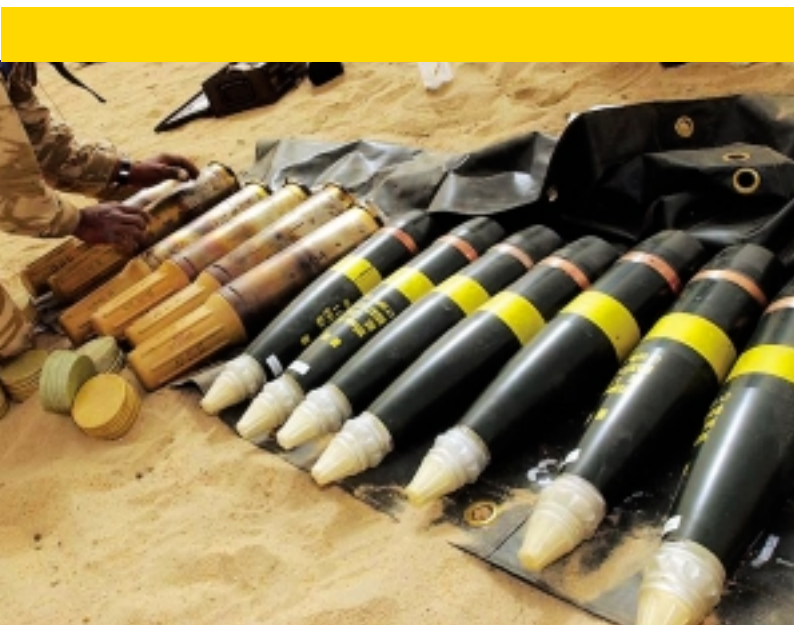


# SALW Ammunition Detection Study



## SEESAC

South Eastern Europe Clearinghouse for the  
Control of Small Arms and Light Weapons



United Nations  
Development Programme





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The **South Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons (SEESAC)** has a mandate from the United Nations Development Programme (UNDP) and the Stability Pact for South East Europe (SPSEE) to provide operational assistance, technical assistance and management information in support of the formulation and implementation of SALW co-ordination, control and reduction measures, projects and activities in order to support the Stability Pact Regional Implementation Plan, thereby contributing to enhanced regional stability and further long-term development in South Eastern Europe.

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## **SALW Ammunition Detection Study, SEESAC, Belgrade 2003**

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## Foreword

SEESAC has a responsibility within its mandate to advise on border control measures and to provide support to projects relating to the control of Small Arms and Light Weapons (SALW) within the South Eastern Europe region. Discussions with a number of individuals and organisations led to the development of a hypothesis that ammunition may be easier to detect than the weapons themselves at border crossing points and during 'search and seize' operations targeted against stockpiles. Yet these discussions also indicated that little formal open source research had been conducted in this area; hence the commissioning of this study.

The research for the study was conducted by Threat Resolutions Limited (UK), who consulted widely with police, customs, national security agencies, military units and other international organisations. The result is this study, which supports the hypothesis that ammunition should, in theory, be easier to detect than the weapons themselves. Yet it also identifies that further research is required in order to develop this hypothesis into a tactical doctrine for the interdiction and location of concealed ammunition. There are obvious security implications in the publication of some of the material identified during this study, and this information has therefore had to be omitted; but this omission does not detract from the findings of the study.

The next stage will be to conduct further research to develop and evaluate the tactical doctrine, and SEESAC will endeavour to identify a donor and appropriate organisation to continue this work. SEESAC will therefore continue to consult widely within the region in order to identify future requirements in this area, thereby continuing to contribute to the reduction of illicit SALW movements.

Belgrade, 30th September 2003



**Adrian Wilkinson**  
Team Leader SEESAC



# Executive Summary

This study was commissioned by the South Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons (SEESAC). The purpose of the Ammunition Detection Study is to determine if there is evidence to support the SEESAC hypothesis that it may be more productive to specifically target the detection of ammunition for Small Arms and Light Weapons rather than the weapons themselves. SEESAC is a developing organisation, with a responsibility to identify information on the precise level of smuggling activity and also advise on measures to reduce cross border trafficking; clearly current search methodologies used to detect weapons and ammunition within the region are an important component of this advice. Following discussions with the SEESAC Team Leader a set of assumptions, to support the Terms of Reference (TOR), were agreed.

Initial desktop research examined weapons and ammunition design and manufacture to determine if and why weapons can be more easily concealed than ammunition and what constituent parts are common or exclusive to one particular commodity. Further analysis was conducted to determine if ammunition and weapons are consistently transported together and examples of occurrences are provided. The investigation has involved visits to specialist organisations and national security agencies that have undertaken to provide data on suitable search and detection methodologies.

Further research was also conducted to identify the benefits and limitations of a wide range of appropriate detection technologies and equipments. Liaison with suppliers and users permitted direct comparisons of these equipments in use, including some in operational situations.

This report concludes that there is significant evidence to support the SEESAC hypothesis. However, the scope of the investigation requires broadening before significant progress is to be made towards the implementation of effective control measures. Any future scope should include:

- The conduct of an Operational Needs Analysis to accurately determine the level of threat, effectiveness of current search methodologies and identify changes to these tactical methodologies that may be necessary to improve the success rate in finding ammunition and weapons.
- The establishment of suitable criteria to determine the minimum detection thresholds at which ammunition must be detected.
- The conduct of trials to determine if suitable scent patterns can be identified from which detection dogs can be trained to consistently locate Small Arms Ammunition.
- The identification of the most suitable combination of tools to consistently detect ammunition and establish if this will also provide an integrated solution.

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# SALW Ammunition Detection Study

## 1 Introduction

In South Eastern Europe a significant problem exists in controlling the proliferation of Small Arms and Light Weapons (SALW) within partner nations and across their respective borders. The ready availability of such valuable commodities in large quantities has created a thriving market for criminal gangs and smugglers alike. For example it is estimated that in Albania alone approximately 300,000 illicit SALW, from over 619,000<sup>1</sup> looted from military stockpiles in 1997, remain in circulation<sup>2</sup>. The resulting impact of their existence presents a significant threat to peace, security and stability in the region and their control has been a key objective of the Stability Pact for South Eastern Europe (SPSEE) since it's formation in 1999<sup>3</sup>

## 2 Background

A key area of responsibility within the SEESAC mandate to the partner nations of the SPSEE (Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Macedonia<sup>4</sup>, Moldova, Romania and Serbia & Montenegro) is to advise on border control measures and implement projects related to the control of SALW in the region. Within SEESAC there is a growing consensus that it may be more productive to specifically target the detection of ammunition for SALW rather than the weapons themselves. A number of reasons for this hypothesis have been put forward, the principles of which are:

- Ammunition is more difficult to conceal than weapons;
- If ammunition is detected, then it is likely that the weapons will be located nearby;
- It may be technically less challenging to detect concealed ammunition rather than concealed weapons; and

- Specifically targeting the interdiction of ammunition may force perpetrators to make greater concealment efforts, thereby interrupting the tempo of illegal operations.

Probably the most influential factors, that demonstrate the ease with which these commodities can be moved and that will have a significant impact on the nature of control measures, are the length of physical 'green' borders across which smuggling can take place and the availability of routes of entry that can be used. Analysis of geographical and economic data for the partner nations reveals the following statistics:<sup>5</sup>

- Land and sea borders around these countries extend for approximately 4,800km.
- There are at least 38 registered working ports, of which 12 are operated at inland waterways, located throughout the region. In addition the natural, geographical features offer a considerable number of alternative unauthorised landing points.
- There are 473 known airports, of which 225 are permanently paved and the remaining 248 are local airstrips.

<sup>1</sup> Lt Col Paphadima Albania MoD

<sup>2</sup> SEESAC Country Assessment, July 2003.

<sup>3</sup> <http://www.stabilitypact.org/stabilitypactgi/catalogue>, May 2003.

<sup>4</sup> Also known as the Former Yugoslav Republic of Macedonia (FYRoM), but referred to as Macedonia in this report.

