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Remote Explosive Scent Tracing (REST)

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Foreword

In July 1996, international standards for humanitarian mine clearance programmes were proposed by working groups at a conference in Denmark. Criteria were prescribed for all aspects of mine clearance, standards were recommended and a new universal definition of 'clearance' was agreed. In late 1996 the principles proposed in Denmark were developed by a UN-led working group into *International Standards for Humanitarian Mine Clearance Operations*. A first edition of these standards was issued by the UN Mine Action Service (UNMAS) in March 1997.

This IMAS reflects changes to operational procedures, practices and norms which have occurred over the past three years. The scope of these standards has been expanded to include the other components of mine action, in particular those of mine risk education and victim assistance.

The United Nations has a general responsibility for enabling and encouraging the effective management of mine action programmes, including the development and maintenance of standards. UNMAS is the office within the United Nations Secretariat responsible for the development and maintenance of international mine action standards (IMAS).

The work of preparing, reviewing and revising these standards is conducted by technical committees, with the support of international, governmental and non-governmental organisations. The latest version of each standard, together with information on the work of the technical committees, can be found at www.mineactionstandards.org. IMAS will be reviewed at least every three years to reflect developing mine action norms and practices, and to incorporate changes to international regulations and requirements.

Introduction

The use of vapour sampling and filter analysis for explosive detection has seen limited acceptance by the international mine action community. Only a few organisations are currently using the system, but it has nevertheless proved to be an extremely fast and cost-effective way of checking suspected stretches of road or sectors of land for mines or UXO. Because of its limited use, the method of vapour sampling will be briefly described.

The system is named Remote Explosive Scent Tracing (REST). It involves the sampling of air and/or dust containing explosive traces near the ground surface, typically undertaken using vehicle mounted- or portable sampling machines capable of sucking air through filter cartridges fitted to the end of plastic tubes. The tubes are typically placed in single or double-headed tube assemblies at the end of a long suction pipe, which is attached to the sampling mechanism.

The filter cartridges currently in use in REST are made from a coiled polyvinyl chloride (PVC) netting, which has the ability to attract TNT molecules. The filter cartridges are placed in a sampling mechanism, which is then carried over a "leg" of 100 – 300 m at steady walking or driving pace. During this movement, there is continuous suction, with the pipe being systematically moved from side to side in a 2-4 metre wide pattern. At the end of this "leg", the filter cartridges are changed, and the used cartridges are systematically marked and stored in plastic containers. Marking is done according to GPS, map readings or manual measurement and each filter cartridge represents that particular "leg" or sector.

Vehicle mounted vapour-sampling machines, widely used some years ago, are considered to be less applicable today. The sampling accuracy has been found to be lower compared with man-portable units. Sampling with portable machines is, however, complicated since the people carrying the sampling machines must be assured safe walking access along mine suspected roads or areas. Safe access is typically ensured by driving mine-proofed vehicles through the area before sampling is undertaken. If the minimum pressure from these vehicles exceeds the maximum pressure caused by normal walking, the tracks created from the vehicles can normally be considered safe to walk in.

With a properly designed mine-proof vehicle, damage to the vehicle resulting from an anti-tank (AT) mine detonation is normally limited to a broken wheel or axle, which can be repaired in the field. If the crew is properly strapped in, the risk of being injured is minimal. Although it takes some hours to repair a blast damaged Casspir or Wolf in the field, very few AT mine detonations normally occur during operations. The repair of the damage and the down time have little effect on the overall cost efficiency and the speed of the operation.

Upon completion of the filter sampling process, the filter cartridges are typically transported to a central location for assessment by means of specially trained sniffer dogs. Their role is to analyse the filter cartridges and indicate if some of them contain traces of TNT or other substance, which the dog is trained to detect. If one or more of the dogs have indicated an explosive contaminated filter cartridge, the sector represented by the filter cartridge will be considered as potentially mined, which requires subsequent and more detailed re-checking of the relevant sector.

When the filter cartridges have been analysed, a follow-up clearance will be required of all the sectors indicated as possibly contaminated. Filter cartridges with no explosive trace represent mine/UXO free sectors, and these sectors will be assessed as having no further need for mine clearance. The re-checking of "positive" sectors is normally undertaken using free-running dogs to pinpoint the exact location of mines/UXO. Manual deminers are finally used to uncover and deal with the finds. Other demining methods can also be used.

The aim of this standard is to provide specifications and guidance for the planning, implementation, accomplishment and management of REST operations. It covers the general principles of the different elements of REST.

Remote Explosive Scent Tracing (REST)

1 Scope

This standard provides specifications and guidelines for the planning, preparation, accomplishment and management of vapour sampling and remote analysis operations. It also describes the sampling process, the analysis process and the follow-up of mine suspected areas subsequent to the completion of the analysis process.

2 References

A list of normative references is given in Annex A. Normative references are important documents to which reference is made in this standard and which form part of the provisions of this standard.

3 Terms and definitions

A list of terms and definitions used in this standard is given in Annex B. A complete glossary of all the terms and definitions used in the IMAS series of standards is given in IMAS 04.10.

In the IMAS series of standards, the verbs 'shall' and 'should' are used to indicate the intended degree of compliance. This use is consistent with the language used in ISO standards and guidelines.

- a) 'shall' is used to indicate requirements, methods or specifications which are to be applied in order to conform to the standard; and
- b) 'should' is used to indicate the preferred requirements, methods or specifications.

The term 'national mine action authority or authorities' refers to the government department(s), organisation(s) or institution(s) in each mine-affected country charged with the regulation, management and co-ordination of mine action. In most cases the national mine action centre (MAC) or its equivalent will act as, or on behalf of, the 'national mine action authority'.

The terms 'demining organisation' and 'mine dog organisation' refer to any organisation (government, NGO or commercial entity) responsible for implementing demining projects or tasks. The demining organisation may be a prime contractor, subcontractor, consultant or agent.

The term 'REST' is an abbreviation of Remote Explosive Scent Tracing, which comprises all elements of the system described in this standard.

The term 'target substance' is used to refer to the scent, which the specially trained sniffer dogs are trained to detect.

The term 'scent trapping' is used to refer to the process of collecting scent in filters.

The term 'breaching' is in this context used to describe the provision of safe access lanes for people involved in scent trapping

The term 'sampling operation' is used to describe the overall field operation established for the purpose of collecting scent in filters. The term comprises the breaching and scent trapping functions as well as other related activities, such as field logistics, rescue services, medical back-up and communication.

4 General

4.1 REST system components

The REST system can briefly be described as a process of collecting target substances (usually traces of explosive vapour) from the surface of a mine/UXO suspected area, using filters that are subsequently analysed by specially trained sniffer dogs. The system has four principal elements:

- a) the breaching and rescue element
- b) the scent trapping element
- c) the analysis element
- d) the follow-up demining element

One of the major challenges is to get access to all the areas where scent trapping is to be undertaken. Safe access is ensured by establishing a breaching team whose main responsibility is to provide safe lanes for the scent trapping teams.

