

RESCUE TECHNIQUES FOR EMERGENCY RESPONSE

Field Guide

Search Techniques



V.I.A.T.I.C.U.M.

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edited by Trevor Calafato



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Contributors

The Search Techniques field guide has been prepared by volunteer members of three teams, who have worked in close collaboration together:

SERVE ON (United Kingdom)

Pompiers de l'Urgence Internationale (PUI, France)

Unidad Canina de Rescate y Salvamento (UCRS, Spain)

More information on these teams may be found on the VIATICUM project website:

<https://www.viaticumrescue.eu/who-are-we/>

The **Emergency Fire & Rescue Unit** (EFRU, Malta) has also supported the creation of this field guide, while overall coordination was performed by **Edelweiss** (Italy).

Editing of this field guide has been entrusted to Trevor Calafato, who has also edited *Rescue Techniques for Emergency Response: An Introductory Manual for European Volunteer Rescuers* Vol. 1 and Vol. 2.

Preface

The purpose of these field guides is to act as a quick reference tool while being operational. Written and compiled by rescuers with vast expertise in different kinds of rescue techniques and who authored both Vol. 1 and Vol. 2 of *Rescue Techniques for Emergency Response: An Introductory Manual for European Volunteer Rescuers*; these field guides contain a pool of techniques that are in use and have been tested in various circumstances.

The aim is to provide a platform that briefs the various rescue methods that could be utilized in diverse scenarios. As editor I could only commend and laud such initiative, where the intention is that even in times of pressure the deployed rescuers can assess the effectiveness and functionality of these different approaches while facing dire circumstances.

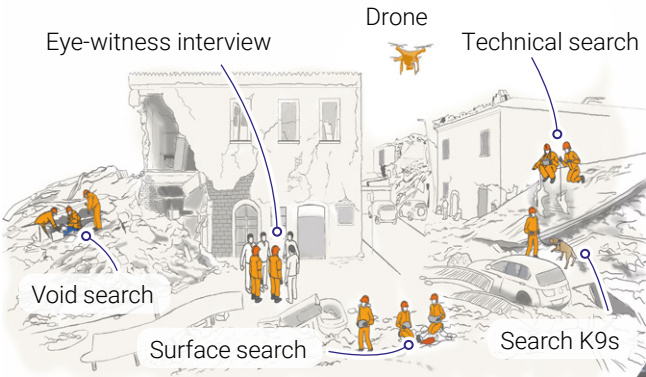
Thus, I hope that the ambition expressed by these authors to provide advice and guidance, that adhere to best practices within the field in a succinct and comprehensive, yet easy manner, is well received and fulfils its principal utilities – the saving of lives while keeping the rescuer relatively safe.

Trevor Calafato
Editor

Introduction

This chapter contains basic information about search techniques that include the use of search dogs (K9) and technical equipment. This is an interpretation and not a representation of what other search teams may commit to in their relevant search environments.

Whatever the task ahead, search teams will use any equipment and techniques available to conduct searches in a timely and efficient manner. All techniques have their limitations, but if used properly, they can accelerate the search and ultimately the rescue of the casualty.



An artistic rendition of a disaster-hit zone, showing several search techniques that may be employed in such situations.

Essentials

Qualities of a Search Dog

There are many breeds of dogs that can be trained to become search and rescue dogs. The breeds that are more commonly used in search and rescue are the herding breeds, such as Border Collies and Shepherds and gundog breeds like Spaniels, Labradors and Retrievers. Terriers are also known to perform extremely well in the collapsed structure environment. The table below describes some desired qualities in search dogs.

Quality	Description / Rationale
Drive	Good play and prey drive, as well as a good search drive to be able to be consistent in their field.
Independence	The dog needs to have a willingness to work away from the handler and show they can work things out for themselves. This is a good quality to have.
Sensitivity	The dog should not show any reaction to noise, should be comfortable in all types of environments and be relaxed in all forms of transportation.

Continued on the next page.

Social Interaction	The dog should not show any fearful aggression towards humans or dogs and must be able to socially interact with team members, both human and dogs alike.
Physical Stamina	Whichever discipline the search dog has, they must be physically and mentally fit and have the stamina to endure multiple searches.

Qualities of a Search Dog Handler

A search dog handler needs to establish a good relationship with the dog to facilitate training, as well as to learn to understand the dog's behaviour. There are desirable qualities that a dog handler should possess, as described in the table below.

Positivity	The handler must always have a positive attitude when training and searching with their dog. Any negativity can be felt by the dog and can limit their development or search. Furthermore, a negative attitude can affect the way the handler thinks while searching.
Patience	A handler can be considered patient if one is able to accept the dog's progress, even if it is delayed, as it is highly dependent on the dog's own abilities.

Continued on the next page.