<sup>5</sup> CIA - The World Factbook 2003.



### 3 Aim

This aim of this report is to provide analysis, and recommendations on the following:

- The SEESAC hypothesis.
- Tactical search methodologies for ammunition as opposed to weapons.
- The effectiveness of Explosives Search Dogs in terms of quantities and ranges at which packaged and concealed ammunition and weapons can be detected.
- Other technical systems for the detection of packaged ammunition and weapons.
- The advantages in terms of time, cost efficiency and staff training and requirements of both approaches.

### 4 Methodology

The study has been conducted using the following methodology:

- Initial desktop research.
- Consultation with national security agencies and search training establishments.
- Analysis of data.
- The development of conclusions and recommendations.

### 5 Assumptions

Since SEESAC has existed for only a short period of time only limited information on the scale or known modus operandi of factions and criminals involved in cross-border trafficking has been acquired.<sup>6</sup> The following assumptions have, therefore, been made in this report:

- SEESAC intends to recommend the development of

further control measures at large consignments of illegal ammunition (and weapons, if an integrated solution is equally effective) only.

- The use of all forms of transport, including road vehicles, ships, barges and aircraft must be considered.
- Given the extent of physical borders, their porosity and the multiplicity of routes of entry, implementing effective control measures will require the provision of both static and mobile responses.
- Given the lack of financial resources within the partner countries available budgetary and human resources are likely to be extremely limited.

### 6 SALW definition

The definition of SALW currently used by SEESAC is:

***“All lethal conventional munitions that can be carried by an individual combatant or a light vehicle, that also do not require a substantial logistic and maintenance capability”.***

SEESAC acknowledges that there are a variety of definitions for SALW circulating and international consensus on a “correct” definition has yet to be agreed<sup>7</sup>. For the purposes of this report the following generic ammunition types have been included:

- Small Arms Ammunition (SAA) and Cannon ammunition up to 30mm.
- Mortars up to 100mm.
- Hand and Rifle Grenades.
- Anti-tank Weapons (including RPG-7 and derivatives)
- Man-Portable Surface to Air Missiles.
- Bulk explosives and accessories.
- Anti-Personnel and Anti-Tank mines.

<sup>6</sup> SEESAC has a mandate to consolidate information, but it is emphasised that it is not a criminal intelligence gathering organisation. That responsibility remains with EUROPOL, INTERPOL, the SECI Centre for Combating Trans-Border Crime and national security authorities.

<sup>7</sup> www.undp.org.yu/seesac Draft RMDS 02.10 - SALW Standards/ SALW definitions.

## 7 Analysis of the SEESAC hypothesis

The opening statement of the SEESAC hypothesis is that:

***“Ammunition is more difficult to conceal than weapons”.***

Examination of the manufacturing process shows that, as a general rule, most SALW are specifically designed and manufactured to permit them to be dismantled for ease of storage, carriage or cleaning<sup>8</sup>. The opposite, however, is true of ammunition where the components are normally permanently assembled during manufacture, not least for reasons of safety but also to maximise performance. There are exceptions to this rule, such as bulk explosives, which can be broken down into small quantities or the barrels of large calibre mortars, which cannot be dismantled, but it is strongly suggested that in most cases the statement is true and SALW could more easily be broken down and concealed than the related ammunition.

The SEESAC hypothesis also suggests that:

***“It may be technically easier to detect concealed ammunition rather than concealed weapons”.***

In order to begin the assessment of whether concealed SALW ammunition is easier to detect than the weapons themselves it is first necessary to examine those materials, which are common to, or differ, in the finished products, which have been listed below:

### ■ Weapons

- Metal, (most commonly steel, aluminium and tinplate).
- Plastics
- Wood.
- Oil.
- Greases and preservatives.

### ■ Ammunition, (including Bulk Explosives)

- Metal, (most commonly steel, aluminium, tinplate, copper, lead and brass).
- Plastic.
- Wood.
- Oil.
- Greases and preservatives.
- Primary explosives, (commonly found in detonators).
- Secondary explosives, (commonly found in mortars, grenades, missiles, mines and demolition stores).
- Low explosives, (commonly found as propellants in SAA).
- Plasticisers, (used in some high explosives).
- Stabilisers, (commonly used in high and low explosives).

It is evident from in the lists provided above that the range of materials found in ammunition significantly exceeds those in weapons. If the existence of suitable search methodologies and tools can be identified, that will detect these additional materials, then it logical to conclude that concealed ammunition is more easily detected than weapons.

The SEESAC hypothesis also maintains that:

***“If ammunition is detected, then it is likely that the weapons will be nearby”.***

There exists substantial documentary evidence to demonstrate that weapons and ammunition are, in most cases discovered together, especially where large shipments have been seized;

<sup>8</sup> Hogg, I.V. “The Illustrated Encyclopaedia of Firearms”, Newnes Books, 2002, pp 11-16.



#### BOX 1: KFOR seizure, May 2002

In May 2002 a large quantity of weapons and ammunition were seized in Kosovo when a truck carrying timber and three cars accompanying it were stopped near the town of Pec by KFOR forces. Among the weapons seized were 52 rocket launchers, five anti-aircraft surface-to-air missiles and a dozen anti-tank rocket launchers, as well as assault rifles and ammunition.<sup>9</sup>

#### BOX 2: Colombian seizure, January 2001

In January 2001 the Colombian air force intercepted a light plane from Venezuela, in Colombian airspace that was carrying an illegal shipment of weapons and ammunition.<sup>10</sup>

#### BOX 3: Illegal firearms trade

A report on the illegal trafficking of weapons and ammunition throughout Europe during the 1990's highlights over 40 major incidents, many of which report ammunition being found with weapons.<sup>11</sup>

A further significant outcome of this evidence is that it supports an integrated approach to detection if that proves to be technically possible; such an approach would offer the advantages of achieving the highest probability of successful interdiction as well as being the most cost efficient means of doing so.

## 8 Principles of search<sup>12</sup>

### 8.1 General

The main purpose of search is to locate and confiscate illegal goods or other forms of contraband, thus restricting the possession, supply and movement of such items. It is a straightforward process that requires trained personnel to physically examine otherwise normal environments or containers such as vehicles,

buildings or people, to detect secreted objects. Basic search techniques do not, therefore, differ when applied to ammunition as opposed to any other commodity except that personnel will require specific training in ammunition recognition and safe handling.

### 8.2 Definition

Search may be defined as:

***“The application of systematic procedures and appropriate detection equipment to locate specified targets”.***

### 8.3 Systematic Search

It is important to ensure that techniques and procedures are systematic for the following reasons:

- To minimise hazards associated with the environment in which the search is being conducted, for example working at height or in confined spaces, where specialist safety equipment may be required.
- To reduce the risk to search personnel posed by the potential presence of measures designed to protect the target assets being seized by security forces or stolen by rival criminals. For example in November 2001, officers from the Hamilton Drug Squad in Canada initiated a potentially deadly booby-trap while searching an abandoned factory, where it was suspected that drugs were being grown. Shortly after entering the premises they were overcome by fits of coughing and shortness of breath and had to make a quick exit. A closer inspection revealed an unusual contraption designed to fill the room with a fine mist of isopropyl alcohol and various minute compounds. The device, a paint spray gun, was triggered by a motion detector. The drug growers had also rigged the steel door leading to the target room, with wires from the mains electrical supply, so that anyone who pushed it from the outside would be electrocuted. For added protection, they even placed open jars of highly corrosive nitric acid in strategic locations and, if spilled, the contents could have inflicted serious burns<sup>13</sup>.

<sup>9</sup> <http://Europaworld Kosovo> “Major Weapons Seizure Thwarts Albanian Rebels”, 18 May 2002.

<sup>10</sup> <http://news.bbc.co.uk/world/americas>, “Colombia Seizes Munitions Plane”, 31 January 2001.

<sup>11</sup> <http://web.ukonline.co.uk/p.mordecai/firearms>, “Illegal Firearms Trade Across Europe”, January 2000.

<sup>12</sup> International School for Search and Explosives Engineers – Search Training Module.