The scent trapping element's primary function is to ensure that air¹ is collected systematically by suction through filters. Each filter represents a specific sector of road or land.

The analysis element's primary function is to analyse the filter cartridges that have been collected. Analysis is typically undertaken with specially trained sniffer dogs that are capable of tracing the scent from a target object. It may, however, be possible to analyse filter cartridges by applying different physical and chemical analysis techniques in a laboratory or other controlled environment. These techniques have not yet been fielded in support of humanitarian mine clearance but extensive research is currently being undertaken to develop suitable technology and concepts. This standard does not address analysis techniques other than mine dog detection. Many of the elements in this standard will, however, have an application for all types of filter analysis, whether in support of dogs or chemical analysis.

The follow up demining element's primary function is to verify the presence of mines or UXO in the sectors that have been identified by the analysis element as potentially mined and to carry out the requisite clearance. The follow-up demining element may consist of any type of demining capacity or combinations of different demining capacities. A combined manual demining and mine dog detection team may for example be used to form the follow-up demining element. Mechanical mine clearance may also be applicable. This standard does not address activity undertaken by the follow-up demining element. Operational procedures for mine dog detection are described in IMAS 09.41. General principles for clearance requirements, is described in IMAS 9.10.

¹ The filters currently in use do not allow collection of dust and soil. The filters will, in fact clog disabling further suction of air through the filter. It has, however, been agreed scientifically that the sampling of dust and soil would provide a much higher concentration of explosives in the filters (approximately 1000 x higher in some cases). Thus, dust and soil should ideally be collected instead of only air from above the surface. There are, however, many practical problems attached to the sampling of dust and soil. Scraping of soil from the ground may pose a potential risk of detonating landmines. Furthermore, soil sampling is perhaps a more laborious and time-consuming process than air and dust sampling. That said, if there were ways to effectively collect soil and dust from the ground, this would probably be the best solution.

4.2 System application

The REST system should not be considered as a demining method but rather as a system for eliminating sectors that do not contain traces of explosives or target scent. Although the system has been applied in the field for a considerable period of time, its accuracy is poorly understood and described. This, combined with physical and practical limitations, suggest the following system application:

- c) REST applied to eliminate sections of road; It is often essential to re-open the road net work at an early stage in the mine action programme, and the REST system has proved to be a fast and cost-effective means of screening large sections of road, thus leaving few sections to be physically demined. Typically more than 90% of the overall road network can be eliminated using the REST system. It will, however, have less application on heavily mined roads or on roads with previous extensive military activity. Such stretches of the road will typically be contaminated by target scent (from mines, mortars, hand grenades, bullets, cartridges, oil spill etc). The scent from bullet cartridges left in the vicinity of the road may for example be recognised by the sniffer dogs. This scent is very distinctive and it is likely that one or more of the sniffer dogs will identify a stretch of road with nearby cartridges as positive, i.e. potentially mined. If a road is heavily contaminated with target scent, the system has little application since very few sectors will be eliminated in the screening process, thus making the system non-cost effective;
- d) REST applied for elimination of sectors of land; Whilst the REST system has no application in areas with regular or patterned minefields, it may have an application if the objective is to determine whether there is a potential mine/UXO threat in a particular area, or where the edge of such a mined area might be. At present, large areas are often demined conventionally only to discover that there were no mines in the area;
- e) the REST system could be applied for general area reduction through elimination of sectors but this way of applying REST is untested. Little empirical and scientific data therefore exist to prove its reliability. The REST system should therefore not be used for general area elimination² without prior testing to ensure its effectiveness and reliability; and
- f) REST applied to eliminate the risk of booby-trapped houses; The REST system may be applied as a verification and elimination method when the objective is to check one or more houses for booby traps. Confined rooms with entrapped air may be ideal for the application of REST. The challenge, however, is to ensure a safe access to houses and to the confined rooms. REST should not be applied if the safety of the people involved is at risk. This standard does not address REST applied for elimination of booby-trap suspected rooms or buildings.

² A study is currently undertaken in Angola (2001) to determine the plume from different types of landmines and subsequently determine whether REST has an area reduction application. If applicable, the aim is to develop guidelines on how to practically apply REST in this role.

5 Management of the sampling process

5.1 General

The sampling operation comprises two main functions, breaching and scent trapping. A successful sampling operation requires careful planning and preparation. The REST approach is considered to be at the current limits of vapour/scent detection technology and small mistakes may have a significant negative impact on the analysis results, thus making the system totally unreliable. There is typically a close linkage between a breaching team and a scent trapping team and the roles and responsibilities of both teams may overlap significantly. The two functions are, however, described individually in this standard, to simplify the responsibilities, roles and obligations of each function.

5.2 The sampling operation

The sampling operation is normally headed by a project manager whose responsibility is to manage the implementation of all field activities, and to co-ordinate the breaching and scent trapping elements of the REST operation. His/her responsibility includes but is not limited to:

- a) planning and management of the overall sampling operation;
- b) co-ordination between the breaching and scent trapping team;
- c) establishment of appropriate security and safety arrangements;
- d) establishment of appropriate medical evacuation procedures;
- e) establishment of appropriate communications procedures;
- f) establishment of an appropriate rescue back-up procedures;
- g) establishment of the appropriate logistic support elements;
- h) establishment of appropriate procedures for the preparation and storage of records including the preparation of maps with plots and records of the exact location of each change of filter cartridge, marking of the filter cartridges, container boxes and other relevant information (landmarks, road condition etc);
- i) confirmation that prevailing procedures for the storage of blank and used filter cartridges are implemented and followed; and
- j) co-ordination of rescue operations in the event of accidents or vehicle breakdown.

5.3 The scent trapping operation

The scent-trapping team typically consists of 5-7 people (see paragraph 6.2 below). It is normally headed by a team leader who is responsible for all activities undertaken by his/her team before, during and after the sampling operation. These include but are not limited to:

- a) inspection of sampling equipment and sampling staff before sampling operations start;
- b) monitoring the sampling staff during sampling to ensure that sampling is undertaken at the correct speed and that the search pattern and change of filter cartridges are undertaken in accordance with the prevailing SOP;
- c) ensuring that the filter cartridges are changed exactly at the spots marked by the marking staff; and

- d) ensuring that the sampling staff walk steady in the centre of their lanes and that the roles of the primary and secondary scent trappers are rotated frequently.