Stability	A handler has to show a stable behaviour towards the dog and be decisive and commanding when required, without exceeding limits.
Understanding	The handler must become familiar with their dog's true abilities and capabilities during the training as well as the limits of the dog's endurance. It is the handler's responsibility to understand the dog's reactions on time and act accordingly.
Sympathy and love for their dog	The handler must show both sympathy and love for the dog. This is a prerequisite in order to develop that special relationship with the dog, which will contribute to the success of the partnership.
Hard working	It takes time and many hours of training for the handler to work with the dog, in order for the team to reach a high level of training.

K9 PPE

Item	Description	When to use them
Search harness	A harness that indicates that this is a working dog.	Wilderness search, victim recovery search, trailing / tracking, immediate area search.
Dog boots	Specially designed boots for dogs to wear whilst searching in areas that may injure the feet.	Avalanche search, collapsed structures, building search, trailing / tracking.
Abseil harness	Specially designed harness to hold the dog securely whilst being lowered or hoisted during search training / operations.	Collapsed structures, wilderness / winching into helicopters.
Safety goggles	Specially designed goggles to fit the dog's head to protect the dog's eyes from exposure to foreign bodies.	Helicopter operations, collapsed structures.
Ear defenders	Specially designed to protect the dog's sensitive hearing from excessive noise.	Helicopter operations / aircraft transportation.



Safety goggles



Ear Defenders



Dog boots



Search harness

Safety equipment for SAR K9.



The dog's abseil harness

Kg Welfare

Another important aspect that should be taken care of is the welfare of the dog. The table below provides a number of essentials that are necessary in such deployments.

Item	Description
Water	Handlers should carry at least 2 litres of water in temperate climate but should carry up to 4 litres in hotter and more humid countries.
Collapsible bowl	Made of rubber, these bowls collapse nicely into a side pocket and are handy if the dog doesn't like drinking out of a hand or the bottle. These bowls can also double up for the dog's food.
Extra lead	A spare lead is indispensable in case the primary one needs to be replaced.
Food	The type of search a dog is trained in may influence the duration of deployment away from the Base of Operations. On this basis, the quantity of required dog food is estimated.
Rewards	Based on the dog's drive for rewards, the appropriate rewards and spare ones should be carried on deployment.

Continued on the next page.

First aid kit	This is a must for any search dog handler. A basic first aid kit needs to include a waterproof pouch to house: sterile dressings, swabs, conforming bandages, antiseptic wipes, saline wash, tick removers, tweezers, blunt ended scissors, thermometer, KY jelly and iodine drops (among other things).
Towel	To dry a dog down or assist with cooling a dog down by soaking the towel in water.
Car harness	To secure the dog whilst traveling to an area when a crate is not available to fully secure the dog in.
Cool vest	Another cooling aid that can be worn while the dog is working.
Transport crate	The crate should be certified for animal transportation, of a suitable size for the dog allowing the dog enough space to turn around, stand up and lie down in.

Dog Team

There are usually three search team members within a dog team. These are the dog handler, the search dog, and the observer (safety). The table below describes the responsibilities of each team member.



The K9 team – handler and dog (left) and observer (right)

Team Make-up

Element	Description
Handler	<ul style="list-style-type: none">• The handler is often the owner of the dog.• Responsible for the welfare and safety of the dog during search and rest time.• Should be competent and confident at reading the dog's body language.• Responsible for assisting the dog with directions to enable the coverage of the search area effectively.
Dog	<ul style="list-style-type: none">• Its primary objective is to have fun.• Be consistent in locating its trained scent.• Be consistent in indicating on its trained scent.
Observer	<ul style="list-style-type: none">• Responsible for the safety of both the handler and the dog.• Responsible for the navigation or mapping of an area.• Responsible for the communications between Base of Operations and the handler.

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Search Dog Team Roles

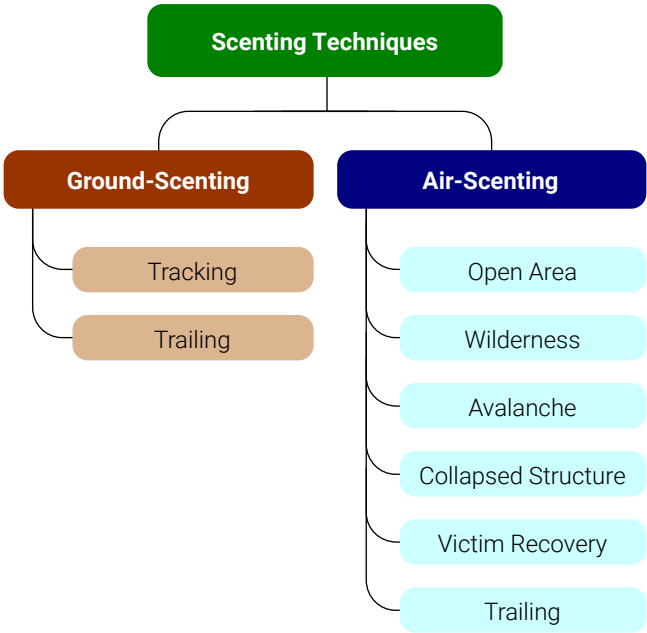
The roles assigned to a search dog team may vary depending on the circumstances or nature of the emergency. The main roles are listed in the table below.