- To give the highest level of assurance that those items being targeted have not been overlooked.
- To ensure the provision and maintenance of accurate search records in order to maintain the continuity of evidence and to support the submission of that evidence in subsequent legal proceedings.

## 8.4 Use of appropriate equipment

It is essential to ensure appropriate and accredited equipment is employed for the following reasons:

- Failure to do so could jeopardise the safety of security forces personnel and civilians. For example the use of detection equipment that employs a radioactive source must comply with International Standards to prevent accidental exposure to radiation.
- If the capabilities of the detection equipment are unsuitable for the perceived threat they will be of little value. For example a metal detector with a range of only a few centimetres is of little use if the target objects are buried at a greater depth.

## 8.5 Specified targets

Whatever search methodology is employed it is essential that specified targets are clearly defined, in order to maximise both the search resources available and the probability of success. It is of little value to stop and search many small vehicles when the desired intention is to intercept large consignments of weapons and ammunition, which could only be carried in large vehicles. It must also be accepted that the use of this tactic will sometimes allow the smuggling of smaller shipments to proceed undetected.

## 9 Tactical search methodologies<sup>14</sup>

### 9.1 Defensive Search

Defensive search is usually conducted at static locations, where there is a regular influx of people, vehicles or cargo, such as permanent checkpoints at national border crossings, seaports and airports. Within this form of search two different tactical types of search may be employed, the first of which is known as primary search. The execution of this search is based on the continuous observation of all human and vehicular traffic, during which individuals or vehicles are selected at random for closer scrutiny. It is, however, important that this selection process is truly random, otherwise ineffective trends may be inadvertently established and such errors will quickly become apparent to those whose intention is to identify and exploit weaknesses in the system. Where the security situation demands random selection can easily be replaced by full searching of all vehicles and individuals, providing adequate resources are available and the resultant reduction in traffic flow is acceptable.

A critical element of this methodology is that it enables search personnel to question people, thus providing the opportunity to assess their general demeanour and quickly analyse verbal responses.<sup>15</sup> Where suspicions are aroused search personnel have at their disposal a further tactical option, i.e. they are able to decide that a more thorough type of search, known as secondary search, is required. In such circumstances, people and vehicles can be segregated and moved to a specifically designated area where a more intensive inspection can be conducted. In some cases the decision to conduct a secondary search may be prompted solely by observation, for example an apparently empty cargo vehicle, which is riding unusually low on its suspension.

It is, however, important to ensure that the area where this activity will be conducted is fit for purpose and essential requirements include:

- A screened position, to deny observation by the general public, of the procedures and equipment being employed.

<sup>13</sup> Royal Canadian Mounted Police Criminal Intelligence Programme Report 2002.

<sup>14</sup> International School for Search and Explosives Engineers – Search Training Module.

<sup>15</sup> This can include the use of 'profiling'. However this is beyond the scope of this study and will not be considered further.



- A dry environment in which vehicle contents can be removed if necessary and where seized items can be easily laid out, for the collection of forensic evidence to be conducted, without them being exposed to extreme climatic conditions.
- Sufficient space in which several vehicles can be held for examination. This allows the conduct of concurrent search operations to be maintained at the required level without causing unnecessary disruption to the flow of traffic.

### 9.1.1 Advantages

The main advantage of defensive search is the successful removal of illegal commodities from circulation. Other, additional, advantages that may also ensue are:

- Disrupting illegal movement of illicit SALW.
- Deterring existing and potential perpetrators from conducting further illegal activities, thus restricting the availability of such goods and reducing the harmful effects on security and stability within the population.
- Forcing perpetrators to take increased risks in an effort to avoid detection, which may cause them to overexpose their activities and increase the chances of interception by security forces.

### 9.1.2 Disadvantages

The main disadvantages of defensive search are as follows:

- The conduct of physical searches may often be time-consuming, particularly with large vehicles, ships or boats. This can sometimes cause unacceptable delays and disruption to commercial activities.
- Where a consistently high level of activity is necessary, or in extreme climatic conditions, search personnel will only be capable of maintaining the required level of concentration for limited periods of time. To maintain effective results may require large numbers of personnel to be employed, which will impose an additional budgetary penalty.

- In countries with extensive borders the initial advantage of deterrence may be negated if perpetrators are able to circumvent established checkpoints by using more isolated routes, which cannot be easily monitored.

## 9.2 Offensive Search

Offensive search is normally conducted without warning and is often instigated as a result of specific, targeted intelligence. Offensive search teams are normally highly mobile, giving a greater degree of flexibility in the range of locations to which they can be deployed. This method of search is invariably used against experienced criminals, who are adept at using carefully prepared methods of short or long-term concealment. Success required the use of well-trained personnel, sometimes using portable, specialist equipment. In these circumstances additional security personnel will usually be required to deploy in advance to cordon and secure an area, building or vehicle prior to the arrival of search assets. This is necessary to prevent perpetrators escaping and to protect search assets from potential attack whilst working.

### 9.2.1 Advantages

The main advantage of offensive search operations, in addition to those for defensive search, is:

- The element of surprise and the deployment of highly skilled search assets greatly enhance the chances of success.

Successful offensive search operations have the potential to severely disrupt the tempo of illegal activities.

#### BOX 4: Jamaica seizures, 2001 - 2002

In Jamaica, during the year 2001-2002 a series of offensive search operations by police yielded 493 illegal weapons and a considerable quantity of ammunition, a five-fold increase on the previous year<sup>16</sup>. The same report also noted that, during the same period, there had been a significant reduction in gun-related murders.

<sup>16</sup> "Oneworld" News Report - 24 February 2003.

**BOX 5: SFOR Offensive Search**

During 2002 offensive search teams from the Stabilisation Force in Bosnia and Herzegovina conducted many successful operations, during which significant quantities of SALW weapons and ammunition were recovered. In one operation alone French troops seized 50 tonnes of ammunition, which required 6 shipping containers to remove it.<sup>17</sup>

The mobility of an offensive search capability can be used to maximum effect since it can be directed into remote areas that are being used by criminals to avoid defensive searches at permanent points of entry.

**9.2.2 Disadvantages**

The main disadvantages of offensive search are as follows:

- If perpetrators are consistently thwarted, the frequency and sophistication of protective measures (possibly booby-traps) used to guard illegal assets, is likely to intensify. This creates a corresponding risk to the personal safety of search personnel.
- The initial financial costs for training and equipment are higher than those required for defensive search.

**9.3 Search training****9.3.1 Analysis**

In order to determine precise search training requirements for any theatre of operations it is first necessary to conduct a detailed Operational Needs Analysis (ONA), which consists of the following:

- A detailed threat assessment
- An analytical survey of existing search procedures, to determine if they meet present and future threats, including:<sup>18</sup>
  - A training survey, which will determine if the current training system is adequate for the

identified threat levels. This survey would also identify appropriate revision of the existing training programme

- Identification of the attributes, qualifications and experience necessary for personnel to undertake training.
- An equipment survey, to determine if the existing assets meet the search requirements.

**9.3.2 Training Levels**

As a general guide search training can be divided into 3 levels, as follows:

- Basic – A short introduction to search principles intended for personnel who are not employed in regular search operations but who are required to be “Search Aware”. This training can be conducted on site, with little disruption to the normal work routine. The duration of training will depend on the results of the ONA but can be as little as one days training.
- Intermediate – A more detailed examination of search principles with practical training in the application of systematic search techniques and use of basic equipment. This training would normally be intended for personnel who regularly conduct search operations in a low risk environment (i.e. where there is a low risk of encountering an improvised explosive device (IED)) as a function of their normal duties, for example border guards. This training can be conducted on site and, depending on the results of the ONA, can be as little as five days training.
- Advanced – Intensive theoretical and practical training of dedicated search personnel, using specialist equipment, who may be required to operate in high risk environment (i.e. where there is a high risk of encountering an IED), or where there are known additional environmental safety hazards. Again this training can be conducted on site and again will depend on the results of the ONA, but could be as little as five days training. It should be

<sup>17</sup> <http://www.nato.int/sfor/historic-moments/historic.htm>

<sup>18</sup> One potential commercial organisation with this capability is the International School for Search and Explosives Engineers (ISSEE). SEESAC can advise on other potential suppliers.



noted, however, that this training can only be undertaken by students who have previously completed the intermediate training.