5.4 The mechanised breaching operation

the breaching team is typically mechanised but breaching may also be manually undertaken or by means of mine dog detection. When mechanised breaching is used, the team is normally headed by a breaching team leader who is responsible for his/her team before, during and after operations. This includes but is not limited to:

- a) inspection of vehicles, accessories and other needed tools/assets prior to the breaching;
- b) ensuring that all personnel sitting inside the mine-proof vehicles are correctly strapped in during the breaching process;
- c) inspection and evaluation of the situation of the road and, if working off-road, on the work area and the suitability of the mine proof vehicles to operate on such roads or areas; and
- d) inspection of the patterns created by the wheels of the vehicles during the operations, with subsequent recommendations as to whether further marking of the vehicle track is required to ensure that the sampling staff can identify the right tracks to walk in.

The breaching team leader is normally located in the first mine-proof vehicle during operations. Radio contact is maintained with the second mine proof vehicle (and the third if available) as well as the project manager and the scent trapping team leader.

6 Sample element, team compositions and functions

6.1 Mechanised breaching team

A mechanised breaching team may be put together in different ways, and its personnel may have different titles and roles and responsibilities to those suggested in this standard, due to the unique character of each operation. A typical breaching team however is normally composed of 9 – 14 people, and their positions and responsibilities should normally be in line with the following principles:

- a) Breaching Team Leader (1); Typically responsible for the management of the breaching team including all safety, quality and operational aspects, including the maintenance of vehicles and equipment;
- b) Para-medical (1); Typically responsible for emergency treatment in the event of mine/UXO accidents, other accidents or illness. The para-medical is normally responsible for establishing adequate field routines for medical evacuation/treatment including management and the preparation of medical equipment. The para-medical may have a secondary role as a veterinary assistant if dogs are used during the sampling process;
- c) Drivers (2-3); Typically responsible for driving and for first order maintenance of the vehicles;
- d) Mechanic (1); Typically responsible for the establishment of maintenance routines, repair of vehicles and planning/preparing the spare part requirements during the operation. The mechanic may be one of the drivers;
- e) Logistic staff (2-4); Typically responsible for logistic support during breaching and scent trapping, including fuel supply for the scent trapping teams, placing and picking container boxes on/from the ground, measuring the driving distance, plotting the exact location of change of filter cartridge and registration/storage;

- f) Marker (1); Typically responsible for the accurate marking and recording of the sectors that have been sampled, including the spots where filters have been changed. The marker may use a measuring tape or another measuring device to measure out the exact distance between each change of filter cartridge. The Marker typically walks behind the first mine-proof vehicle but in front of the sampling team. He/she marks the spots where filter cartridges are to be changed; and
- g) Deminers (2-3); Typically responsible for emergency manual demining in the event of accidents, vehicle breakdowns or similar. The deminers may also hold secondary positions as logistic staff or scent trappers.

6.2 Manual scent trapping team

Scent trapping can be undertaken mechanically although manual scent trapping has lately proved to have greater application. A suggested manual scent trapping team is described below, and its basic functions are outlined. In practice, such a team may be composed in any form, so its personnel may have different titles and roles due to the unique character of each operation, but the basic requirements remain. A typical scent trapping team is normally composed by 5 – 7 people. A functional breakdown of positions and responsibilities should incorporate the following principles:

- a) Team Leader (1); Typically responsible for the planning and accomplishment of the sampling process. The Team Leader will normally follow behind the sampling staff where he/she monitors their walking steadiness/speed, search pattern and change of filter cartridge as well as the marking of the safe lanes provided by the breaching team. The team leader normally has a supervisory and command role;
- b) Primary scent trappers (2); Typically responsible for the manual scent trapping. They will normally walk in the safe lanes/tracks (one in each lane) where they will sweep the area with the flexible tube attached to the sampling machines; and
- c) Secondary scent trappers (2); Will typically walk 2-3 m behind the primary scent trappers. Their role is to monitor the sample pattern and the walking speed of the primary scent trappers and to change filter cartridges and decontaminate the cartridge assemblies at the long end of the flexible tube.

Scent trapping involves extensive walking. The team leader should therefore ensure that the scent trappers are given the necessary rest periods, and that the primary and secondary function of the scent trappers is frequently rotated.

The scent trappers are normally responsible for the maintenance of the sampling equipment and they may also be responsible for the handling, marking and storage of the filter cartridges.

7 Operational requirements, breaching team

7.1 Safe access, general considerations

A key element of the sampling process is the provision of safe access for the sampling team. Although it is indeed possible to provide safe access by manual demining, this clearly reduces much of the speed and cost-effectiveness of the operation due to the slow nature of manual demining. It may under rare circumstances be possible to use paths that are already in use by the local population. Neither method can be depended on, so alternative ways of providing safe access must therefore be planned.

7.2 Rescue plan

The use of a vehicle-mounted breaching team presupposes the possibility of detonation of anti-tank mines. It is therefore likely that at some stage a vehicle will need to be rescued and recovered. This process can be extremely difficult and dangerous if the demining organisation has not taken the necessary precautions in advance of the operation. A rescue strategy and plan shall therefore always be prepared prior to the start of sampling operations. The rescue plan should at minimum take into account the following factors:

- a) the use of safe lanes; Due to the mental and physical strains undergone by the people inside a detonation wrecked vehicle, these people should not be allowed to walk out of the area in safe lanes created by the wrecked vehicle. The shock pressure may have caused dizziness and inability to walk steadily;
- b) Manual demining element: Every sampling operation should have a manual demining element capable of demining wider safe lanes from a safe area to the wrecked vehicle. Team members with other primary functions may be used as deminers provided that they have been trained and operationally accredited for manual demining. The manual deminers may also have to demine a safety zone around the wrecked vehicle, to facilitate its repair or recovery;
- c) Secondary vehicle for rescue of personnel; A secondary vehicle may assist by transporting rescue staff closer to the wrecked vehicle. It should, however, not drive all the way up to the wrecked vehicle without prior manual demining of tracks since it is likely that other mines may detonate in the same area. It is, however, possible to demine safe lanes manually in support of the secondary vehicle; and
- d) Secondary vehicle for rescue of the wrecked vehicle; The REST system normally relies on the use of a second mine proof vehicle to rescue a wrecked vehicle. This rescue can sometimes be extremely difficult due to access limitations. The demining organisation should establish a rescue policy incorporating a series of different access and rescue alternatives dependent on potential situations on the ground.

