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Enhancing Quality in Commercially Used Explosives Detection Dogs

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ABSTRACT

Explosives detection dog (EDD) teams are deployed at mass events such as concerts, annual general meetings of large listed companies or in air cargo security. However, outside of EU-regulated air cargo, there is no common quality standard for commercial EDD in Germany and many neighboring countries. While law enforcement agencies have access to experienced chemists and can conduct dog training with homemade explosives, small commercial security services do not have comparable capabilities and face additional legal hurdles. The DIN SPEC 77201 was developed within the project to fulfil the need for a generally accepted quality standard. A training workshop was developed and transferred from the academic sector to commercial partners in order to improve training opportunities with home-made explosives, providing new insights for training EDD teams with TATP, HMTD or training aids.

1. INTRODUCTION

1.1 Commercial explosives detection dogs

EDD have been used for many years by armed forces, police authorities and commercial security service providers. One reason for this is undoubtedly the fact that, compared to technical devices, sniffer dogs exhibit advantages in real time detection, mobility and versatility. Their detection performance depends on a variety of factors such as the individual quality of the dog, physical stress, environmental conditions, target odor, training and the dog handler [1-6].

Commercial EDD are used by security service providers in air freight and to secure major events such as concerts, shareholder meetings or major international events. In the air freight sector, EDD are regulated at EU level describing, among other things, the areas of application, approval requirements and quality assurance measures [7]. Major events are obvious soft targets for terrorist attacks and have been attacked repeatedly in the past. Despite the potential importance of EDD for the security of major events no widely accepted regulations comparable to the air freight are applied in Germany and many EU countries.

In the German speaking area, the security service providers that deploy EDD-teams also cross-border at major events are generally small, specialized companies that recruit additional teams as required by subcontracting micro-companies. Personnel requirements (e.g. via subcontracts) are continuously adapted to the order situation, which leads to constant staff turnover. The professional backgrounds of the staff vary greatly and range from dedicated, self-taught dog handlers to former explosives detection dog handlers in state institutions. Compared to authorities that keep service dogs, these companies do not have widely accepted standardized quality assurance measures for their sniffer dog teams.

Users of the EDD service (e.g. organizers of large events) often lack the expertise and possibilities to test the performance of the detection dogs commissioned. Without independent certification, the decision in favor of a provider is based on recommendations and the price as the only measurable factor. A situation that is also criticized by providers who fear price competition at the expense of quality. There is interest in the introduction of independent certification. However, earlier efforts, such as a certificate for EDD by a chamber of industry and commerce, have been unsuccessful [8]. In the USA the issue was addressed earnestly with “The canine Detection Improvement Act” from 2007. With the support of the Scientific Working Group on Dog and Orthogonal Detector Guidelines (SWGDOG), basic standards and requirements for EDD as well as other sniffer dogs were developed [9]. In the field of EDD, the activities in the USA resulted December 2021 in the publication of an approved ANSI standard [10]. In the recent past, the EU has at least funded two projects (RECCEDD, EDK9C) for the development of certification procedures for explosives detection dogs which are now finished [11, 12]. In the RECCEDD project, the original goal - providing 600 - 1000 EU-certified EDDs - shifted to the provision of 50 explosives detection dogs for Ukraine [13]. In the EDK9C project - motivated by the need for EDD for major events such as the 2024 Olympics in France - the goal of developing certification processes for EDDs was continued [12]. So far, however, there is no indication that an independent certification body is currently available that could be used for example by German or Austrian companies to certify their EDD.

1.2 Handling of explosives

In Germany, the handling of explosives is legally regulated by the national Explosives Act (SprengG). The managing director of a company handling explosives requires an official personal license, for which certain requirements such as personal reliability must be met. Persons in the company with direct contact to explosives or explosives containing objects also require an official certificate of competence. Prerequisites for obtaining this include reliability and officially recognized specialist knowledge. The scope of the handling of explosives permitted by license and certificate of competence is usually restricted. Companies with commercial explosives detection dogs are generally not authorized to manufacture explosives themselves. This applies in particular to home-made explosives (HME) such as TATP and HMTD, which are generally not fit for sale or transport and should only be manufactured by experienced chemists for safety reasons.