## 9.4 Costs

The cost of training varies considerably as many companies offer significant discounts, which are dependant on a number of factors, such as level, duration and number of students. As a general guide search training at an accredited international establishment is likely to cost between \$300-500 per student, per day. Costs of in-country training by a specialist training team could be significantly less. The provision of suitable search equipment depends entirely on the size and role of the team and it is therefore not possible to cost at this stage.

## 10 Detection dogs

### 10.1 General

Dogs have been used very successfully as a detection tool for many years and today their extraordinary sense of smell is used in a wide variety of roles, from detecting buried earthquake victims to malignant



"Photograph courtesy of DANMINAR A/S"

melanomas on hospital patients.<sup>19</sup> This report, however, is specifically interested in the ability of trained detection dogs to consistently locate illegal

weapons, explosives and ammunition. In order to provide a comparison between detection dogs and other machines used for the same purpose it is first necessary to explain how a dog becomes such a successful detection tool.

### 10.2 Theory of scent<sup>20</sup>

Scent is created by the gaseous molecules of a substance which, when combined with moisture and air give off a vapour, or scent. These molecules are carried in the air and can best be described as a gas or smoke. As in the case of smoke scent can impregnate other substances, similar to the way in which the

smoke from a bonfire will impregnate clothing. A scent that is carried on air is known as "air scent" or "windborne scent."

The sense of smell is one of the weakest human senses and considerably poorer than that of a dog. As humans evolved they became reliant on the sense of sight, whereas the dog has retained its sense of smell as its strongest sense.

The mechanics of the human sense of smell are quite simple. Scent molecules are drawn into the nostrils by breathing in through the nose. These molecules come into contact with a mucus membrane covering the olfactory receptors, which are sited at the top and rear of the nasal cavity. The molecules stick to the mucus covering these receptors and pass this information via nerves to the olfactory bulbs, situated at the bottom of the brain. These bulbs decipher these scent codes and establish what is being smelt. Humans are capable of distinguishing as many as 10,000 different odours.

The physical mechanics of the dog's nose are very different to humans, as the dog's nose is designed to be intensely efficient and extremely sensitive. In the nostrils there are two openings, with flaps on the outer sides, enabling maximum air intake. A septal organ can, if required, initiate a sniffing processing at up to 300 times a minute. An excellent description what constitutes a sniff is provided in the latest publication from the Geneva International Centre for Humanitarian Demining (GICHD)<sup>21</sup>


***"When a dog is sniffing, there is not just a one-way flow of air into the nasal cavity. Each sniff consists of five to seven small inhalations and exhalations per second of about 50 millilitres of air. The air blown out has a high humidity and can gather molecules outside the nose. Because the same air is sucked back in again immediately, any odour molecules that are released by increasing humidity are likely to be drawn into the nose".***

In the nasal cavity there is a bony structure, called the Submethoidal Shelf, which enables the dog to build up

<sup>19</sup> Williams H. and Permbroke A. "Sniffer Dogs in the Melanoma Clinic?" The Lancet, April 1989, p746.

<sup>20</sup> Provided by the Metropolitan Police Dog Training School - United Kingdom.

<sup>21</sup> "Mine Detection Dog Training, Operations and Odour Detection", GICHD, Geneva 2003, p17.



more concentrated samples of scent. The air and samples of scent are passed through a series of bony channels called Terminate Scrolls. These scrolls increase the speed at which the scent molecules strike the thick mucus covering the olfactory receptors, which are sited at the rear of the nasal cavity (the average dog has around 220 million scent receptors in its nose compared to around 5 million in the human nose). Nerves from the receptors carry the scent through the Cribiform Plate to the very large olfactory bulbs in the dog's brain. This highly honed piece of equipment that the dog possesses enables diluted forms of scent to be detected and the very large olfactory bulbs allows for much greater scent memory than humans.

### 10.3 Scent patterns

All solids and liquids emit a certain amount of vapour and the pressure of the gas phase above them is called "vapour pressure". Its value corresponds to the maximum pressure of the gas that exists above the substance's surface. An appropriate example in the context of ammunition is the space above some TNT (Trinitrotoluene) contained in closed bottle, when equilibrium has been reached (as many molecules evaporate from the substance's surface as are reabsorbed). The vapour pressure is therefore a very important indicator of how easily a substance tends to evaporate and of how likely detection of that vapour is going to succeed.<sup>22</sup>

A critical element of detection dog training is to isolate and identify the vapours, or scent pattern, of the target substance to avoid inadvertently training the dog to detect a contaminant from the environment in which the substance exists, such as the packaging. This requirement can be practically illustrated with detection dogs employed in humanitarian demining operations in Somaliland. There, dogs that have been trained to detect the explosives in landmines, have given positive indications on buried objects, which have subsequently proved to be buried SAA containers.<sup>23</sup> The most likely explanation of these occurrences is that the containers have been used to store or transport landmines and have become contaminated with vapour from the explosives in the landmines. It is, however, also possible that the dogs are detecting a vapour left by the

original contents, i.e. the SAA, which closely matches the vapours on which they were trained. It is stressed that these indications have in no way detracted from the performance of the dogs in the conduct of their primary function. What this example also provides, however, is evidence that if the scent pattern of the packaging is stronger than the contents then that could be used for training the dog in preference, or in addition, to the scent pattern from the contents.

The strength of a scent pattern will vary considerably depending on many variables, which affect the conditions in which the substance is found. They can be increased by extremes of heat and decreased in extremely cold conditions or after rainfall. Where a flow of air is restricted by concealment so the scent pattern will also diminish and it will become more difficult for detection dogs to operate successfully. In the case of buried substances the scent pattern will vary depending on the soil type and the moisture and nitrate content because the volatility of molecules in the buried substance will be affected by these and other conditions.

### 10.4 Threshold limits

In order to maximise the capability of a detection dog it is important to ensure that the dog understands exactly what it is being asked to find. A dog can be trained to ignore small quantities of substances or objects in order to concentrate his attention on larger amounts. To illustrate this requirement compare a mine detection dog to one searching large vehicles at a border checkpoint, where it is believed explosives and ammunition are being smuggled in large quantities. In the case of the mine detection dog it is absolutely vital that the dog is trained to indicate on the minute scent pattern of what may be a single anti-personnel mine, as it is not acceptable for it to miss one of these dangerous objects. Where a similar scent pattern is found in a large vehicle it may simply be because there is contamination within the vehicle from previous smuggling activities, or only a very small quantity is being carried. The time spent conducting a thorough search of this vehicle could possibly have been used more productively on a different vehicle with a much larger scent pattern. If the dog has a high

<sup>22</sup> Claudio Bruschini, "Commercial Systems For The Direct Detection of Explosives, Final Report, February 2001

<sup>23</sup> Reported by Alan Sims, owner of Karenswood International Specialist Dog Training School, August 2003.

threshold limit, there is a greater chance that when it does indicate it means there is a stronger likelihood of the presence of a large quantity of the target substances.

The potential problems, which must be considered when attempting to determine such limits are as follows:

- How to decide what constitutes a “large” amount of weapons, ammunition or explosives.
- A dog trained to a very small threshold limit could be indicating on a large consignment, which is very well concealed and emits only a small scent pattern.
- It is possible that a dog trained to a small threshold limit may ignore a strong scent pattern since it believes this is not what it has been trained to locate.