7.3 The use of mine proof vehicles

The use of mine proof vehicles has proven useful for the provision of safe access for scent trapping staff. V-shaped personnel carriers, which afford a high level of cabin protection for the occupants even in the event of an anti-tank (AT) detonation, are the most common ones. Repairs of these vehicles in the event of anti-tank detonations are designed to be undertaken in the field using spares carried with the vehicles. If mine proof vehicles are to be used, the following principles shall be applied:

- a) the vehicles shall be designed to withstand antitank mine detonations without putting its personnel at intolerable risk;
- b) the vehicle should be able to withstand antitank mine detonations with no substantial or irreparable damage inflicted to the vehicle itself. Irreparable damage is typically prevented by using armoured protection combined with a raised distance from the detonation point to the vehicle body. Supplementary protection can be achieved by V-shaping the vehicle thus steering the blast away from the vehicle body. It is also normal to pre-construct breakpoints in wheel suspensions and axles;
- c) at least two vehicles should be used in pair to support one sampling operation. The primary vehicle's main function is to provide safe access for the scent trapping staff. The secondary vehicle's main function is to provide rescue support. The second vehicle must therefore be sufficiently equipped in terms of towing hooks and cables, crowbars, spares and medical equipment;

- d) the vehicle shall provide a ground pressure, which by far exceeds the pressure caused by walking sampling staff equipped with protective clothing and the sampling machines. The ground pressure from a foot may vary from 2 kg/cm² to about 15 kg/cm². This depends on the soil hardness coupled with the speed, way of walking and the pressure distribution in the footwear. The ground pressure created by the most common mine proof vehicles (Casspir and Wolf) will vary from 10 – 45 kg/cm² dependent on surface evenness, pressure distribution, wheel pressure, load and speed. The relatively small margins between the pressure applied by the vehicle and the foot gives reason for caution. Thus if these vehicles are to be used, the demining organisation should ensure that the concentrated load on the ground caused by sampling staff is sufficiently distributed. This can be done by issuing footwear that is constructed to effectively distribute the pressure. Military boots with hard heels will facilitate a reduced pressure area making them less suitable. Soft and large rubber soles will facilitate a better distribution and reduce the concentrated load on the ground;
- e) each track (safe lane) created by the vehicle should be at least 30 cm wide but an even wider track is preferred. If the track is not clearly visible for the sampling team or it can be mistaken with other similar tracks, the staff in the vehicle should mark the centre of each track with tape/paint or similar while driving. This process should ideally be undertaken mechanically since this would provide the greatest accuracy and the highest level of safety for the people involved;
- f) the driver and other staff being in the mine proof vehicle during breaching shall always be sufficiently strapped to prevent a throw-out of from seats if the vehicle detonates an anti-tank mine. If some of the staff need to undo the strapping during driving, the vehicle shall be stopped before the straps are undone and remain parked until all the staff are fully strapped again; and
- g) unstrapped equipment and spares can cause serious injuries to the staff inside the vehicle. Thus, all equipment carried inside the cabin must be adequately strapped.

8 Operational requirements, scent-trapping team

8.1 Sampling pattern

The sampling pattern shall ensure that all the sectors have been sampled with a complete coverage. No pockets larger than 25 x 25 cm² should remain unsampled³. Moreover, the sampling procedures should ensure a minimum of 30 cm overlap between each sampling lane.

The sampling units currently in use do not allow a wider search than approximately 2.3 m to each side. If we consider the need to establish a 30 cm overlap, the effective search width of a lane is 4 m. Consequently, a sector, which is between 4 and 8 m wide requires the establishment of 2 sample lanes. If the sector is between 8 and 12 m wide, this requires 3 sampling lanes.

8.2 Sweeping technique

The following aspects should be considered during sweeping:

³ The detectable plume with current equipment and techniques has not yet been sufficiently established. Experience suggests that air suction will detect target scent as far away as 8 m from the target object. Further research is, however, required to determine the minimum detectable plume from a mine or UXO (ref Angola project 2002-2003).

- a) the sweeping shall be undertaken at a steady and constant speed. The sweeping drill, the walking speed and the frequency between each change of cartridge shall be monitored by the scent trapping team leader during the search;
- b) the filter cartridge should be kept close to the surface during sampling, to ensure a maximum contamination. If air is filtrated near the surface, dust and soil particles will inevitably be sucked into the filter material. Whilst this in principle is positive since it is believed that the level of target substance concentration in the filter material will be increased, the currently used filter cartridges have a tendency to clog. This can prevent contaminated air from passing though the filter consequently resulting in large sector pockets remaining un-sampled. The distance from the filter cartridge to the ground should therefore be kept to a minimum but large enough to prevent the filter cartridge from clogging. On dry dirt roads, a surface - filter distance of 20 cm should be seen as a maximum. The establishment of adequate procedures to ensure a suitable surface - filter distance should be based on experience with the sampling machines and the filter material coupled with internal trials; and
- c) if sampling is undertaken in areas with high foliage, the filters should be stroked on the foliage, as this will increase the level of target substance in the filters.

8.3 Filter change

Scent trapping procedures shall be thoroughly described in the demining organisation's SOP. Correct scent trapping drill is crucial for a successful subsequent analysis of the filter cartridges. When establishing scent-trapping procedures, the following minimum requirements⁴ shall apply:

- a) the frequency of cartridge change is typically given to be a certain length of steady walking. A more accurate measurement would be to indicate the volume of air allowed to pass through the filter cartridge. There is nevertheless insufficient scientific data currently available to support a maximum air volume per filter cartridge. Although the same type of filter cartridge is in use by the different demining organisations, varying practices exist. The differences embrace from 100 - 300 m steady walking distance between each change of cartridge. Further research is required to determine the ideal cartridge change frequency and possible negative consequences with infrequent or too frequent change;
- b) if we assume that cartridge change frequencies between 100 and 300 m steady walk is within the acceptable limitations⁵ thus causing no reduction in trapped target contamination, the preferred cartridge change frequency should be established based on an overall evaluation of cost efficiency. 100 m between each change of cartridge will allow a greater elimination of sectors than change of cartridge for every 300 m. On the contrary, 3 times as many filter cartridges will be required consequently making the analysis process 3 times bigger. A larger distance between each change of cartridge is typically applicable in areas with few positive sectors. Many positive sectors, however, will result in larger areas to be re-investigated thus making the system less cost effective. A smaller walking distance between each change of cartridge is then recommended;

⁴ These recommendations apply to the use of currently available equipment. If new filters and sampling equipment are developed, other procedures may be more applicable.

⁵ A study is currently undertaken (2002-2003) to determine the suitability of currently used filters. The results from this study may help to define optimal filter change frequencies.

- c) the scent trapper shall not touch the filter cartridge, the inner side of the container or the filter cartridge assembly as this may add undesired recognisable contamination. If the filter cartridge or the assembly has been touched accidentally during filter change, this shall be reported to the scent-trapping manager and properly recorded;
- d) appropriate procedures shall be established to ensure that the filter can be fitted in the tube assembly prior to scent-trapping and removed from the assembly and stored in the filter container with no physical contact between these assets and the scent-trapper; and
- e) the filter cartridge assembly at the long end of the flexible tube shall be decontaminated prior to the first use during a day and between each change of filter cartridge.