In terms of occupational health and safety, the handling of explosives in Germany is regulated by the regulations - in particular DGUV Rule 113-017 "Tätigkeiten mit Explosivstoffen" (activities involving explosives) - of the German Social Accident Insurance (DGUV). Knowledge of these rules is part of the expertise required for the afore mentioned certificate of competence.

In the EU, the handling of explosives is regulated by national law and differs from country to country. Licenses, certificates of competence and recognized specialist knowledge apply nationally and are not harmonized.

The German Explosives Act contains exemptions for the armed forces, police forces, specific official institutions and also for educational and research institutions, which simplify handling of explosives within the scope of the respective tasks. Research institutions can produce small quantities of explosives and use them for research purposes without the need for additional licenses and certificates of competence. However, for universities offering training courses for EDD-teams for a fee while providing explosives is considered a commercial activity and remains fully subject to legal requirements.

1.3 TATP and HMTD

Research indicates that EDDs should be trained regularly, more often than once a year, on the respective explosives [14]. Training with highly sensitive, home-made peroxide explosives such as TATP and HMTD poses a particular challenge for commercial EDD teams. TATP has repeatedly been used in terrorist activities in Europe in the past (Paris 2015, Bataclan; Berlin 2016, Magomed Ali C.; Chemnitz 2016; Marseille 2017; Paris 2017). This substance is also used by criminals - among others - to blow up ATMs. HMTD has also, although less often, appeared in a terrorist context (London 2005, Liverpool 2021).

The synthesis of TATP and HMTD is easy to carry out with widely available chemicals. The synthesis of TATP also produces the explosive DADP (diacetone diperoxide) as a by-product [15]. Depending on the synthesis route, TATP also gradually converts to DADP if the raw product is not thoroughly purified [16, 17]. It can be assumed that terrorists and criminals do not purify the substances during the manufacturing process, as this involves additional effort, risk and also reduces the yield of the explosive. The target to be detected by dogs might therefore contain the explosive, by-products, precursors and degradation products.

Trainers claim, that EDD can easily trained with TATP. One reason might be the vapor pressure of TATP (66 ppmV @25°C) which is much higher compared to most conventional explosives [18, 19]. HMTD on the other hand has a very low vapor pressure and tends to decompose in a number of highly volatile substances such as formic acid, acetic acid, formaldehyde, formamide, dimethylformamide, and trimethylamine [20, 21]. For safety reasons, neither of these explosives can be transported via public transport routes unless special transport bombs are used.

Due to the dangerous nature of the substances, the sniffer dogs are often trained using safe training aids – usually authorized by responsible authorities - containing very small quantities of the explosive, which are applied to a carrier material [22, 23]. In case of TATP usually purified TATP containing only small amounts of byproducts is used for the production of the training aids [24]. The question from the dog team's point of view is whether the dog recognizes likely to be encountered raw TATP, even though it has been trained exclusively with pure TATP. In the case of HMTD training aids, it can be assumed that some time has passed between the synthesis of the substance in the laboratory and the use of the training aid by the dog handler. The substance will therefore already be aged and contain decomposition products that may distinguish it from freshly produced HMTD in terms of odor.

Dog handlers report that sniffer dogs have difficulties in detecting large quantities of explosives unless they have been trained to do so [25]. The very small odor sources used in dog training for safety reasons could therefore result in large odor sources not being detected by the EDD. Authorities in Germany that keep service dogs counter the above-mentioned problems by organizing training sessions in which larger quantities of explosives are freshly produced on site by experts and destroyed again after the training is completed. However, private security companies do not yet have the means to carry out comparable operations.