Roles	Description
Information gathering	<ul style="list-style-type: none">• Integrated with an assessment team for USAR in a collapsed structure environment.• Can be used to give early indication of live casualties trapped in the rubble.• Can be used to obtain the direction of travel of a missing person in the wilderness (only if there is a last known position and scent article available).
USAR (Air-scenting)	<ul style="list-style-type: none">• This resource is used in partnership with the technical search team.• One of the first resources to be used (if possible) to search a designated search area.• To primarily identify live human scent emanating from a collapsed building during the search and rescue phase of operations.• Victim recovery dogs are used to locate the deceased in the recovery phase of operations.

Continued on the next page.

Roles	Description
Wilderness (Tracking/Trailing/ Area)	<ul style="list-style-type: none"> • These disciplines can be used in partnership with one another. • Area dogs should be able to range a good distance away from their handler using the air currents (air-scenting) enabling the team to search an area in a short amount of time. • Each discipline is trained to detect live scent, but the trailing dog is used to trail a specific scent of a missing person. • Each discipline should be an integral part of a wilderness search team.
Search and Detect	<ul style="list-style-type: none"> • In collapsed structures the scent of live casualties and the deceased emanates through the voids and tunnels created by the collapse. Therefore, the dogs are used to search an area and detect where the scent pool is strongest.
Search and Locate	<ul style="list-style-type: none"> • As the scent of a person in the wilderness is free to travel in the wind or remain on the ground, dogs are trained to search and locate the live scent source. • Avalanche dogs are similar to collapsed structure dogs but are trained to search snow fields and locate the buried skier / mountain climber.

In order to fulfill the assigned role, generally, search dogs either use ground-scenting or air-scenting techniques. However, trailing dogs may apply both techniques to their advantage during the same search.



Scenting techniques and their common applications in search operations.

Search Considerations

Before tasking the dog to search an area, a dynamic risk assessment must be done. By obtaining the search brief from the team leader or coordinator of the search, the handler can better manage their expectations of the dog's performance. When utilizing a dog to search, there are a lot of hazards that can limit a dog's performance that need to be taken into consideration. Some hazards that can affect the dog's performance are listed below.

Hazards	Description
People	<p>These can be crowds that gather around a collapsed building area, search technicians or general walkers within the wilderness search area.</p> <p>Crowds can hinder the novice search dog's performance with the build-up of their scent, the noise and possibly abuse the dogs, as some cultures perceive dogs as a sign of evil.</p> <p>Search technicians may distract the dog from search by interacting with them. Although rare, it is worth considering briefing the teams on how to act around search dogs.</p> <p>General walkers may not know what is going on and distract the dog from its search, but the main consideration here is that the dog may indicate on the walkers (which isn't wrong).</p>

Continued on the next page.

Environment	<p>The environment that the dog has been tasked to search may be very dry and hot, limiting the time that the dog is able to search – frequent hydration and nose wetting is necessary to assist with the scenting ability.</p> <p>The dust from collapsed structures can also restrict the nasal cavity, which in turn limits the dog to around 15 to 20 minutes search time. Reinforcing bar in concrete can inhibit the dog’s movement over the rubble / collapsed structures and can impede the dog’s safe travel on the rubble pile.</p> <p>Voids present a significant danger for the dogs whilst working in the collapsed structure environment.</p>
Animals	<p>Animals such as wild dogs, wild boars and snakes may injure the dog while it is searching. A general safety brief should be given before the designated area is searched.</p>
Gasoline fumes / Smoke	<p>Gasoline fumes can inhibit the dogs scenting ability by up to 60%.</p> <p>The dog should be housed in an area free from any noxious / hazardous fumes.</p> <p>Smoking near the dog may also affect its scenting capabilities.</p>

Continued on the next page.

Temperature	<p>Temperature can limit the duration of the dog's scenting capabilities.</p> <p>The cooler the temperature the better and longer the dog can work, as this allows the scent to hang / travel at the same height as the medium dog's nose level.</p>
Time of day (dependent on time of year and country)	<p>The sun is at its hottest between 11am and 3pm and can reduce the wind current, sending the scent directly up (chimney affect / thermocline). This means the dog needs to be directly on top of the scent to locate the casualty which means the dog must work harder.</p> <p>The best times for a dog to be utilised are early morning / late afternoon, early evening or during the night.</p>
Wind conditions	<p>Wind conditions should be monitored whilst searching especially in the urban and wooded environment.</p> <p>The wind may be moving in one direction down one side of the street and in the opposite direction on the other side of the street.</p> <p>While searching a wooded area, the dog may be on the boundaries of the wood and is picking up the wind nicely but 30 meters into the wood, the air is almost motionless.</p> <p>Wind movement is like water movement where there are currents, eddies, strainers, and stoppers. They all have the same type of effect, diverting, thinning, and stopping movement.</p>

Scent

Search dogs rely heavily on identifying and following human scent to help them reach a trapped or missing person. The scent movement is affected by the surrounding environment, weather conditions and time of day. Therefore, it is critical for the search dog handler to understand these factors and their effect on the performance of the dog. This section provides an overview of the composition of human scent, how it moves through the air and how it is affected by the aforementioned factors.