9 Logistics, sampling operation

9.1 General logistic requirements

A good logistic back-up system is key for a sampling operation to become effective. Sampling operations are often undertaken in remote areas with limited access to regular re-supply. Moreover, sampling is often carried out in areas where other vehicles are prevented access until the demining operation has been completed. A sampling team should therefore be designed, equipped and managed in such way that the team is almost self-sufficient for longer periods at the time. This compels a significant effort put into the planning of the logistic requirements prior to the operation and the establishment of comprehensive logistic field mechanisms.

9.2 Filter cartridges

Proper management of the filter cartridges is a critical element of the sampling operation. A typical sampling task requires access to a high number of clean filter cartridges. Current sampling techniques require between 13 and 40 filter cartridges per sampling km. 4 different filter cartridges typically represent the same sector. When considering that 10 – 20 km of sectors can be sampled per day coupled with the fact that a typical operation may last up to one week with no return of used filter cartridges, it is important to establish adequate procedures for proper management, registration and storage of the filter cartridges. The following considerations should be addressed:

- a) required number of new and clean filter cartridges; The planning of the operation should address the requirement for new and clean filter cartridges. It must be taken into account that some sectors may require re-sampling due to procedural mistakes. Clean filter cartridges may also accidentally be subjected to undesired contamination rendering them useless. A 20-40% excess consumption should therefore be expected when planning the filter cartridge requirement;
- b) storage of clean filter cartridges; Clean filter cartridges must be stored with caution, to prevent them from undesired contamination. The filter cartridges should always be stored in individual containers that should only be opened immediately before the filter cartridges are to be used. The containers should again be stored in container boxes. These boxes should be stored in a clean and dry environment. The container boxes should never be stored in the same tent, room or proximity (50 m minimum distance) as used filters or other material/products that may create undesired contamination. Such material/products can be:
 - c) Weapons
 - d) Ammunition
 - e) Explosives and demolition accessories
 - f) Fuel and petroleum products

- g) Personnel that have been in contact with any of the material/products shall not be allowed to enter the storage tent/room before they have been through a proper de-contamination;
- h) storage of used filter cartridges; Used filter cartridges should be stored in the cartridge containers that again are stored in boxes. The cartridge containers should ideally be made of a material with limited permeability, such as glass or metal. Plastic is less suitable due to a higher permeability. If plastic containers are to be used, they should be made from a plastic type with a low permeability. The cartridge containers and the boxes should be stored in a cool and dry environment and under no circumstance be subjected to direct sunlight for longer periods at the time. Used and unused filter cartridges should not be stored together since this may result in a contamination of the unused filter cartridges. The used filters should also not be stored with assets/products as described under point b; and
- i) management of filter cartridges; The demining organisation is responsible for the establishment of an unambiguous marking system for new and used filter cartridges. The system should be designed to prevent that even an unintentional mix-up of filter cartridges will result in a misinterpretation of the positive and negative sectors. The numbering system should be thoroughly described in the demining organisation's SOP. During marking of filter cartridges, at least two people should verify the marking correctness.

9.3 Scent trapping equipment

The sampling machines currently in use house a standard two-stroke engine similar to the commercially used motor saw or grass cutting engines. The flexible suction tube has a double filter cartridge assembly at the long end, which accommodates two filter cartridges. The sampling kit normally consists of the sampling machines with machine accessories/spares (air filters, oil/fuel cans, grease, extra flexible pipes and tools), spray bottles, gloves, tape measures, earmuffs, spray paint boxes and sometimes marking machines. Some major precaution measures to consider are:

- a) the sampling machine should always be clean and free from oil and gasoline spill during sampling;
- b) the filter cartridge assembly should be decontaminated adequately before each time the sampling machine is used and between each filter change;
- c) the samplers shall avoid touching the tube holder during sampling as this subsequently may cause undesired contamination of the filters; and
- d) if the filter cartridge assembly has been touched, it should be properly decontaminated before re-use of the sampling machine.

9.4 Breaching equipment

The breaching team, if mechanised, typically consists of 2-3 mine proof vehicles. If operations are undertaken in remote areas, special attention should be paid to ensuring sufficient fuel for the vehicles and the sampling machines. Fuelling points must be identified during the initial survey. Other important requirements are: repair facilities and tools/spares for maintenance and repair. The breaching team should be capable of recovering its own vehicles. This will require a significant stock of spares and tools to be brought along during an operation. (Extra wheels, axel, welders, etc)

10 The analysis process

10.1 General

Upon completion of the sampling process, the used filter cartridges are usually brought to a central location for investigation by means of specially trained sniffer dogs capable of detecting traces of target substance emanating from the filter cartridge. The filter cartridge is placed in holders or stands, typically in a row or a circle. Between 6 and 12 holders or stands are normally used. Each stand can accommodate one or two filter cartridges⁶, the latter accommodates one filter cartridge collected from each side of the same road stretch. The dogs will sniff on all the filter cartridges in the row or in the carrousel and indicate if a filter contains traces of TNT or other target substance. The stand (or filter cartridge) will be removed and the remaining filter cartridges will be analysed again. This process is repeated until the dog doesn't indicate any positive filter cartridges. Due to the very low concentrations of target substance emanating from the filter cartridge, it is necessary to use several sniffer dogs successively to ensure satisfactory results. Between 3 and 10 dogs are typically used in succession.

The marginal concentration of target substance emanating from many of the positive filter cartridges makes the sampling process very sensitive to external influences. A small mistake in the layout of the test site or the test procedures may result in a totally unreliable result. It is therefore necessary to be extremely careful when planning and preparing the analysis process.

10.2 The analysis site

Analysis sites can be designed in many different ways depending on the training of the dogs, the climate and other factors. There are, however, a few basic principles that should be applied. The analysis site:

- a) shall be free from any target substance contamination since this may cause inaccurate analysis results;
- b) shall be placed in adequate distance from explosive/munitions stores, minefields or places where other strong-smelling material is present;
- c) shall be kept in adequate distance from crowded roads and areas with potentially disturbing air pollution and noises;
- d) shall be kept in adequate distance from crowded areas where people, dogs or other activity may disturb the dog's concentration during investigation;
- e) should be located at a cool, non windy location allowing the dog to feel comfortable during investigation; and

10.3 Handling filters and accessories before and during analysis

A REST dog is typically trained to recognise one or several target scents. It may, however, easily adapt a habit of detecting additional substances, such as the scent from human beings or other dogs. It is therefore important to be careful during training and operational analysis when preparing the filters for analysis and to ensure that all possible negative influences have been eliminated. The following principle aspects should be considered:

⁶ Recent tests in Angola have revealed some problems with the currently used twin stands. Typically each stand will either be represented by two positive or two negative filters since it is likely that a sample from one side of the road will be contaminated by scent from the other side of the road. On rare occasions, however, there may be one positive and one negative filter in the stand. Dogs are capable of distinguishing between the filters and a dog may not understand that a positive and a negative filter should in fact be indicated as a positive. Whilst some dogs may indicate correctly under these circumstances, other dogs may not. This problem can be overcome by applying changes in the training, or even better, by redesigning the stands so that the dog can only sniff on one spot (tube) with scent from both filters.

