

Canine Detection | Search & Screening

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Canine Detection

 **Knowledge Level:** Intermediate

 **Protection Stage:** Operate & Detect

 **Time to read:** 7 minutes

Explosives detection dog teams can provide a versatile, mobile and real-time search and detection capability that can offer significant benefits to many operations

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An introduction to animal learning for working dog users

What is this note about?

This note provides a basic introduction to the main principles of animal learning. It explains the different types of learning that may occur during working dog training and deployment, and what relevant scientific terms mean. It provides suggestions for how to use this knowledge to improve working dog capability.

Who is this note relevant for?

All dog trainers and other personnel responsible for training and deploying working dogs, or who deliver handler training courses.

Introduction

What is learning?

Learning is a change in an animal's knowledge or behaviour in response to a **stimulus** (or 'stimuli' if there are more than one). A stimulus can be any kind of event or change that the animal sees, hears, feels or smells (e.g. changes in the environment like encountering a new object, sound or odour; changes in its own physiology such as feeling full or tired; changes in the actions of other animals including humans). Learning can occur gradually over time, or occur very rapidly if the consequence of the stimulus has an important impact on the animal. Learning often results in long-lasting changes in memory and behaviour, but it can sometimes be forgotten or reversed to some extent.

Animals learn every day throughout their lives. It is important to keep in mind that a working dog is learning all the time, not just during training sessions, and this could either have a beneficial or negative effect on its working ability depending on what learning takes place.

Types of learning during working dog training

Understanding different types of learning is important to optimise working dog training and operational performance, resolve issues and ensure good welfare.

Table 1 summarises key types of learning, which are explained in more detail below. Dog handlers and trainers will routinely apply some of the principles described, even if they are unfamiliar with the scientific terms.

Innate behaviours

Some behaviours do not need to be learnt. They are either already present at birth or 'instinctively' develop later. For example, dogs do not need to learn how to bark, dig or mark their territory. **Reflexes** are very simple examples of innate behaviours (e.g. scratching reflex). Innate behaviours can sometimes be changed by learning.

Table 1: Summary of key types of learning relevant to working dogs, with examples.

Habituation A dog gradually learns to ignore/accept something that they often encounter if it is not important to them (i.e. nothing good or bad happens). Example: A dog gradually learns to ignore the sound of building work in a nearby location.	Sensitisation Rather than getting used to something over time (habituating), a dog reacts more strongly each time it encounters a stimulus, even if it has no direct effect on them. Example: A dog becomes increasingly fearful of firework 'bangs' each time it hears them.
Imprinting A puppy rapidly develops a strong attachment to a particular person, animal or object by spending time with them during a critical period in early puppyhood. Example: A dog has a strong bond with a particular person who raised it as a puppy.	Social learning A dog learns a specific behaviour by watching, or interacting with, other dogs, animals or humans that are carrying out the behaviour. Example: A dog learns to search inside a box after watching other dogs search inside it.

Classical conditioning

A dog has an existing innate response to a certain meaningful stimulus, but doesn't respond to another 'neutral' stimulus. When the neutral stimulus occurs just before, or together with, the meaningful stimulus enough times, the dog learns that they are linked. Once learning has occurred, the neutral stimulus alone causes the dog to respond in the same way as it does to the meaningful stimulus.

Example: A dog's handler whistles when putting a food bowl down for the dog. Over time, the dog learns to associate the whistle with food and feels excited and salivates when it hears the whistling alone.

Operant conditioning

A dog learns that its actions cause a consequence that it either likes (which increases/strengthens the behaviour) or dislikes (which decreases/weakens the behaviour).

Example: A dog learns that if it indicates next to the odour of explosives it gets a ball reward, strengthening this behaviour.