1.4 Project “Campus to World”

One aim of the publicly funded project “Campus to World” was to contribute to the quality of commercial EDD. To this end, a TATP training workshop for commercial EDD was prepared. Considering the feedback from the participants, the workshop was expanded and transferred from the academic to the commercial sphere. During the workshops, initial steps were taken to answer questions about the detection of purified/unpurified TATP and fresh and aged HMTD. Initiated by EDD-providing security companies a uniform standard (DIN SPEC 77201) was developed.

2. METHODS

2.1 Surveys and observations

The initial design of the workshop was based on individual interviews and discussions with commercial EDD providers in the context of user symposia such as the "Odorologie Symposium" and joint research projects [26, 27]. At the end of the first workshop, the participants were asked anonymously in a questionnaire about their satisfaction with individual theoretical contents, the practical part, their overall satisfaction and their suggestions for improvement. Additional

information was obtained through observations and discussions between the participants and between participants and speakers. The subsequent workshop was further developed on the basis of the information thus obtained.

2.2 Preparation of TATP and HMTD odor sources

Warning! TATP and HMTD are initial explosives. The substances can detonate on impact, friction, electrostatic discharge and thermal stress. The synthesis, handling and destruction of the substances may only be carried out by experienced specialized personnel in compliance with the relevant laws and health and safety regulations. The quantities must be kept as low as possible. Possible interactions between partial quantities or additional hazards, e.g. flammable substances, must be avoided at all costs. The quantities utilized and protective measures must be adjusted in such a way that there is no danger to persons even in the event of an unintentional explosive conversion.

TATP was prepared according to Oxley et al. [16] using sulphuric acid (30%) as catalyst. For the purified TATP the precipitated product was filtered, washed with potassium carbonate solution (1% w/w in deionized water) and deionized water, recrystallized in methanol and dried for 72 h at room temperature. For the raw TATP the precipitated product was filtered, washed once with deionized water and dried for 12 h at room temperature. The raw TATP was used within 48 h. Both versions of dried TATP were mixed (w/w: 1/100) with baked (4 h @450°C) aluminium oxide balls (Alodur, 0.5–1 mm). The aim was on the one hand to phlegmatize the explosive and on the other hand to increase the strength of the odor sources by increasing the surface area.

HMTD was synthesized using formaldehyde and citric acid as described in literature [21]. The product was washed with water and methanol and subsequently dried at room temperature for 12h. To types of HMTD (fresh and aged) were prepared. The fresh HMTD was used within 72 h after synthesis, while the aged HMTD was stored for 4 weeks before usage.

Additional odor sources consisting of small amounts < 50 mg of unprocessed explosives placed in non-splintering vessels, EMPK® and cotton balls which both contain < 10 mg of explosive were provided by ExploTech GmbH (Germany). The latter two have been tested by the relevant authority and are no longer considered to be explosive with regards the German explosives act and the ADR, thus simplifying handling.

The identity of the synthesized and dried explosives was verified with a handheld Raman-spectrometer (First Defender RM). No additional Raman signals were found that would indicate substantial content of educts or by-products. However, impurities in the lower percentage range cannot be ruled out.

2.3 TATP training workshop

The workshop consisted of theoretical and practical content. In the theoretical part covered topics such as:

- *Occupational safety advice for the Workshop* (General safety advices, advices when working with dogs, behavior when working close to the explosives in the practical part of the workshop)
- *Physical and chemical properties of odorants in general* (molecular weight of odorous substances, concept of ageing and degradation of substances, equilibrium vapor pressure and its temperature dependence, permeation, adsorption, dilution)
- *Physical and chemical properties of explosives* (equilibrium vapor pressure of relevant explosives, composition of commercial explosives, the role of volatile by-products, ageing and degradation, possible benign sources e.g. medical use of nitrate esters)
- *Physiological olfactory process in dogs* (sniffing process, perception by olfactory cells and nasal-trigeminal system, neuronal processing of the odor stimulus, perception of individual odors and odor mixtures)
- *Occupational safety when handling explosives* (focused on usage of safety data sheets and toxic properties of explosives)

The theoretical content was presented in the form of PowerPoint-supported lectures lasting 30-60 minutes.