- a) the stands and other accessories that the dog will be in contact with during analysis should be adequately decontaminated before they are taken into use;
- b) the filter cartridges should remain in the filter containers until such time when they are to be placed in the holders in the stands’;
- c) when placing the filter cartridges in the stands the filters shall not be in contact with the human body or anything else that might cause undesired contamination; and
- d) when stands are shifted around in the row or carrousel they shall not be in contact with the human body or anything else that might cause undesired contamination. The use of specially designed lifting hooks is recommended; and
- e) it is believed that a slight moistening and heating of the filter cartridges immediately before investigation will create a higher emanation of scent. A careful moistening and a temperature increase of 1 to 2 degrees may increase the target scent emanation with several magnitudes. Although the positive effects of moistening and heating filters is known, further research is required to accurately determine this effect and optimal heating and moistening procedures.

10.4 Distance between filters

If the stands are placed too near each other during analysis, there could be a potential for cross-contamination of the filter cartridges or the air surrounding the filter cartridges. Few tests and trials have been carried out to determine this potential effect. It is therefore impossible to suggest accurately how distinctive this effect is. It is, however, unlikely that a distance greater than 50 cm between filters would have a recognisable negative impact.

10.5 Inspection of the analysis process.doc

The analysis process should always all times be supervised and monitored by a qualified analysis manager who should also be responsible for the recording of the analysis results.

10.6 Criteria for elimination of road stretches or areas

The following criteria shall apply when eliminating sectors as a result of REST application:

- a) if 3 dogs are used successively to investigate the same filter cartridges, the sector represented by the filter cartridge shall be considered as potentially mined if 1 or more of the dogs indicate positively on that filter cartridge;
- b) if 4 to 6 dogs are used successively to investigate the same filter cartridge, the basic rule is that the sector represented by the filter cartridge shall be considered potentially mined if 1 or more of the dogs indicate positively on that filter cartridge. A cartridge indicated as positive by only 1 dog may, however, be re-investigated;
- c) if 7 to 10 dogs are used successively to investigate the same filter cartridges, the basic rule is that a sector represented by a cartridge shall be considered potentially mined if 1 or more of the dogs indicate positively on that cartridge. A cartridge indicated as positive by only 2 or less dogs may, however, be re-investigated;
- d) secondary investigation shall be undertaken using all the dogs. If the same result appears, the sector represented by the filter cartridge shall be considered as potentially mined. If none of the cartridges are indicated as positive by any of the dogs during secondary investigation, the sector represented by the cartridges can be eliminated;
- e) secondary investigation shall always include additional positive filter cartridges in every row of stands, to prevent speculation by the dog handlers;

- f) if a sector has been eliminated and it borders a sector, which has not been eliminated, the verification of the potentially mined sector shall ensure an overlap of a minimum of 10 metres into the eliminated sector;
- g) it is anticipated that the REST system has a limited accuracy (+/- 8 m but dependent on the wind). If a sector consists of 3 or less sample lanes, a positive indication on one of the 3 filter cartridges representing the sector shall qualify for a re-investigation of the whole sector width;
- h) if a series of sampling lanes are established in parallel as part of an area reduction task, the 2 nearest sampling lanes to both sides (8 m) shall be considered as potentially mined thus qualifying for re-investigation; and
- i) if less than 30% of a sampled area can be eliminated as a result of filter cartridge analysis, the system is considered to be unreliable and thus no sections should be eliminated.

10.7 Analysis of the back-up filters

The sampling machines currently in use have a two-headed filter cartridge assembly accommodating 2 cartridges. The small distance between the cartridges in the assembly suggests that the level of target substance in these two cartridges is relatively equal after scent trapping. This opens a potential for secondary investigation of filter cartridges as part of quality control, accident investigation or re-checking according to the principles described under clauses 9.8. d and e.

Back-up cartridges should be treated with care and according to the same principles as the primary filter cartridges. If the filter cartridges are not immediately used for secondary verification, they should be stored for a minimum period of 5 years. The following considerations should also be taken into account:

- a) the filter cartridges should generally be stored to prevent a reduction of target substance in the filter material and a cross contamination;
- b) the filter containers should ideally be made of a non-permeable material or a material with low permeability;
- c) the filter cartridges should be stored in a cold, dark and dry environment;
- d) the filter cartridges should be stored separately from assets that may add undesired contamination to the filter material over time. Such assets can be: petroleum products, weapons, explosives and munitions.

10.8 Storage of filter cartridges subsequent to analysis

Filter cartridges that have already been analysed should be sealed and stored for a minimum period of 6 months or as required by the national mine action authority. This enables a re-investigation of the filter cartridges and a comparison with the back-up cartridges if accidents should occur.

10.9 Required number of dogs

Vapour sampling and remote analysis offers extremely small concentrations of explosive vapour. Dogs may therefore fail to recognise some contaminated filter cartridges. There can be many explanations. Some dogs may not recognise extremely low concentrations because they have only been trained on higher concentrations. Other dogs may fail to detect due to incorrect search and sniffing techniques, handler errors, temporary illness or environmental influence (i.e. a sudden breeze or a camouflage scent). It is realistic to anticipate that several dogs analysing the same filter cartridges successively will increase the accuracy of the system. This does not, however, eliminate all scent detection problems since there may be common reasons for all the dogs to fail, such as equally wrong training methods or equally negative influential factors.

The required number of dogs could theoretically be determined mathematically. This has, however, proved to be difficult since it would be necessary to use several currently non-measurable variables. Individual reliability can be determined by calculating the average reliability of a dog based on a series of tests. The individual reliability will, however, only indicate reliability over time. A dog may prove to be reliable 10 times in a row and suddenly prove unreliable the 11th time. Furthermore, a measure of reliability can only be established by measuring whether the dog is capable of detecting detectable filter cartridges. There is currently no benchmark for what should be considered as detectable filter cartridges. Emanation of target substance will vary significantly, thus making some cartridges easily detectable to most of the dogs while other cartridges will only be detectable to some dogs.