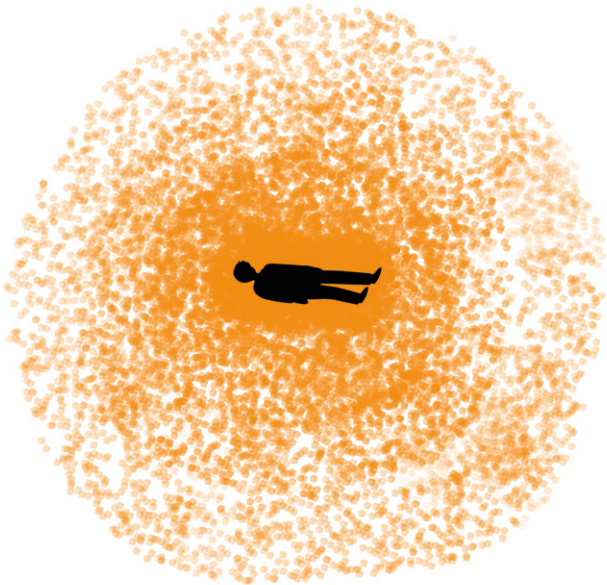
Human Scent Make-up

The human scent make-up is generally influenced by a variety of factors, listed in the table below.

Chemical	Odour	Material	Toiletries
Petrol Oil Diesel Shoe polish Nail polish	Sweat Breath Skin Gender Ethnicity Fungal	Clothes Shoes Leather Nylon Cotton	Shampoo Soap Aftershave Deodorants

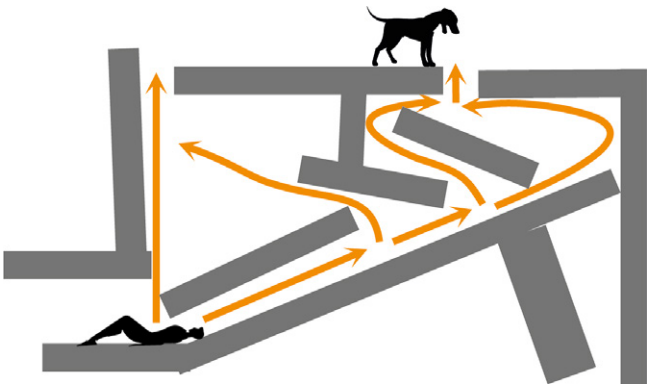
Diffusion

Diffusion is where the scent rafts move evenly in all directions from the scent source (casualty). The live casualty has its own natural air current (due to the body heat) and will expel skin cells (rafts) from the body at around 2 miles per hour.



Collapsed Buildings

This diagram shows how the scent moves within the voids of a collapsed building. The dog is alerting as it has detected the scent of a live casualty. The air movement within the voids can be slower near the casualty due to the cooler temperature, but as it reaches the surface it may flow faster, depending on the external temperature.

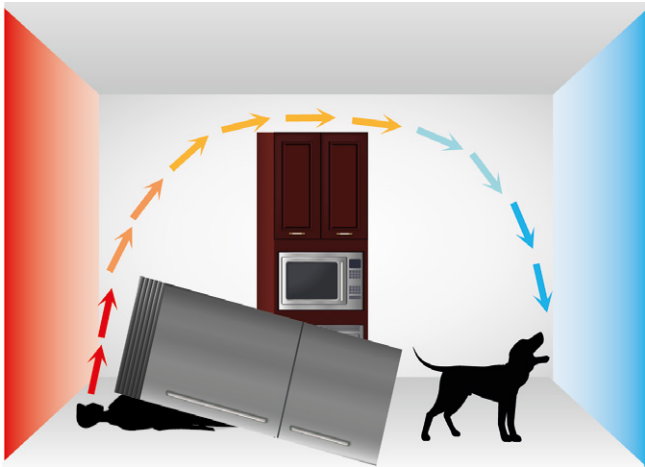


Scent flow through voids

Wall Temperature Effects

The hot and cold wall effect happens in buildings or structures where, during the day the sun is warming the outside of the building while the inner-most wall will be cooler. Heat rises and then crosses the ceiling, where it starts to cool and descend against the inner wall. The K9 will indicate at the strongest pool of scent which would have built up at the floor level next to the inner wall.

The reverse happens when night falls. The outside walls become cooler, and the inner walls will be relatively warmer. In this instance the dog will then indicate near the cooler wall as this is where the scent will be strongest.