All dog handlers involved, as well as persons with direct contact, had a valid, officially recognized qualification for handling explosives.

For the practical part, two 150 g batches each of the phlegmatized TATP variants (purified, raw) were prepared. The phlegmatized TATP was tested in advance as non-explosive. Each batch contained 1.5 g explosive and was spread out in a flat metal tray (200×150×30 mm (l/w/h)). For the dog search, 6 search locations were prepared in unused furnished offices. These consisted of 2 search locations each for raw and purified TATP, as well as two rooms without explosives. In all search locations, strong odor sources (e.g. bath salts, volatile organic substances such as 4-bromo-chlorobenzene, methylbenzoate and worn clothing) as well as worn gloves were placed as distractors. Using gloves, the objects were hidden out of sight in drawers and cup boards. Afterwards surfaces and objects in the 6 offices were randomly touched and manipulated with freshly gloved and bare hands. Each room contained 5 odor sources. After a waiting time of 30 minutes, the EDD-teams were brought to the rooms one by one for the search. Each EDD-team searched the rooms only once. The position of the odor sources was not changed between the search runs of the EDD-Teams. However, surfaces close to the odor sources and the distractors were cleaned with fresh paper towels. The dog handlers were told that some offices might not contain any explosive and that maximum one explosive odor sample was hidden per room. The interpretation of the search dog's behavior was carried out exclusively by the dog handler. The dog handler finished a search by verbally indicating a "find" at a specific location or a "no find" for the entire room to the documenting experimenter. The experimenter was out of sight of the searching EDD-team until the search was completed and had no view of the room himself, thus ensuring double blind conditions. Eleven EDD-teams from Germany, Switzerland and The Netherlands participated in the workshop. The average age of the dogs was 3.9 years. The participants claimed to have trained the dogs in average 3,3 h/week on the detection of explosives. Among the participating dogs were the breeds Malinois (4), Malinois mixed breed (4), Beauceron (1), Border Collie (1), and German Shepherd (1). Of these, 7 teams claimed to have EDD trained with TATP facilitating TATP-training aids such as TATP containing cotton balls, EMPK® (Echtstoff-Mikromengen-Prüfkörper; real substance micro amount test bodies) or ionic liquid with TATP and were subsequently approved for the searches.

2.4 TATP/HMTD-workshop transferred into the commercial sphere

The workshop was prepared in close consultation with the explosives regulatory authority and was held in a commercial property by commercial actors. The following requirements, among others, were demanded and checked by the supervisory authority:

- Detailed description of the planned handling of the explosives from synthesis to processing, storage, use during training and destruction on-site. This included access restrictions to the site and the temporary storage of explosives in two small vaults, which were set up in a storage room with a solid construction
- Clear assignment of responsibilities for handling the explosives by a small number of particularly specialized personnel
- Clear, contractually defined relationship between the companies involved, including a declaration of consent from the owner of the property authorizing the handling of explosives in their building
- Valid and sufficient official licenses from the companies involved for the planned handling of the explosives
- Safety measures (hazard description, operating instructions, safety instructions for all participants, measures to protect third parties and provision of safety facilities and equipment)

Based on feedback from the previous participants, the focus of this event was placed on the scent imprinting of dogs using scent line-ups and scent wheels (Figure 1). In addition, search scenarios with hidden TATP in various preparations (TATP raw and purified, as EMPK® or in cotton wool, phlegmatized with aluminiumoxide, small (amounts < 50 mg) unprocessed quantities in non-splintering containers) were used. The aim was to provide the EDD-teams with a variety of different odor sources. HMTD (fresh and aged) was provided unprocessed in small (< 50 mg) quantities, as well as processed as EMPK® or in cotton balls to be used in scent line-ups. All detection dogs were trained with TATP. Training with HMTD was carried out to a much lesser extent.