Figure 1

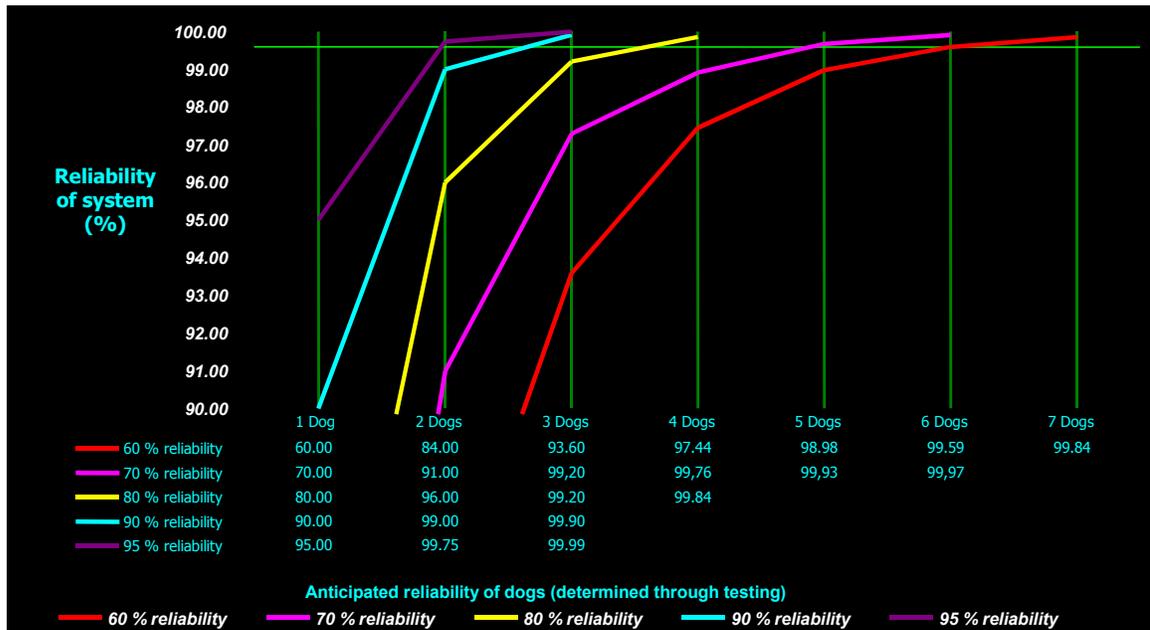


Figure 1 represents a simplistic mathematic calculation of the increased system reliability as a result of the use of an increased number of dogs. The table should, however, only be seen as an indication since the effective system reliability will probably be lower than the calculated values in the table. Until it has been established accurately how reliable the system can be at best the following minimum requirements shall apply:

- a) at least 3 dogs shall be used if the average team reliability exceeds 95%;
- b) at least 4 dogs shall be used if the average team reliability is between 95 and 85%;
- c) at least 5 dogs shall be used if the average team reliability is between 75 and 85%;
- d) at least 6 dogs shall be used if the average team reliability is between 70 and 75%; and
- e) a dog with an average reliability below 70% should not be used for REST analysis.

10.10 Determination of reliability

The individual reliability of each dog can be determined through a series of internal tests. The dog team reliability is found by totalising the average individual reliability (in percentage) of each dog and dividing the sum by the number of dogs. The following principles should apply when testing analysis dogs:

- a) a prevailing test should use no less than 10 different target scent contaminated filter cartridges and 50 used but non-contaminated filter cartridges;
- b) the contaminated filter cartridges should be placed randomly in the row or ring of stands thus preventing dog or handler speculation;
- c) if several dogs are set to sniff on the same filter cartridges during a test, the filter cartridges should be rotated to prevent possible detection of dog scent on cartridges previously detected by other dogs;

- d) contamination of filter cartridges should be done by using a scent trapping team to sample a test area where mines and UXO have been buried. The mines should have been subjected to soak time and decontamination procedures as described in IMAS 09.43 (clauses 4.5 and 4.6);
- e) the scent trapping team should apply the same operational procedures as they would have done during live scent trapping and they should be unaware of the location of the mines/UXO;
- f) there is a significant difference between unused and used filter cartridges with no target scent contamination. A used filter cartridge will emanate a variety of substances that are typically present during life operations. A blank filter cartridge will have no such emanation. Blank filter cartridges shall therefore not be used during testing; and
- g) if a dog is found to detect less than 70% of the mines as an average through successive testing, this dog should be considered as unreliable. It should therefore not be used before it through re-training has proved to be capable of detecting 70% or more of the positive filters.

11 Recording and mapping

11.1 General

Mapping and recording procedures are crucial elements of a REST programme. Vast sectors are initially sampled and some of these sectors will need a re-investigation. Inaccurate mapping and recording may result in wrong sectors identified as potentially mined and inaccurate secondary verification of positive sectors. A demining organisation shall therefore ensure that adequate mapping and recording procedures are established prior to the implementation of REST. Mapping and recording procedures should incorporate the following principles:

- a) Planning map; Typically prepared during the initial reconnaissance. The map should provide a simple diagrammatic representation of the area and include information about the sample sectors, map scale, legend, north direction and other relevant information, such as reference points, bridges, rivers, villages, suitable campsites etc. It is often impossible to incorporate a high degree of accuracy when preparing the planning map, due to a lack of accessibility to the target area. Aerial photos may, however, assist. Traces from ordinary land maps may also be useful;
- b) Master map; Typically prepared when a sampling task is undertaken. The master map represents accurate measurements of the different scent trapping sectors or sector blocks. The master map should be continuously updated to reflect the work progress. Each sector (or block) should be represented on the map with reference numbers corresponding with reference numbers on used filter cartridges or container boxes. A container box may for example contain 24 filter cartridges representing a total of 600 meters of road in 6 sectors. This sector block should be marked on the master map and the marking should be equal to the container box marking;
- c) Master trace; Typically prepared after all the filter cartridges from a task have been analysed. The master trace can be traced from the master map provided that all the sectors are recorded on the master map and not only the sector blocks. All sectors identified as potentially mined should be plotted on the master trace; and
- d) Clearance map; Typically prepared on a master trace copy and when a secondary follow-up of positive sectors is undertaken. The clearance map should represent accurately all measurements of positive sectors and the sections that have been verified, including base lanes and overlap with neighbouring sectors. Task title, date and report number, location reference, legend, scale and north indicator should also be recorded on the clearance map.

Annex A (Normative) References

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this part of the standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of the standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid ISO or EN:

- a) IMAS 09.42 Operational accreditation of mine dogs;
- b) IMAS 09.41 Operational procedures for mine detection dogs;
- c) IMAS 09.10 Clearance requirements;
- d) NPA SOP Mine Dog Detection, Angola;
- e) Mechem Operational procedures, various documentation; and
- f) FOA statistical information.

The latest version/edition of these references should be used. UNMAS hold copies of all references used in this standard. A register of the latest version/edition of the IMAS standards and references is maintained by UNMAS, and can be read on the project website (www.mineactionstandards.org). National mine action authorities, employers and other interested bodies and organisations should obtain copies before commencing mine action programmes.