## 10.5 Multi-scenting

The versatility of the detection dogs is further demonstrated by the fact that they can be trained to reliably detect a number of different substances. For many years’ firearms and explosives search dogs, employed by law enforcement agencies around the world, have been trained to detect weapons and a wide variety of explosives. In the USA for example it is reported that a single Firearms and Explosives detection dog can be trained on the oil from weapons and 9 different high explosives.<sup>24</sup> What is interesting to note is that detection dogs do not appear to be routinely trained on Small Arms Ammunition (SAA). This may be because there are a great many different manufacturers worldwide and it may be that there are too many scent patterns on which to effectively train the dog. It is, therefore possible that if SAA were being moved separately from weapons the chances of successful interdiction would be very low. If it is established that the bulk of these supplies come from a small number of manufacturers it should be possible to isolate these scent patterns and add them to the dog’s training.

## 10.6 Detection ranges

A specific requirement of the SEESAC Ammunition Detection Study TOR is to report on the ranges at which detection dogs can locate concealed ammunition. Because of the many variables detailed above, which can affect the production and diffusion of vapours, accurate data on precise detection ranges is not available. This is illustrated by experiments in which detection dogs were used to determine the range at which landmines containing TNT (Trinitrotoluene) could be detected. An hour after a mine was laid it could be detected at a range of approximately 1 metre but after a month the mine could be detected from as far away as 30 metres, depending on the prevailing conditions.<sup>25</sup> What is significant in terms of the SEESAC application is that trained detection dogs are capable of indicating the presence of buried ammunition at considerable distances and, providing they are correctly trained to focus on the source of that indication, can pinpoint the location of that ammunition. There is also considerable, scientific evidence to support a proposal that detection dogs offer a better opportunity of success for locating many other types of concealed ammunition and explosives, compared to machines used for the same purpose, the key point of which is as follows:

***“Dogs can be trained to detect odours at vapour pressures well below the detection capability of currently existing chemical detection devices.”***<sup>26</sup>

## 10.7 Other research

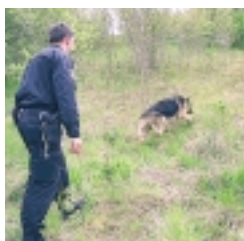
There is considerable, additional evidence that dogs have been successfully trained to detect specific types of ammunition, in projects conducted within several European countries. The classified nature of this evidence prevents its inclusion in this report but liaison between interested parties can be conducted by SEESAC.

<sup>24</sup> ROUHI A.M. “Detecting Illegal Substances” Chemical and Engineering News, 29 September 1997.

<sup>25</sup> “Mine Detection Dog Training, Operations and Odour Detection”, GICHD, Geneva 2003, p 169.

<sup>26</sup> “Mine Detection Dog Training, Operations and Odour Detection”, GICHD, Geneva 2003, p 16.

## 10.8 Benefits



“Photograph courtesy of SMEEDS”

The benefits of using detections dogs are as follows:

- They can detect and pinpoint the precise location of concealed ammunition and weapons.
- They are robust, agile and possess exceptional stamina, so can operate for long periods of time with only short breaks and in restricted spaces inaccessible to humans.
- Their operating speed significantly exceeds what can be achieved by physical search.

## 10.9 Limitations

The limitations of detections dogs are as follows:

- They will only find what they have been trained to find.
- Their effectiveness is highly dependent on the ability of the dog handler.
- They are susceptible to injury and illness.
- Associated veterinary treatment or a replacement dog in cases of serious injury) can incur significant financial penalty.

## 10.10 Costs

Without a detailed breakdown of precise training requirements it is difficult to accurately cost the training of detection dogs (and handlers). As a guide it is likely that the training of a “standard” Firearms and Explosives Detection Dog team would cost in the order of \$19,000 - \$29,000, (excluding the handler’s salary).

## 11 Detection equipment

### 11.1 General

An immense range of detection equipment is currently available on the commercial market, which ranges in cost from only a few thousand to several million dollars. It is therefore intended to provide examples of each type of equipment with a short explanation of how they work and their practical application. Since a comparison of individual models within an equipment type is not within the scope of this report comments on performance have been restricted to known benefits or limitations that are associated with each of the technologies, the majority of which have been collated by gathering anecdotal evidence from operational users.

Common to all detection equipment is the possibility of incorrect readings or indications. Within the industry two terms are generally used to describe these occurrences, as follows:

- A “*False Positive*” occurs when equipment indicates that a target object or substance has been detected or observed but, after subsequent investigation, that object or substance proves to be innocuous.
- A “*False Negative*” occurs when detection equipment fails to detect the target object or substance for which it is designed, but, after subsequent investigation, that object or substance is found to be present.

### 11.2 Induction coil metal detectors<sup>27</sup>

These detectors operate by using a metallic 'search' coil, sometimes called a search 'loop' which locates metallic objects. An electric alternating current is passed from the metal detector's battery through the search coil. This current induces an alternating electromagnetic field around the search coil. This field is uniform and looks similar to the field which iron filings pick out around a bar magnet. However, the field is easily distorted by a metallic object, for example a coin,



“Photograph courtesy of Ebinger GMBH”

<sup>27</sup> <http://www.sciencenet.org.uk/articles>, “Metal Detectors”, 27 July 2003.



or an object that is magnetised, such as a nail or naturally magnetic mineral like magnetite. A conducting metallic object produces an electromagnetic field, which opposes the induced electromagnetic field of the search coil. The opposing electromagnetic fields are produced by eddy currents within these objects. When the uniform electromagnetic field of the search coil passes over a metallic object with an eddy current, the detector's field is weakened and distorted. The opposite happens with a magnetic object in an alternating electromagnetic field (the field produced by a metal detector) the object causes the field to be strengthened and distorted.

All induction coil detectors have an audible note produced by the mixing of two oscillators. One oscillator produces a 'reference' frequency which is very similar to that produced by another oscillator circuit within the search coil. The search coil frequency is dependent on the distortion of the electromagnetic field it produces, i.e. the materials it passes over buried in the ground. When a search loop is passed over a conducting metallic object, the detector's electromagnetic field is weakened – this raises the frequency within the search coil oscillator, making an audible difference. When a magnetic material enters the field of the detector and concentrates it, a lower frequency is produced in the search coil oscillator, resulting in an opposite audible beat.

### 11.2.1 Benefits

Induction coil detectors are commonly used by low-level security forces' search teams to conduct routine searches and have the following benefits:

- Easy to prepare and use.
- Cheap to procure.
- Lightweight, (man-portable).
- Robust.
- Easily maintained.
- They require less than 1 days training to become a competent operator.

### 11.2.2 Limitations

The limitations associated with induction coil detectors are as follows:

- The detection range is limited and can vary significantly from the performance specifications claimed by manufacturers. In general terms all fall within the range of approximately 10 cm for small metallic objects, for example anti-personnel mines, to approximately 30cm for anti-tank mines and depths of up to approximately 1m for larger metallic objects. However, an independent study of the performance of 29 commercial detectors carried out by the International Pilot Project for Technology Cooperation<sup>28</sup> in 2000, should serve as a useful guide
- They cannot differentiate between metallic objects, which may be ammunition or weapons, and innocuous items. Therefore, where they are used in an environment of high metal contamination, they will give a greater number of false positive readings which must be subjected to further investigation, normally using physical search or digging.
- Not capable of detecting bulk explosives packaged in non-metallic containers.
- They are only effective in substances of a light density, such as soil or sand.

### 11.2.3 Cost

The cost of metal detectors ranges from \$1,000 - \$5,000 each, but considerable discounts can be obtained for multiple purchases.

## 11.3 Magnetometers<sup>29</sup>

Magnetometers are the most sensitive version of ferrous metal detectors and are particularly useful for finding large metal objects below ground buried at depths up to 6m. They differ from induction coil detectors in that they detect anomalies, in the naturally occurring magnetic field within the earth, caused by ferromagnetic objects. Audible warning and/or visual signals are also provided and most

<sup>28</sup> <http://demining.jrc.it/ipptc/abstract.htm>

<sup>29</sup> "Metal Detectors Catalogue 2003", GICHD, Geneva, February 2003.

magnetometers have a stepping switch and visual display the combined use of which allows the sensitivity to be adjusted and visually monitored. This enables the user to more easily differentiate the depth, size and orientation of the object. Although more commonly used for locating Unexploded Ordnance (UXO) these detectors can also be effectively used to locate buried ammunition and weapons in hides.