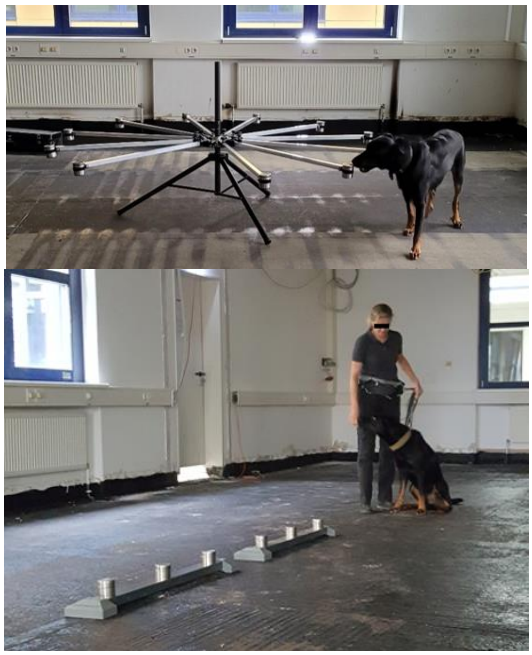

Figure 1. EDDs working on scent wheel and line-up

The initial odor imprinting of the sniffer dogs was carried out under the guidance of experienced trainers with a professional background as police or army dog handler which were used to the more widespread TATP-training aids. Due to the focus on training, searches with EDD were only carried out under double-blind conditions in exceptional cases.

No scientific evaluation of the dogs' search performance was possible. Only qualitative statements could be made based on observations and feedback from the participants. The theoretical parts were continued and supplemented with operational tactics. Overall 12 EDD-Teams participated actively with their EDD.

2.5 Development of a quality standard for commercial EDD-teams

In addition to the superordinate DIN 77200-1/2 (Security services - Part 1: General requirements for security service providers; Security services - Part 2: Extended requirements for security service providers for special service areas), a DIN committee was established to create a DIN-SPEC for guard dogs, as well as EDD. The committee was made up of representatives of commercial security service providers, scientists and a representative of the German Federal Aviation Authority.

3. RESULTS AND DISCUSSIONS

3.1 Training workshop at university

The results of the dog searches (Office without explosive, TATP raw, TATP purified) are shown in Figure 2 below. The figure summarizes the results of the two searches per type (No Explosive/TATP (purified)/TATP (raw)). "Correct" means that the team reported the correct location of the hidden explosive or, in the case of scenarios without explosives, that in a room without explosive the team correctly did not indicate a “find”. "False positive" means the supposed discovery of TATP although there was none at this location, while "false negative" means that the hidden explosive was not found by the team.

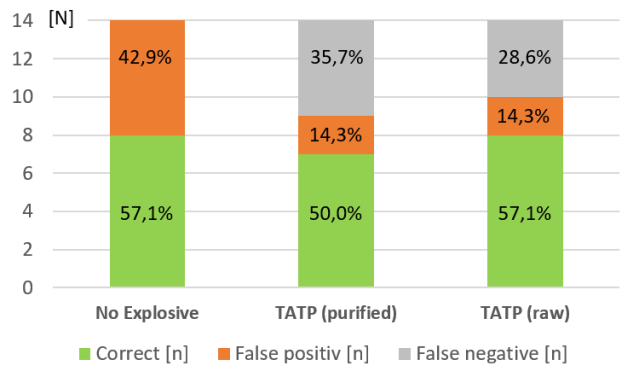

Figure 2. Results of the search efforts of TATP trained EDD (N=7) in search scenarios (no Explosive, TATP (purified), TATP (raw), two each) containing five odor sources each

With an expected value of 20% for 5 odour samples/search with a random distribution, the results show that the preceding TATP-training was only successfully in some dogs. False positive alerts were preferentially made at very strong odour

sources such as aromatised bath salts, in individual cases also at locations where no odour source was present. The results show no obvious indication that TATP (purified) and TATP (raw) cause a difference in the detection behaviour by the EDD, although the dogs were previously trained with purified TATP only. In view of the observation that dogs often perform better under controlled conditions than in real situations, the hit rate fell well short of expectations [4].