Annex B (Informative) **Terms and definitions**

1.1.

target substance

A single compound or a mixture of different substances from a mine or UXO for which the dog is trained to detect.

1.2.

filter cartridge

Removable cartridges containing explosive-absorbing material

1.3.

filter container

A container in which a single filter cartridge is stored before and after scent trapping.

1.4.

filter box

A box in which a series of filter containers are stored before and after scent trapping. The most common boxes today house 24 filter containers

1.5.

sampling machine

A machine with the capability to draw air through the removable cartridges.

1.6.

flexible tube or pipe

An un-reinforced tube attached to the sampling machine. The current model is fitted with a two-headed filter assembly in the long end. During scent trapping, air is drawn through the cartridges and into the flexible tube and further through an exhaust valve in the sampling machine before release

1.7.

stand

In this context a contraction designed to hold filters during investigation by specially trained sniffer dogs. A stand normally holds two filters although this may vary dependent on the analysis concept.

1.8.

positive, negative and blank filters

A positive filter is a filter, which has been identified by one or several dogs as containing traces of the target scent. A negative filter is a filter, which has not been identified by any of the sniffer dogs thus containing no target scent traces. A blank filter is an unused filter.

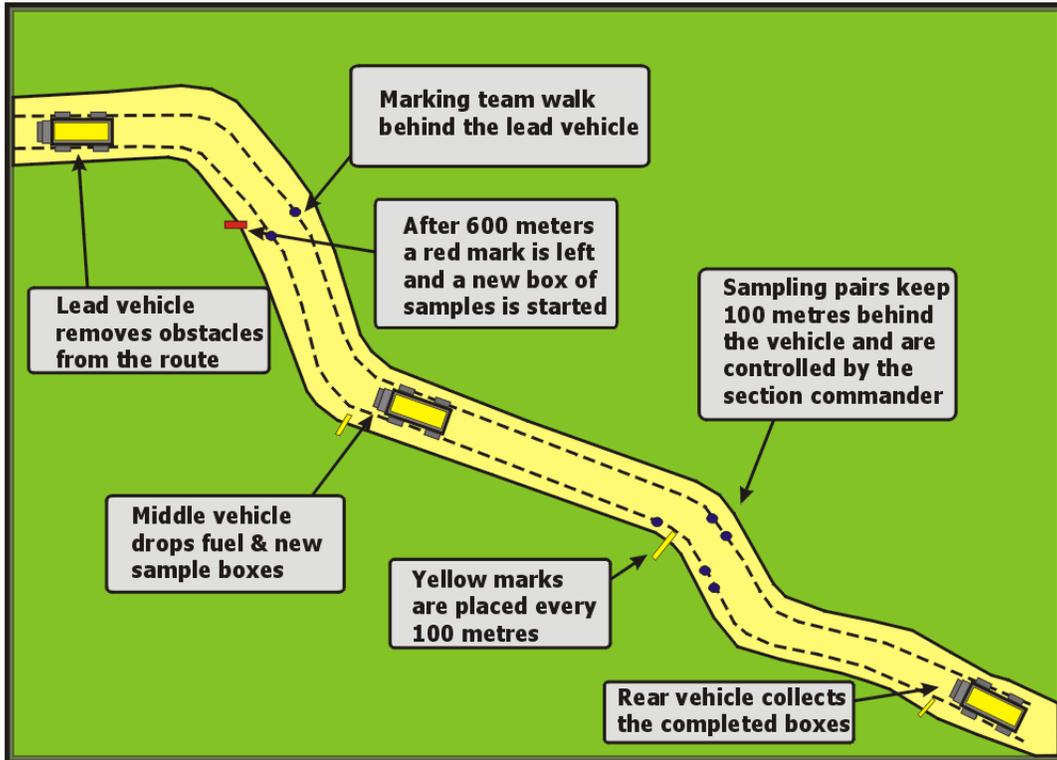
1.9.

emanation

A product escaping from a source. In this context the scent or target substance (from the mine or UXO) which is released to the soil, water or the air

Note: These definitions and terms are so specific to REST that they have not been included in IMAS 04.10 Glossary.

Annex C (Normative) Illustrative sketch of a typical scent trapping process



Annex D (Informative) Example of a REST analysis sheet

TASK CODE:	BH-13	DATE:	16.07.00	LOCATION:	LUBANGO	FILTER CHANGE: 100 M	TOTAL LENGTH: 2100 M			
BOX NO:	1, 2 AND 3	ANALYSIS START:	06.00	WEATHER CONDITIONS: SUN, DRY, NO WIND		RESPONSIBLE: KEN OLSSON				
SAMPLING SHEET NO:	L-04	ANALYSIS STOP:	08.38			SIGN: KEN OLSSON				
ANALYSIS SHEET NO:	L-04	TEMP:	25 ⁰ C							
FILTER NO	NAME OF REST DOGS (HANDLER IN BRACKETS)							POSITIVE	NEGATIVE	NEW INSP.
	REX „MARK“	LASSIE „MARK“	KING “GEORGE”	LIZZIE “GEORGE”	BEN “MARTIN”	BOSS “MARTIN”	NO DOG			
TIME	06.00 - 06.10	06.12 - 06.22	06.24 - 06.30	06.30 - 06.35	06.38 - 06.45	06.50 - 07.00				
1 & 2	POSITIVE	POSITIVE	POSITIVE	POSITIVE	NEGATIVE	POSITIVE		X		
3 & 4	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE			X	
5 & 6	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	POSITIVE				X
7 & 8	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE			X	
9 & 10	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE			X	
11 & 12	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE			X	
13 & 14	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE			X	
TIME	07.03 - 07.10	07.13 - 07.17	07.20 - 07.24	07.28 - 07.33	07.35 - 07.40	07.45 - 07.50				

15 & 16	NEGATIVE	NEGATIVE	NEGATIVE	POSITIVE	POSITIVE	NEGATIVE		x		
17 & 18	POSITIVE	POSITIVE	POSITIVE	POSITIVE	NEGATIVE	POSITIVE		x		
19 & 20	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE			x	
21 & 22	NEGATIVE	NEGATIVE	NEGATIVE	POSITIVE	NEGATIVE	NEGATIVE				x
23 & 24	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE			x	
25 & 26	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE			x	
27 & 28	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE			x	
TIME	07.55 - 08.00	08.02 - 08.07	08.10 - 08.16	08.20 - 08.27	08.30 - 08.36	08.40 - 08.38				
29 & 30	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE			x	
31 & 32	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE			x	
33 & 34	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE			x	
35 & 36	NEGATIVE	NEGATIVE	NEGATIVE	POSITIVE	NEGATIVE	NEGATIVE				x
37 & 38	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE		x		
39 & 40	NEGATIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE		x		
41 & 42	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE	NEGATIVE			x	