Wall temperature effects on scent

Eddying

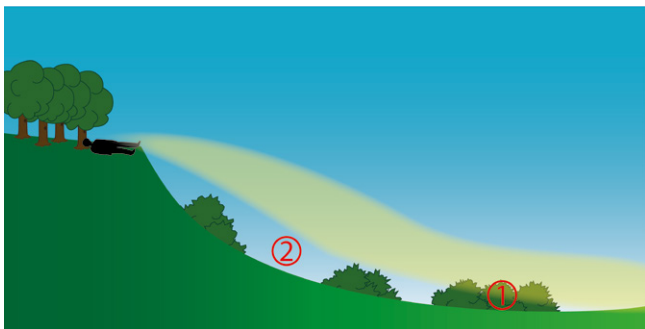
Buildings or sudden terrain drops will cause air movements to become turbulent. If the air movement is favourable to the dog, they will demonstrate an airing up motion with their nose. This may lead the dog to indicate even though it is not near the casualty, depending on how strong the scent is. The dog's body language showing interest communicates this. Although it may seem that the dog is indicating incorrectly, this is not so in reality, as the dog would still be indicating where it has detected a strong scent presence. The handler needs to be aware of these situations to interpret the indication correctly.



Scent flow around buildings

Open Areas / Wilderness

The diagram below shows how the scent disperses down the embankment from the casualty, where some will get caught in the bushes and grass ①. There will also be some dead ground areas ②, where the concentration of scent will be almost non-existent. The concentrated scent may move quite a distance away from the casualty and this is where the dog will pick up the scent and work towards where the casualty is. The handler will need to use their knowledge to be able to assist and direct the dog when needed.



Effects of vegetation on scent flow

Laminar Flow

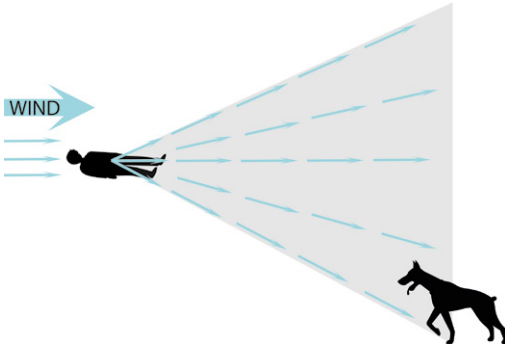
Laminar flow is where the air movement, together with scent, is not interfered and/or interrupted by any obstacle or condition.



Unobstructed movement of scent in laminar flow.

Scent Plume

The diagram below illustrates how the scent fans out and creates a scent plume, sometimes also referred to as a scent cone. As the scent fans out, its concentration also diminishes.



Scent disperses in a cone as it is carried away by wind.

Fumigating Plume

The cool air before sunrise brings the scent plume down into the valleys and low spots, creating fumigating plumes. A subject may be detected by a dog down below easily at this time. Fumigating plumes break with the morning sun. Refer to figure on page 31.

Lofting Plume

When the ground is cooling but the air aloft is still warm, lofting plumes are formed. This is typical of valleys in the late afternoon, and in the early evening elsewhere. In such conditions, when the weather is calm, handlers should work their dogs along ridges or higher ground. Refer to figure on page 31.

Coning Plume

Coning plumes are typically found on cloud-covered days and present the ideal conditions for air-scenting dogs. Refer to figure on page 32.

Fanning Plumes

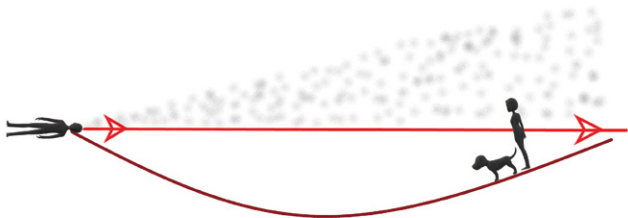
Fanning plumes occur at night in stable air. The scent will be held at the same elevation. A dog may indicate at a victim located across the valley at the same elevation but may be unable to follow the scent to them. Refer to figure on page 32.

Looping Plumes

Looping plumes are typically found in clear or high cloud days, at around midday, where high convection currents occur. Scent will rise, cool, loop back down, heat up and rise back up again. The dog will possibly indicate or show interest and air up. The handler needs to take note of this body language to interpret it correctly. Refer to figure on page 32.



Fumigating plumes occur before sunrise.



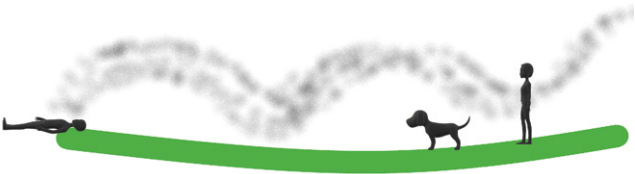
Lofting plumes occur during late afternoon or early evening.



Coning plumes are ideal for air-scenting dogs.