### 11.3.1 Benefits

The benefits of using magnetometers are as follows:

- Easy to prepare and use.
- Lightweight (man-portable).
- Increased detection ranges over induction coil detectors. For example a hand grenade can be detected at a range of approximately 50cm and an anti-tank mine at ranges of up to approximately 2m. Much larger objects, such as aircraft bombs can be detected at ranges up to 8m, depending on the type. This extended detection range means that they are useful for detecting ammunition or weapons.
- After only one or two days training an operator can easily become proficient in determining the size and depth of metallic objects, which allows some readings to be discounted and thus reduces the amount of time required for subsequent physical search

### 11.3.2 Limitations

The limitations of using magnetometers are as follows:

- Magnetometers are generally less robust than induction coil detectors and most require regular calibration, although there is one notable exception, the Foerster FEREX 4.032, which carries a lifetime probe guarantee.
- As with other metal detectors magnetometers cannot differentiate between metallic objects, which may be ammunition or weapons and innocuous items therefore positive readings must be subjected to further investigation by physical search or digging.

- They are not capable of detecting bulk explosives packaged in non-metallic containers.

### 11.3.3 Cost

The cost of a single magnetometer ranges from \$4,000 – 8,000 but considerable discounts can be obtained for multiple purchases.

## 11.4 Trace explosive detection<sup>30</sup>

In trace detection explosive is detected by chemical identification of microscopic residues of the explosive compound. These residues can be in either of two forms, vapour or particulate. Vapour, as described earlier in this report is the gas-phase molecules that are emitted from a solid or liquid explosive, depending on its vapour pressure.



“Photograph courtesy of Smiths Detection”

Particulate contamination refers to microscopic particles of solid material, which adhere to surfaces that have, directly or indirectly, come into contact with an explosive material. Particulate contamination is usually

sampled by wiping the surface to be screened with a swipe pad, provided by the manufacturer of the detection system being used. The pad is then inserted into a sampling port on the instrument and within a few seconds it can be analysed for the presence of explosives. Particulate detection is particularly useful for explosives such as RDX (cyclotrimethylenetrinitramine or Research Developed Explosive) and PETN (pentaerythritol tetranitrate), which have very low vapour pressures.

The most widely used technique within the field of trace detection is Ion Mobility Spectrometry.<sup>31</sup> The method of operation is that air is drawn into the instrument and ionised, by being passed through a chamber which contains a piece of metal coated with a radioactive substance to form positive or negative ions, in the case of explosives it is negative ions that are formed. Ions pass through an electronic shutter gate and are subjected to an electric field in a tube to measure the transit or “drift time” of the ions. This

<sup>30</sup> US Department of Justice Report, “Guide For the Selection of Commercial Explosives Detection Systems for Law Enforcement Applications”, September 1999.



transit time is then measured against stored transit times of known compounds making it possible to distinguish the target material.

#### 11.4.1 Benefits

The benefits of using IMS instruments are as follows:

- Easy to prepare and use.
- Portable machines are available, which can be carried in the boot of a large saloon vehicle or small cargo vehicle.
- Short analysis response times mean that a high throughput of people of vehicles through a checkpoint can be achieved.
- Can detect smokeless propellant from SAA as well as a range of high explosives.<sup>32</sup>

#### 11.4.2 Limitations

The limitations of using IMS instruments are as follows:

- Variable threshold limits cannot be programmed into IMS instruments. This means that in an environment of relatively minor explosive contamination, such as a vehicle previously used to carry explosives, they will give a false positive indication.
- Whilst they do not present a health risk the use of radioactive source equipment may require legislative approval before use and regulatory oversight once operational.
- Most IMS systems require the use of mains electricity, therefore their use in field operations is either restricted to less efficient, hand-held equipments or they must be supported by a suitable generator.
- IMS equipments are not as sensitive as detection dogs and normally would not be able to follow an

indication to its source. For example in the rear of vehicle where ammunition or explosives are hidden the IMS equipment will alarm but a suitably trained dog should be able to isolate the source of the scent, thus reducing the time required for subsequent physical search.

- Changes in atmospheric pressure caused either by climatic conditions or using the equipment at an elevation of more than approximately 100m may necessitate recalibration of the equipment, which can be conducted by the user.

#### 11.4.3 Costs

The costs range from approximately \$5,000 for a hand-held detector to \$300,000 for a human portal equipment. Vehicle screening portals can be obtained but are likely to cost significantly more than the human portal and quotes could not be obtained at this stage.

### 11.5 Vapour odour detection system (VODS)

VODS is a UK commercial variant of the Mechem Explosive and Drug Detection System (MEDDS), which was developed in South Africa in 1985 to trace smuggled explosives and ammunition.<sup>33</sup> The technique used entails the screening of drawn scent samples from sealed or enclosed environments such as sea containers, vehicles, or packing cases. By use of a mobile pump, air is drawn through a vacuum line, over a special filter, which is designed to absorb maximum scent for pre-selected specific substances, such as explosives or ammunition. Samples are then taken to a controlled environment where a detection dog (with its handler) is used to determine if traces of explosive have been found on the filters. If a positive indication is observed a second detection dog is used for confirmation.



"Photograph courtesy of Chilport (UK) Limited"

<sup>31</sup> Provided in manufacturers' brochure.

<sup>32</sup> Provided in manufacturers' brochure.

<sup>33</sup> "Mine Detection Dog Training, Operations and Odour Detection", GICHD, Geneva 2003, p165.

### 11.5.1 Benefits

The benefits of using the VODS are as follows:

- A very high throughput of traffic can be achieved. In addition it is possible to conduct the analysis away from view of the general public thus maintaining the secrecy of how the system works.
- The system is ideal for use in countries where for cultural or religious reasons the use of detection dogs in close proximity to humans is unacceptable.
- The dogs work in a comfortable, controlled environment where there is little risk of injury.
- The system is self-validating as the dogs can be tested with control samples at any time whilst they are working.
- The system is easily portable and can, therefore, be utilised in multiple locations. In addition it can be used in environments where dogs cannot normally work, such as a stack of large containers at a port, where samples can be drawn using a portable platform.

### 11.5.2 Limitations

As with all trace detection systems the possibility of detecting residual contamination is always possible. The system is a method of screening and must be supported by a physical search capability. There is also an obvious lapse time between obtaining the samples and presenting to the dog.

### 11.5.3 Cost

The cost will vary depending on the anticipated supply level of filters and storage tubes and the precise training requirements for the dogs and handlers but as a guide can be estimated at approximately \$76,000, subdivided as follows:

- Technical equipment and spares \$42,000.
- 3 dogs (includes 1 reserve) \$29,000.
- Training of handler \$5,000 (Excluding salary and subsistence).

## 11.6 X-Ray<sup>34</sup>



"Photograph courtesy of Smith Detection"

X-ray equipments have been in use as screening equipment for many years and a wide range of machines are now available that can examine items as small as a

letter to the biggest heavy good vehicle.

All X-ray based systems involve irradiation of a target item, usually followed by detection of an image created by X-rays that are either transmitted or backscattered by the item. Fluoroscopic imaging refers to a transmission x-ray system where the transmitted x-rays form an image of the objects onto a fluorescent screen. This is the simplest type of system, exposing the entire object with a cone of x-ray energy, often for extended periods. The fluorescent screen is normally used in real time using a 45° mirror (built into the machine to avoid standing in direct line with the x-rays).

Standard transmission x-ray systems use a fan or flying-spot of x-rays to scan the object as it is carried past the scanner by a conveyor belt. A black and white image is produced directly, with a linear array of sensing diodes. The resulting image is stored in digital memory and displayed on a TV or computer screen for operator viewing.