Dog handlers usually use a few grams of loose explosives for initial scent training. These odour sources emit continuously over a long period of time. The TATP training aids named before, on the other hand, contain only a few milligrams of the volatile substance, which can easily be lost. As a result, these training aids have much shorter storage and utilisation times compared to loose explosives. A fact that not all users were fully aware of. In addition, there were clear differences in experience among the dog handlers: Some were police officers with several years of experience in handling service and detection dogs, while others had acquired the skills to handle an EDD through self-taught or peer-to-peer training. Finally, the dogs were previously only trained with training aids containing mg-amounts of TATP and were never confronted with stronger TATP odour sources before. Survey of the participants and discussions between the organisers and the practitioners led to the following findings and requests for changes for a follow up training workshop:

- Theoretical parts were evaluated positively to very positively, but additional need was identified in areas such as operational tactics
- There was a need for further training with TATP (substance imprinting) and the correct use of training aids; there was interest to add HMTD as additional high-sensitive HME
- Some dogs were distracted by strong odor sources: Strong and very large odor sources (up to hundreds of kilos of explosives) should also be trained
- The handler's expectation of success is a possible cause for false positives
- Independent observers and double-blind tests help to identify errors in self-implemented training programs which obviously did occur in the run up

For continuation and due to legal requirements, the training workshop concept had to be transferred to the commercial sphere. The transfer of the workshops to the commercial sector was also a declared project goal. Adjustments were made to the concept, taking account of the participants' feedback. The main objective of the subsequent event was the odour imprinting by specialised personnel, while theoretical content was continued and supplemented.

3.2 TATP/HMTD-workshop transferred into the commercial sphere

As previously mentioned, a quantitative scientific evaluation of dog behavior towards the substances TATP and HMTD was not possible due to the predominant lack of double-blind conditions. The non-profit workshop was prepared with regard to odor training and not as scientific experiment. The following statements are therefore based on qualitative observations and statements by the participants:

- The training of the dogs with TATP was successful. After initial training the dogs were able to reliably find and indicate TATP in line-ups and in search scenarios
- Aged or fresh HMTD did not appear to smell similar enough to the few dogs trained with the substance to indicate both if they had previously been trained with only aged or only fresh HMTD

HMTD has a very low vapor pressure. The substance could therefore be detected by the dog's nose via more volatile residues of the reactants or decomposition products of the explosive, which should be investigated in more detail. The synthesis pathway and the ageing state of the substance could be relevant for the detection behavior of the animals and the dog training adapted to this.

The guidance provided by experienced dog handlers during the initial substance input was considered very helpful by the participants.

In future, independent double-blind tests - including relevant indoor and outdoor scenarios - should again be carried out in the workshops, as this is the only way to obtain reliable information about the success of the training.

3.3 Development of a quality standard for commercial EDD-teams

In addition to training concepts for difficult-to-handle explosives, the development of minimum standards for commercial EDD used outside of air freight was pursued. If these are not stipulated by law, as is the case with air freight, one way is to create industry standards such as DIN. DIN-SPEC 77201 was developed for explosives detection dogs in addition to the superordinate DIN standard 77200 [28, 29].

DIN-SPEC 77201 sets out national minimum requirements for the dog handler, the dog, the company employing the EDD team and the search skills of the team:

- Company employing the EDD-team: license in accordance with the Trade Regulation Act for the security industry; authorization under the Explosives Act to handle explosives
- EDD handler: minimum age of 21; basic cynological knowledge and skills; proof of reliability via official authorization to work in the security industry
- EDD: minimum age of 18 months; EU pet passport with current vaccination status; identification by chip; healthy appearance
- EDD-Team: proof of at least 8 hours of training/month, for example via a written and signed training documentation; ability to locate and passively indicate explosives

The prerequisites for certification of the EDD-team are checked by means of proof of corresponding documents, a written and two practical tests. The written tests cover basic knowledge in the areas of occupational health and safety, cynology, legal issues, operational tactics and first aid for dogs. In the practical part, the team must correctly and indicate passively a selection of the substances listed in the annex to the DIN-SPEC with a high degree of probability. This is done on the one hand by line-ups and on the other hand in operationally relevant search situations. In the latter operational tactics and self-protection must be considered by the dog handler. The searches are carried out under double-blind conditions. Offences against the animal protection law lead to exclusion.