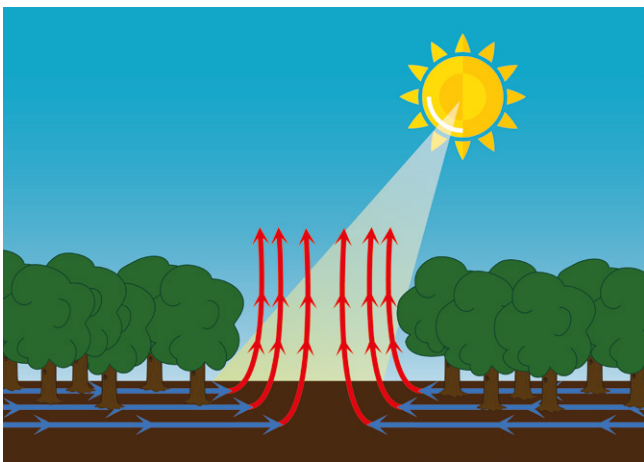
Fanning plumes create a difficulty for the dog to follow the scent.



Looping plumes

Thermoclines

Thermoclines are generally seen in woods and forestry areas. These happen when there is a break in woodland, a fire break or a natural break. These air currents occur during the warmest time of the day, where the ground is warm, while the air currents within the forest are cooler than those in the open. This forces the air current to rise swiftly over the clearing, taking the moderate and lighter weight scent particles with it.



Thermoclines above a clearing in a wooded area.

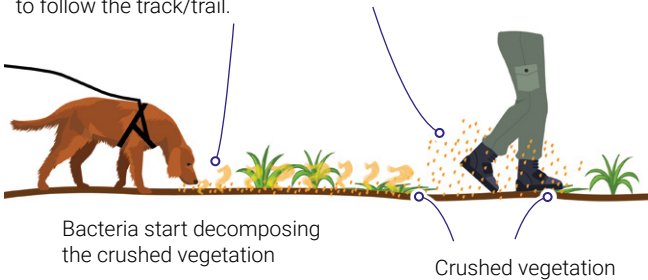
Crushed Vegetation

In general, dogs in search and rescue are trained to use live human scent to locate casualties. However, during tracking/trailing, the ground-scenting dogs also learn to use the scent of crushed

vegetation, together with human scent, to identify the route taken by a missing person, thus helping to lead the search party to the missing person. The following image illustrates this process.

K9 uses a combination of the human and vegetation scents to follow the track/trail.

The heavier skin rafts drift to the ground



Human skin rafts falling to the ground and bacteria acting on crushed vegetation produce the scents that lead a ground scenting K9 to a missing person.

Search Strategies

The search strategies employed by rescuers will be determined by a number of variables in the surrounding environment such as terrain, wind and weather. The main kinds of search strategies are indicated in the table below.

Type	Strategy
Area Search (Wilderness)	<ul style="list-style-type: none">• Sectorise the search area.• Hasty search whilst traveling to sector (30m either side of track).• Perimeter search<ul style="list-style-type: none">◦ Following natural boundaries.◦ This will allow full coverage of the sector boundaries.• Grid search<ul style="list-style-type: none">◦ Typical search pattern used on relatively flat terrain.◦ Work across wind and make parallel passes through the entire sector.◦ Distance between sweeps will depend on vegetation and terrain.• Contour search<ul style="list-style-type: none">◦ Generally used on steep terrain with prevailing updraft winds.◦ Start search on highest boundary.◦ Traverse sector by working across the slope, maintaining height until the opposite boundary has been searched. <p>Note: Cover ALL boundaries for any strategy used!</p>

Continued on the next page.

Type	Strategy
Building Searches	<ul style="list-style-type: none">• Sectorise or zone.• Floor by floor.• Free search<ul style="list-style-type: none">◦ Allow the dog to have its nose on the floor and investigate the zone/ floor.◦ Select a set distance for the dog to go before calling them back to do a directed search.• Directed search<ul style="list-style-type: none">◦ Directing the dog to search room by room watching for any indicative body language.• Fingertip search<ul style="list-style-type: none">◦ Detailed directed search when the dog has given an indication or expressed interest in a trained scent.◦ Handler should be actively looking to direct the dog's nose to small gaps in floors and walls, etc.• Second dog<ul style="list-style-type: none">◦ Should be brought in to clarify find or interest.