Backscatter systems produce an image from x-rays that is scattered from the screened object. They will measure the effective atomic number (Z) of the screened item and will automatically alarm in the presence of materials that have an effective Z in the correct range for explosives. The backscatter system produces two images and both the backscatter and transmission images are displayed. Because low-Z

<sup>34</sup> US Department of Justice Report, "Guide For the Selection of Commercial Explosives Detection Systems for Law Enforcement Applications", September 1999.



materials are more efficient at scattering x-rays, explosive-like materials are imaged as bright in the backscatter image, while they are barely visible in the transmitted image. Whilst the backscatter image is usually most effective for the detection of explosives the transmitted image is still useful for viewing metal items. One problem with backscatter machines is that they cannot discriminate between similar low-Z materials, for example military plastic explosive and other, innocuous plastic items.

Dual-energy x-ray systems yield superior material discrimination through comparison of the attenuation of x-ray beams at two energies. Materials of specific Z numbers (the same effective Z as explosives) can be clearly highlighted for the operator by adding colour to the image. A material that has a high Z number (metals) is often coloured green, while low-Z materials are coloured orange and materials with the same Z as explosives are red. Like backscatter machines dual-energy systems can also have an automated alarm system fitted.

### 11.6.1 Benefits

The benefits of using x-ray systems are as follows:

- A high throughput of human and vehicular traffic can be achieved. Truly random selection of targets for inspection can also add a considerable tactical advantage through the element of surprise or offer the added benefit of deterrence.
- X-ray systems can be extremely effective when used by experienced operators.
- They can be used to detect ammunition, explosives and weapons.

- Vehicle mounted versions, including the largest vehicle scanners, are available and can, therefore, be utilised in multiple locations. Again, where truly random selection is used, surprise and deterrence are added benefits.

### 11.6.2 Limitations

- Whilst initial training may take only a few days it may require several months practice with specialist supervision to produce a competent operator.
- Whilst they do not present a health risk the use of radioactive source equipment may require legislative approval and regulatory oversight once operational.
- All x-ray systems must be supported by a physical search capability.
- Where staff are required to work at high levels of attention to monitors or screens, adequate concentration can rarely be maintained for longer than 20 minutes<sup>35</sup>. To maintain effective results may require large numbers of personnel to be employed or the purchase of an electronic audit system such as the Threat Image Projection System (TIPS)<sup>36</sup>, which will impose a significant budgetary penalty.

### 11.6.3 Cost

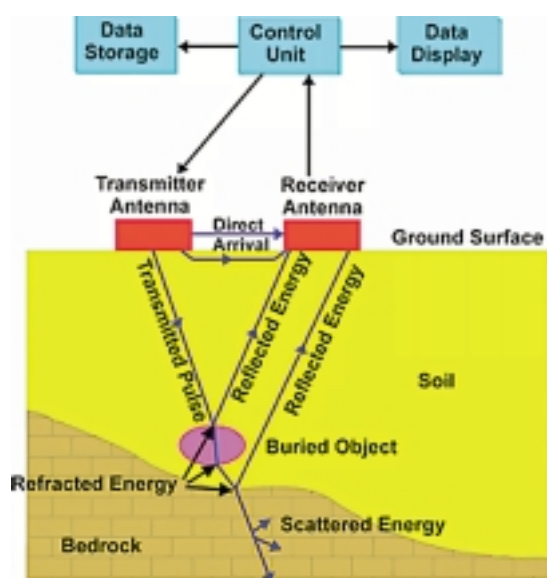
The cost of equipment varies from approximately \$70,000 for a machine used to screen large packages to over \$3,000,000 for a machine used to screen heavy good vehicles.

<sup>35</sup> Groves, M. "An Overview of Detection Technology in UK", Presentation Paper to Explosives-World Conference, April 2003.

<sup>36</sup> A commercial software package the purpose of which is its purpose is to monitor the x-ray operator's performance level by discretely projecting images of threats into bags being scanned by the x-ray.

## 11.7 Surface penetrating radar (SPR)<sup>37</sup>

SPR works by generating pulses of electromagnetic energy and launching them directly into the surface to be investigated. The radar measures the time it takes



\*Photograph courtesy of www.ttdlientc.com\*

for this pulse of energy to travel to the target and back to the antenna. A transmitter-receiver interfaces the antenna system to the user controller and processes the basic pulse information in order to improve the clarity of the radar signal and the resultant image, both of which are of extreme importance. The operator views the results in real-time through a controller unit.<sup>38</sup> Both concealed metallic and non-metallic objects can be located.

### 11.7.1 Benefits

The benefits of using SPR are as follows:

- It can be used to detect hidden or buried weapons, ammunition and explosives in deep hides, especially under concrete floors and in walls.

- It can be operated on batteries for use in field operations.
- It is man-portable.

### 11.7.2 Limitations

The limitations of using SPR are as follows:

- Its use is specialised but limited.
- Whilst initial training may take only a few days it may require several months practice with specialist supervision to produce a competent operator.
- When used in soils that have a high percentage of dissolved salts or wet clay depth of penetration and resolution of the images can be significantly degraded.

### 11.7.3 Cost

The cost of a single SPR is approximately \$40,000 – \$48,000.

## 12 The human factor<sup>39</sup>

Irrespective of how advanced technology may be the use of all detection equipments will at some stage require a human input. The high levels of attention required for working with monitors and screens, shown above, is an excellent example and the requirement for similar levels of concentration can be applied to all associated disciplines. Most literature on human resources management contains agrees that **“the workforce is the most vital asset”** or **“it is people that make the difference”** and such statements are well accepted and understood.<sup>40</sup> Therefore, in order to maximise the success of any control measure that is to be implemented, it is strongly suggested that close

<sup>37</sup> Also often referred to as Ground Penetrating radar (GPR).

<sup>38</sup> Provided in manufacturer's brochure.

<sup>39</sup> Groves, M. “An Overview of Detection Technology in UK”, Presentation Paper to Explosives-World Conference, April 2003.

<sup>40</sup> Storey, J. and Sisson, K. “Managing Human Resources and Industrial Relations”, Open University Press, 1996, p1.

<sup>41</sup> An individuals' competence to successfully and safely complete a task is determined by their operational experience, education and training. Experience alone does not necessarily equate to competence!



attention is paid to those aspects of human resources management<sup>41</sup> detailed below. It is stressed, however, that this list is offered as a guide and is not exhaustive:

- Qualifications.
- Selection.
- Initial training.
- Supervision.
- Audit.
- Continuation training and education.
- Personal development (especially through membership of an accredited professional body).

Similar attention must also be paid to the employment of dog handlers in this field, where there may be a misconception that the only required attribute is a love of dogs. Whilst this is clearly an important factor there are a significant amount of complex scientific knowledge, related to ammunition and explosives and animal behaviour, which a handler must be able to assimilate during his/her training.

### 13 Operational analysis

The evidence presented shows that the most effective resources, to detect SALW and ammunition, are likely to be a combination of physical search and detection dogs. A comparative analysis of the rate at which each can operate, based on anecdotal evidence from operational units is tabulated below. It is accepted that these rates are subject to a considerable number of variables, but they are only intended to be indicative:

<b>BOX 6: Comparisons</b>	<b>Open Ground (100m2)</b>	<b>Standard Shipping Container<sup>42 43</sup> (38m3)</b>	<b>Heavy Goods Vehicle Trailer Unit (117m3)</b>
<b>Search Team<sup>44</sup></b>	40 150 min (magnetometers)	180 min (hand held explosive detectors)	480 min (hand-held explosive detectors)
<b>Detection Dog</b>	15-20 min	5-10 min	15-45 min
<b>VODS</b>	N/A	15 - 20 min (including analysis of samples)	20 -25 min (including analysis of samples)

<sup>42</sup> May also be considered as a room in a building.

<sup>43</sup> VODS may be required where high volume of sealed containers are present, e.g. at ports.

<sup>44</sup> Search team of 2 pairs of searchers

## 14 Conclusions

There is a considerable amount of evidence to support the SEESAC hypothesis, as follows:

- The design and manufacture of ammunition makes it more difficult to conceal than weapons.
- The range of materials used in the manufacture of ammunition significantly exceeds those used in weapons. Since a wide variety of tools and equipments are available to detect these materials, especially explosives, it is highly likely that SALW ammunition will be technically less challenging to detect than the weapons.
- There is a wealth of evidence to demonstrate that where ammunition is found weapons are often also present and that seizures of large consignments severely disrupt the tempo of illegal operations.

