example of an internal training for a ZUB institution would be the senior radiation protection advisor meetings which occur on a regular basis at BfS. These meetings are for BfS experts only and include among other things scenario-based table-top exercises. Another example would be internal BfS measurement exercises, where teams of experts measure, identify and quantify radioactive samples using the same equipment as available in a deployment. The second level of training and exercises internally within the ZUB occurs between the subgroups of the different institutions. Examples of this kind of training are: lecture-based education on radiation protection for all non-BfS ZUB staff, organised by the BfS; crime scene work exercises between forensic experts and radiation protection specialists; training police in how to use specialised radiation protection equipment and training BfS staff on police procedures and equipment.

The first level of training and exercises within each partner institution maintains the skills base, forges stronger communication links and strengthens the feeling of commitment of the institution's members. The second level of training, between subgroups of different ZUB partner institutions, strengthens the communication link between the people in the subgroups, keeps skills updated and allows for the boundaries of the expertise of the other institution to be assessed. This is particularly useful for a deployment, as deployment leaders need to have a realistic idea of the capabilities of each institution within the ZUB.

Another type of exercise is that between the ZUB and one of the German Bundesländer. This kind of exercise is the largest and most costly of all the exercises and training undertaken by the ZUB and it is arguably the most important. The lessons learned from such an exercise have a profound effect on the future course of the ZUB and many changes are made following a review of an exercise.

Exercises and training are one of the main methods used for improving best practise in the field of the defence against nuclear hazards in Germany. If the different institutions within the ZUB are to work smoothly with each other, then communication channels have to be opened early and both sides have to be informed about their capabilities, methods and protective measures. Trust, training and education, built up before a deployment, will lead to it being far more likely that radiation protection advice is followed and the primary risks of radiation exposure minimized.

5. Lessons learned from Hamburg – actual versus perceived harm

In late 2006 the city of Hamburg in Northern Germany was faced with a potential dispersal of radioactive Po-210. The Russian citizen Dimitri Kovtun was investigated by Hamburg Police and found to have stayed in the city in late October 2006 before flying to London to meet with British citizen Alexander Litvenjenko at the beginning of November 2006. Litvenjenko was murdered in November 2006 in London by radiation poisoning from the incorporation of Po-210. The Hamburg Police considered it possible that Kovtun brought the illicitly-trafficked Po-210 from Moscow

to London via Hamburg. At the time, the presence or scale of the dispersal was unknown, leading the city of Hamburg to call on the German Federal authorities for assistance in the form of the ZUB.

Although 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 at no time were any members of the emergency services or the public at risk from the health effects of radiation [6] [7] [8] [9], the problems caused by poor communication during the deployment illustrate that the difference between the perceived harm caused by radioactive materials can be much greater than the actual harm caused. These differences in separating the perceived from the actual harm caused (or risks involved) with Po-210 were felt in three main areas of communication, namely: the internal communication between the different organisations; the external communication with the public and press and the discrepancies between the internal and external communication.

5.1. Internal communication challenges

A public example of the consequences of ineffective internal communication was given when the family members of the owner of one of the forensic sites were persuaded to take further medical tests after having already left the site 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 the site. 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 Figure 1. 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. In addition, as the photos were in the public domain, the effects had to be dealt with using further external communication efforts, as discussed in Section 5.2 below.

FIG. 1. *Photos taken from outside a hotel in Hamburg, demonstrating an inappropriate response by the emergency services.*

5.2. External communication challenges

External communication was delivered formally in the form of police press conferences in Hamburg and informally in the form of pictures taken by journalists from the perimeter of the forensic sites. The press conferences were broadcast live on German television in the first week of the deployment and were used not only to confirm that traces of Po-210 had been found, but also to reassure the public that there was no risk to human health from the trace amounts found. These press conferences were partly undermined by a large proportion of the press coverage, which included pictures taken by journalists from the perimeter of the forensic sites (for example, those shown in Figure 1). After the publication of these pictures, breaking news reports on German news channels reported that the health consequences of the Po-210 contamination were in reality much more serious than previously admitted by the authorities. Journalists began to demand explanations from the deployment leaders at the scene, causing disruption to the deployment.

In the following example, taken from newspaper coverage [10], the BfS employees are wearing white forensic suits and carrying radiation contamination detectors, see Figure 2. The fact that the white forensic suits are normally used in all police forensic investigations is not at the forefront of the coverage, so the lasting impression on the readership is that there are measures being taken that are not purely precautionary, or that the scale of the operation is greater than the authorities have admitted. This impression, once established, undermines the trust the public has in the emergency responders and leads to a higher level of scepticism regarding the information presented formally in police press conferences. This headline appeared the day after the events described in Section 5.1 and the suspicious nature of the coverage is partly due to the unfavourable impression made on the journalists by the pictures shown in Figure 1. This example shows how important the internal communication is for ensuring effective and homogeneous external communication.

FIG. 2. *Page 6 of the Bild Hamburg, 15th December 2006. "Sieht so Entwarnung aus?" (Does this look like the all clear?)*

5.3. Discrepancies between internal and external sources of information

A communication challenge faced during the deployment in Hamburg that specifically related to the discrepancy between different internal and external sources of information was the fact that the police force involved in securing the forensic sites in the first hours of the deployment had little or no official information about the situation. The information they did receive was via telephone from friends and relations who had access to media sources. This led to information being passed around the police force that was in some cases misleading. The result was unnecessarily heightened anxiety in the police force and a reduction in the effectiveness of the deployment.

Another example of the discrepancy between the internal and external communication was the fact that several “worried well” from the police force and their families demanded health check-ups based on their impression of the situation from the media coverage. These police officers had not been inside the scenes involved in the deployment, so they were not under radiation protection surveillance. The check-ups were provided and resulted in an unnecessary strain on health physics resources.

5.4. Consequences of poor communication

The consequences of poor communication during a deployment are at the very least a loss of trust of the public and emergency responders, heightened anxiety and strains on health physics resources. In the worst case, poor communication of the radiation protection measures to be undertaken by the public and deployment forces could lead to deterministic radiation doses or to loss of life. This means that effective communication should be considered vital to ensure the ALARA principle is followed during a deployment. Based on the evaluation of the Hamburg deployment, a new ZUB communication strategy has been put in place that emphasises a customised, homogeneous and appropriate (made-to-measure) response [11]. The strategy includes information material for pre-deployment briefings and information cards for first responders and the public. An emphasis is put on routine education and training of ZUB first responders in radiation protection, as mentioned in Section 4.

6. Summary

Radiation doses during serious incidents involving radioactive materials should be minimized not only to reduce primary risks due to radiation exposure for first responders and the public, but also to help reduce the psychological trauma inflicted by the incident. In order to achieve this aim, radiation protection not only has to be ensured through the integration of radiation protection experts into the heart of the deployment infrastructure, but the radiation protection information must be effectively communicated. Communication should be treated as vital to the success of a deployment and considered within the emergency planning well in advance of a deployment [12].

Minimizing the radiation exposure risk during emergency situation management due to malevolent acts is a large task that involves a lot of preparation and planning. The radiation protection education of non-expert staff, joint training and exercises of emergency responders and the collection of pre-prepared information material for the

deployed forces and the press is time consuming and costly. However; the benefits of the investment will be seen clearly if these efforts lead to the deployed forces and members of the public following the radiation protection advice given by the BfS, as this will contribute greatly to allowing the ALARA principle to be adhered to in a deployment situation.

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