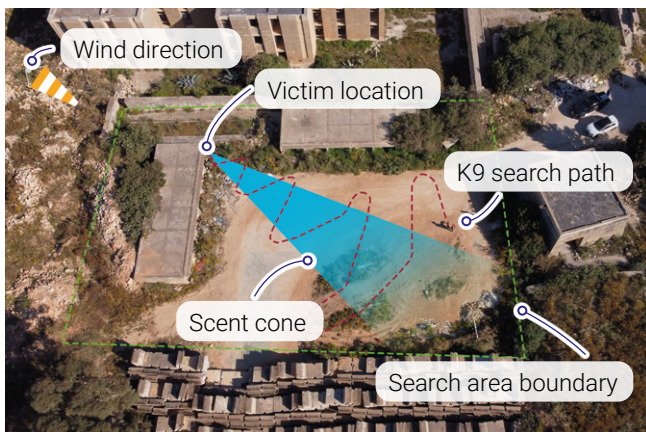
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Type	Strategy
Collapsed Structures	<ul style="list-style-type: none"> • Sectorize or zone. • Perimeter search <ul style="list-style-type: none"> ◦ Following natural boundaries of collapsed buildings. ◦ This will allow full coverage of the sector boundaries. ◦ Can be done during building assessment. ◦ Can give early indications that there is life within the collapsed building. • Free search <ul style="list-style-type: none"> ◦ Allow the dog to have its nose on the floor and investigate the zone/ floor. ◦ Select a set distance for the dog to go before calling them back to do a directed search. • Directed search <ul style="list-style-type: none"> ◦ Directing the dog to search, watching for any indicative body language. • Fingertip search <ul style="list-style-type: none"> ◦ Detailed directed search when the dog has given an indication or expressed interest in a trained scent. ◦ Handler should be actively looking to direct the dog's nose to small gaps in floors and walls, etc. • Second dog <ul style="list-style-type: none"> ◦ Should be brought in to clarify find or interest.

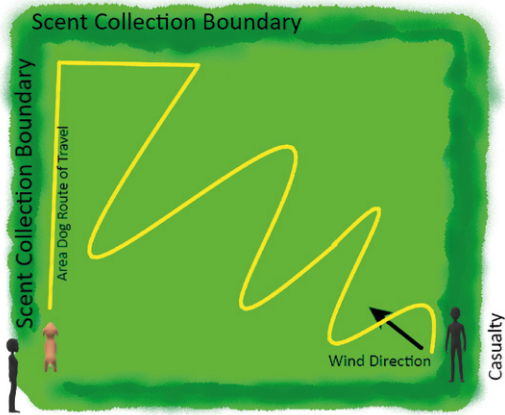
Search Patterns

While conducting a search, the dog is effectively seeking scents and following their increasing intensity to locate the strongest scent point. In order to do so, the handler devises a search pattern and guides the dog to systematically cover an area until a scent is identified. At this point, the dog zig-zags through the scent cone to find the area of highest intensity.

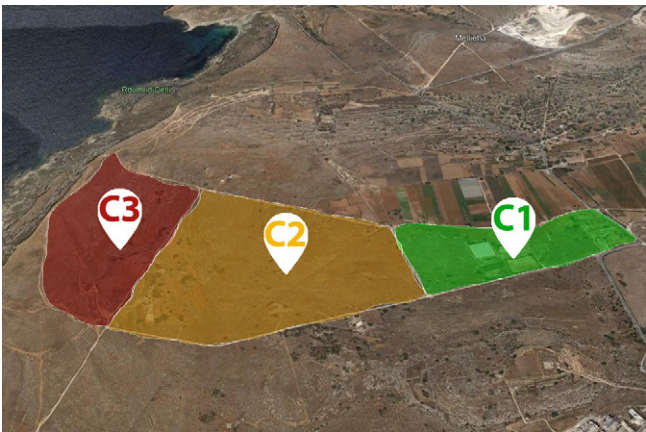
Search patterns are governed by the wind, environment, and the strategies employed. Large work areas may be sectorised to ensure that they can be effectively covered.



The effect of wind on the scent cone requires careful consideration for a successful K9 search.



Open area search strategy



K9 work area sectors

Variants of Indication

As soon as the dog locates the strongest scent point, it communicates this to the handler by giving an indication, such as barking or sitting. The type of indication that the dog should be trained in depends on the discipline and environment that it will work in.

Stand Over and Bark

Generally, the stand over and bark indication is used when searching in collapsed structures. The dog is trained to:

- give a verbal indication of where the live scent is emanating from, so that the handler can mark the area; and
- stay in a single area and does not move back and forth across what can be an unstable environment, which could cause further collapse.



Re-find or Shuttle

This indication, used for the Area Search, consists of the dog running back and forth between the casualty and the handler (who may be quite far away) to indicate that it has found the casualty. This helps the handler reach the casualty faster.

Bringsel

A bringsel is a piece of wood or another object that is attached to the dog's collar. On finding the live scent the dog will put the bringsel into its mouth and sit down, indicating that it has found a scent. This is often used in avalanche scenarios.



Lie Down or Sit

This indication is generally used in trailing, to indicate that the dog is on scent or has located the missing person. This indication is often used in victim recovery (cadaver search dogs).



Technical Search Equipment

The area of technical search equipment is vast and depends on the search discipline. The table below shows the most common technical equipment used by wilderness or USAR search teams.

	USAR	Open area	Wilderness
Drones	✓	✓	✓
Sound locators	✓		
Thermal imaging cameras	✓	✓	✓
Night vision cameras		✓	✓
Technical search cameras	✓		
Carbon dioxide probes	✓		

Drones

Drones vary in size, ranging from pocket-sized drones controlled by a phone to a six-propeller unit capable of carrying a thermal image camera or a high-resolution zoom camera. Most search teams have drone capabilities these days as they have become a very useful resource in the location of a missing person in the wilderness / open area or being able to assist with the assessment of a collapsed building.