Detection dogs are very probably the most effective tool for finding packaged and concealed ammunition but it is not yet possible to determine precise ranges, or if they will detect ammunition with greater ease than weapons.

The detection tools available for Small Arms Ammunition are limited and whilst, in principle, detection dogs are capable of conducting this task they are not routinely trained in this discipline.

Progress toward the introduction of effective control measures is hampered by a lack of comprehensive information on the current threat and existing responses.

The importance of the “Human Factor” must not be overlooked if control measures are to remain effective.

Apart from hand-held detectors and VODS all other technical systems require an extensive combination of training and practice to produce competent operators.

The introduction of cost-efficient, integrated control measures may yet be possible but cannot be determined until minimum detection thresholds are established, i.e. what constitutes a “large shipment” of weapons and ammunition.

## 15 Recommendations – Way Ahead

One recommended way ahead to progress introduction of effective control measures is as follows:

- Conduct an Operational Needs Analysis to accurately determine the level of threat, the effectiveness of current search methodologies in partner nations and identify changes to these tactical methodologies that may be necessary to improve the success rate in finding ammunition and weapons.
- Establish suitable criteria to determine the minimum detection thresholds at which ammunition must be detected.
- Carry out trials to determine if suitable scent patterns can be identified from which detection dogs can be trained to consistently locate Small Arms Ammunition.
- Identify the most suitable combination of resources to consistently detect ammunition and establish if this will also provide an integrated solution.

# Annex A

## (Informative)

# Terms and Definitions

### A.1.1

#### **booby trap**

an explosive or non-explosive device, deliberately hidden with the intent of causing casualties when an apparently harmless object is disturbed or a normally safe act is performed<sup>45</sup>.

### A.1.2

#### **defensive search**

a form of search usually conducted at static locations, where there is a regular influx of people, vehicles or cargo, such as permanent checkpoints at national border crossings, seaports and airports.

### A.1.3

#### **detonation**

the rapid conversion of explosives into gaseous products by means of a shock wave passing through the explosive<sup>46</sup>.

### A.1.4

#### **detonator**

a device containing a sensitive explosive which produces a detonation wave, which is normally used to initiate other, less sensitive, explosives<sup>47</sup>.

### A.1.5

#### **false negative**

when detection equipment fails to detect the target object or substance for which it is designed but, after subsequent investigation, that object or substance is found to be present.

### A.1.6

#### **false positive**

when equipment indicates that a target object or substance has been detected or observed but, after subsequent investigation, that object or substance proves to be innocuous.

### A.1.7

#### **IED**

#### **(improvised explosive device)**

those devices placed or fabricated in an improvised manner incorporating potentially destructive, damaging or lethal chemicals, designed to destroy, disfigure or harass. They may incorporate military stores, but are normally designed from non-military components.<sup>48</sup>

### A.1.8

#### **IMS**

#### **(ion mobility spectrometry)**

### A.1.9

#### **low explosive**

an explosive, which does not detonate under normal conditions of use<sup>49</sup>.

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<sup>45</sup> NATO Allied Administrative Publications (AAP) No.6 - 2003.

<sup>46</sup> [www.undp.org.yu/seesac](http://www.undp.org.yu/seesac) Draft RMDS 02.10 - SALW Standards/ SALW definitions.

<sup>47</sup> NATO Allied Administrative Publications (AAP) No.6 - 2003.

<sup>48, 49</sup> Ibid.

#### **A.1.10**

##### **MEDDS**

**(MECHEM explosive and drugs detection system)**

a method of capturing samples of air, which are subsequently analysed by specially trained detection dogs.

Note: It was originally developed in South Africa, in 1985, to trace smuggled explosives and ammunition.

#### **A.1.11**

##### **offensive search**

a tactical search methodology normally conducted without warning and often instigated as a result of specific, targeted intelligence.

#### **A.1.12**

##### **ONA**

**(operational needs analysis)**

#### **A.1.13**

##### **PETN**

**(pentaerythritol tetranitrate)**

a high explosive used extensively in military applications<sup>50</sup>.

#### **A.1.14**

##### **primary explosive**

an explosive, which is readily detonated by a small mechanical or electric stimulus<sup>51</sup>.

#### **A.1.15**

##### **primary search**

a type of search based on the continuous observation of all human and vehicular traffic, for example at a border checkpoint, during which individuals or vehicles are selected at random for closer scrutiny.

#### **A.1.16**

##### **propellant**

an explosive used to a projectile or missile, or to do other work by the expansion of high-pressure gas produced by burning.<sup>52</sup>

#### **A.1.17**

##### **RDX**

**research developed explosive**

**(cyclotrimethylenetrinitramine)**

a high explosive used extensively in military applications.<sup>53</sup>

#### **A.1.18**

##### **RPG**

**(rocket-propelled grenade)**

#### **A.1.19**

##### **SAA**

**(small arms ammunition)**

#### **A.1.20**

##### **SALW**

**(small arms and light weapons)**

all lethal conventional munitions that can be carried by an individual combatant or a light vehicle, that also do not require a substantial logistic and maintenance capability.<sup>54</sup>

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<sup>50</sup> NATO Allied Administrative Publications (AAP) No.6 – 2003.

<sup>51, 52, 53</sup> Ibid.

<sup>54</sup> [www.undp.org.yu/seesac](http://www.undp.org.yu/seesac) Draft RMDS 02.10 - SALW Standards/ SALW definitions.



#### **A.1.21**

##### **search**

the application of systematic procedures and appropriate detection equipment to locate specified targets.<sup>55</sup>

#### **A.1.22**

##### **secondary explosive**

an explosive which can be made to detonate when initiated by a detonation wave or other shock front but which does not normally detonate when heated or ignited.<sup>56</sup>

#### **A.1.23**

##### **secondary search**

a type of search where people and vehicles can be segregated and moved to a specifically designated area where a more intensive inspection can be conducted

#### **A.1.24**

##### **SEESAC**

**(South Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons)**

#### **A.1.25**

##### **SPR**

**(surface penetrating radar)**

#### **A.1.26**

##### **SPSEE**

**(Stability Pact for South East Europe)**

#### **A.1.27**

##### **TIPS**

**(threat image projection system)**

a commercial software package the purpose of which is its purpose is to monitor the x-ray operators performance level by discretely projecting images of threats into bags being scanned by the x-ray machine, detecting the operator's response to these threats, and recording the threat projections and operators responses in a database.

#### **A.1.28**

##### **TOR**

**(terms of reference)**

#### **A.1.29**

##### **UXO**

**(unexploded ordnance)**

any explosive ordnance which has been primed, fuzed, armed or otherwise prepared for action and which has been fired, dropped, launched, projected or placed in such a manner as to constitute a hazard to operations, installations, personnel or material and remains unexploded either by malfunction or design or any other cause.<sup>57</sup>

#### **A.1.30**

##### **VODS**

**(vapour odour detection system)**

a UK commercial variant of MEDDS.

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<sup>55</sup> International School for Search and Explosives Engineers – Search Training Module

<sup>56</sup> NATO Allied Administrative Publications (AAP) No.6 – 2003.

<sup>57</sup> Ibid.





The South Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons (SEESAC) is a joint UNDP-Stability Pact for South Eastern Europe project. Launched in May 2002 and managed under the auspices of the UNDP Country Office in Belgrade, SEESAC works to co-ordinate, facilitate and encourage efforts to combat the proliferation of small arms and light weapons (SALW) and related munitions in the region, offering technical expertise and support to ongoing initiatives and funding for smaller scale activities designed to complement project undertaken by other actors. SEESAC works towards the implementation of the Stability Pact Regional Implementation Plan on SALW in eight countries in South Eastern Europe - Albania, Bosnia and Herzegovina, Bulgaria, Croatia, the Former Yugoslav Republic of Macedonia, Moldova, Romania and Serbia & Montenegro.

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## SEESAC

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