The aim of the DIN-SPEC is to confirm the basic operational capability of German EDD teams in the simplest possible way. However, it is not possible to dispense with some basic requirements, such as number of explosives to be tested, conducting the searches under double-blind conditions

in order to avoid "Clever-Hans" effects, measures to avoid cross contaminations or the independence of the certifying body. The effort involved in carrying out EDD certification is therefore considerable.

Based on self-organized structured interviews with stakeholders in the field of commercial explosives detection dogs, the number of commercial EDD in Germany is estimated at 140 - 160 teams. Almost half of these are active in the air freight sector and are already regularly inspected and authorized by the German Federal Aviation Office (LBA). The establishment of an accredited national certification body therefore represents a major economic challenge due to the comparatively small number of potential customers. Due to the cross-border deployment of the teams, certification would also have to be accepted across borders, which is not unrealistic.

One alternative could be the creation of a uniform European standard (e.g. via CEN/CENELEC) and few certification bodies, which can then be used by teams from all member states. Another possibility would be the creation of a European directive - comparable to air freight - and the authorization of teams via designated official bodies.

4. CONCLUSIONS

Peroxidic explosives - especially TATP - have repeatedly appeared in terrorist and criminal activities in the past. The ability to detect these substances, for example by sniffer dogs, represents an important contribution to homeland security. The project “Campus to World” was the first time that training courses with highly sensitive home-made explosives for commercial EDDs in Germany were organized and transferred to the commercial sphere. However, the use of training aids with comparatively clean odorants in the training of detection dogs and their detection performance compared to real mixtures should be further investigated.

Collaboration between application experts and scientists contributes to the improvement of detection dog training. By providing help for self-help an open dialogue between academia and users has been enabled, which would otherwise not take place. This helps to identify content for future practical and theoretical curricula and raises awareness of potential skill gaps. The realization by the handlers that the EDD-team should also be trained with strong odor sources is such an outcome. In addition to the HME courses, some participants are now organizing exercises with large quantities of industrial explosives, e.g. in quarries. The aim is not so much to train the dog for extremely large quantities, but for the handler to get to know his dog's behavior when it is confronted with a very large scent field.

In line with the priority public interest of improved protection against explosive attacks, the scientific development of standards is a prerequisite for independent testing, authorization and certification of private security service providers. Purely price-driven competition without verifiable qualitative criteria would jeopardize public safety, as low-cost providers without assured quality standards would drive high-quality services out of the market. Thus, standardization and independent auditing are essential prerequisites for the future development of a free market in this specific area. The introduction of new standards in a hitherto largely unregulated market - in Germany and most EU countries - such as the private-sector provision of security checks by explosives detection dogs cannot be assessed using the classic cost-benefit ratio: economic interests must take second place to public and state interests. In a long-term perspective, i.e. after the establishment of internationally (or EU-wide) harmonized and mandatory standards and corresponding testing and certification institutions, the cost burden for security advertising could fall internationally due to competition from different certification institutions and create comparable starting conditions for providers. Independent accreditation or authorization could also increase the overall acceptance of commercial explosives detection dogs and thus expand the market for this service. The implementation of certifications is associated with considerable costs for the companies concerned, which may not be able to be passed on directly to customers. However, appropriate certification could relieve the EDD team and the company of liability risks [30]. Publishing the "EU Guidance on Operating Procedures for Explosive Detection Dogs in Public Spaces" and presenting "A Counter-Terrorism Agenda for the EU: Anticipate, Prevent, Protect, Respond" (COM (2020) 795 final, the EU is supporting the development of corresponding, initially voluntary standards.

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NOMENCLATURE

℃	temperature in Celsius
h	hour
l/w/h	length/width/height
mm	millimeter
mg	milligram
N	number
ppmV	volumetric parts per million