Sound Location Devices

These devices are used to locate persons trapped in collapsed buildings using sound. There are many types of sound location devices, one of which is the DELSAR® LifeDetector®, which has a modular probe system (see image below).



The modular probe system enables the search team to place the probes on the terrain or rubble in strategic locations that permit any sound emitted by a casualty to be detected. The system can also be deployed with an acoustic probe so that communication with the trapped casualty can be facilitated.

Search Camera

Search cameras vary in size, length and functionality and are a versatile and important piece of the equipment. Cameras are used to give a visual understanding of what lies behind a wall before breaching in or to visually confirm the location of a casualty after an alert by a search dog.



Thermal Image Camera

Thermal image cameras are widely used in collapsed building and wilderness searches. The produced images are based on the heat intensity of objects. The aim is to help in distinguishing a person in the dark through body heat compared to the surrounding objects.



CO₂ Detector

As humans breathe, the exhaled air contains a higher concentration of CO₂. CO₂ detectors may pinpoint voids with higher-than-normal CO₂ values that may indicate possible human occupancy. However, higher concentrations of CO₂ in voids may also be due to other factors, such as decay of rotten fruit. Therefore detection of higher CO₂ concentrations should lead to further investigation.



Storage of Technical Equipment

To make sure that the technical equipment is constantly in good working order the storage and maintenance notes summarised below should be taken into consideration.

Device	Storage	Maintenance
Drone	<ul style="list-style-type: none">• Robust travel case• Remove batteries from drone• Remove rotor blades and store securely• Protect camera	<ul style="list-style-type: none">• Check for damage after use• Charge batteries• Check for updates
Sound locations	<ul style="list-style-type: none">• Robust travel case• Remove batteries• Disconnect cables, wipe clean and store neatly• Clean probes and store neatly	<ul style="list-style-type: none">• Check unit and cables for damage after use• Check battery output

Continued on the next page.

Device	Storage	Maintenance
Thermal image camera	<ul style="list-style-type: none">• Robust travel case• Remove batteries• Wipe clean	<ul style="list-style-type: none">• Check unit for damage after use• Charge batteries
Search camera	<ul style="list-style-type: none">• Robust travel case• Remove batteries• Wipe clean	<ul style="list-style-type: none">• Check unit for damage after use• Charge batteries
CO ₂ detector	<ul style="list-style-type: none">• Robust travel case• Remove batteries• Wipe clean• Store neatly	<ul style="list-style-type: none">• Check unit for damage after use• Charge batteries• Check unit calibration

Limitations

All tools have their limitations, be it technical equipment or search dogs. Becoming knowledgeable, confident and competent in their use and handling requires training and understanding of the working abilities and the environments where the respective search tools are best exploited to aid the search in locating and eventually rescuing the casualty or missing person.

Tools	Limitations
K9	<ul style="list-style-type: none">• Animal welfare considerations• Constant performance maintenance• Needs to rest• Needs feeding and watering• In particular environments is easily injured• Has off days• Gets sick• Gets tired
Drones	<ul style="list-style-type: none">• Operating time limitation due to power pack• Easily damaged if conditions not right for flying• Depending on country, there may be limits to areas allowed to fly• Technology short circuits• Radio wave interference and rendering unresponsiveness• Operator experience

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Tools	Limitations
Sound location	<ul style="list-style-type: none">• Battery operated• Multiple points of failure due to connections• Resonance issues with regards to type of building construction and placement of probes• Operator tiredness or knowledge of equipment• Other external noise sources
Technical search camera	<ul style="list-style-type: none">• Battery operated• Multiple points of dirt ingress on telescopic poles• Operator tiredness or lack of expert knowledge of equipment• Multiple points of technical failure due to connections
CO₂ probe	<ul style="list-style-type: none">• Battery operated• Electronic calibration required• Multiple points for dirt ingress• Rotting organic matter may give false readings

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Tools	Limitations
Thermal image camera	<ul style="list-style-type: none">• Battery operated• Cannot see through glass• Cannot see through water• Operator's awareness of heat signature
Night vision camera	<ul style="list-style-type: none">• Need to adapt the eye to the camera. The technician must be accustomed to its use for correct visual interpretation.

Conclusion

Search techniques are employed in a variety of rescue applications, whenever the location of the casualty is not immediately known. Diverse situations require the use of specific or a combination of various tools, where the ultimate aim is locating the casualty/ies in the most efficient and expeditious way possible.

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- “How Scent and Airflow Works.” Hound and the Found, February 26, 2012. <https://houndandthefound.wordpress.com/2012/02/22/how-scent-and-airflow-works/>
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List of Abbreviations

CO ₂	Carbon dioxide (chemical formula)
FEMA	Federal Emergency Management Agency
K9	Canine (homophone for dog)
PPE	Personal protective equipment
SAR	Search and rescue
TIC	Thermal image camera
USAR	Urban search and rescue

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