Habituation

Habituation occurs when a dog's response to something gradually reduces with repeated encounters. The stimulus may be something that the dog is initially fearful of, or excited by, but is something that does not have an important consequence for the dog (i.e. nothing directly happens to the dog that it likes or dislikes). As the dog encounters the stimulus repeatedly, with no significant consequence occurring, it learns to accept or ignore it and stops reacting. Habituation is important in any situation where a dog trainer wishes to accustom the dog to accept or not respond excessively to something, for example:

- New working environments (e.g. new buildings, escalators, different floor surfaces etc.).
- Unfamiliar people (e.g. wearing unusual clothing, large groups, excited children, people doing unfamiliar activities).
- Loud noises (e.g. vehicles, machinery, music).
- Handling and transport (e.g. being picked up, entering its vehicle cage, being transported in a moving vehicle, harness being put on and worn, husbandry and veterinary checks).
- Other animals (e.g. other dogs, farm animals, birds).
- Odours the handler does not want the dog to be distracted by during search activity (e.g. food, cleaning products, perfume, vehicle odours).

Some of the main principles of successful habituation include:

- Starting to gradually introduce a wide range of new stimuli at a young age, as part of a planned puppy programme.
- Introducing a stimulus at a low level at first and gradually increasing the intensity (e.g. present quiet sounds until the dog learns to ignore them, then

gradually increase the volume in stages as long as the dog remains happy).

- Regularly allowing the dog to encounter something to help maintain habituation (e.g. checking dogs' teeth, tail, paws etc. regularly to maintain habituation to these events). In contrast, if dogs only rarely or infrequently encounter a stimulus it is unlikely that they will habituate to it (e.g. a dog that encounters a loud forklift truck twice a year may show fear reactions to it every time).

Sensitisation

Sensitisation is when a dog's response to a stimulus increases with repeated encounters. Like habituation, the stimulus may be something that does not have a direct positive or negative consequence for the dog (i.e. nothing directly happens to the dog that it likes or dislikes). Working dogs can become sensitised to certain things in the operational environment (e.g. loud noises, machinery, fireworks bangs, people) if these are not introduced gradually, at a low intensity level, and as part of an overall positive experience for the dog (see habituation and associative learning sections). Fear responses can sometimes become extreme, to the point where they are like a 'phobia'.

If a dog appears to be becoming sensitised to something such as a loud noise (i.e. fear reactions are increasing rather than decreasing), the advice on habituation (above) can be applied to try to gradually accustom the dog to the stimulus. Sensitisation problems can be difficult to overcome, and if the problem persists or worsens then it may be beneficial to seek guidance from a certified clinical animal behaviourist [1].

Imprinting

Imprinting is where puppies rapidly learn attachment to another dog, person, animal or object (**Figure 1**). It is thought that puppies imprint most strongly in the first few weeks and months of life, though it is not definitively known exactly when this imprinting period starts and ends. This in one reason is why it is important to begin an effective puppy socialisation programme from birth.

It should be noted that some detection dog users refer to 'imprinting' dogs when training them to detect new odours for the first time. This process involves associative learning (see below), not imprinting in the scientific sense.

Social learning

Social learning is a broad term for when dogs learn something from watching or interacting with other dogs and humans. We still do not fully understand what behaviours dogs can or cannot learn through social learning. However, it would be best practice to assume that:

- Allowing trainee dogs to see experienced dogs enjoying their training and work may:
 - Increase the trainee dogs' interest in the task, or encourage them to copy the experienced dogs, improving training efficiency (e.g. allow trainee dogs to watch other dogs conducting odour identification (ID) training).
 - Encourage the trainee dogs to learn to accept new working environments more quickly (e.g. allow trainee dogs to watch experienced dogs enjoying working in noisy environments).
- Puppies are likely to learn certain preferences from watching and interacting with their mothers and so allowing puppies to see their mothers working, accepting being handled etc. may help to improve their general suitability as working dogs in later life.
- Dogs may gradually learn undesirable behaviours from watching other dogs performing them, so it may be best to avoid dogs regularly seeing other dogs performing undesirable behaviours (e.g. frequently watching other dogs behave aggressively).

Associative learning

Most dog training involves the dog learning links (associations) between different stimuli and consequences that they either like (pleasant, enjoyable events) or dislike (unpleasant events or the removal of something pleasant). The two main types of associative learning are '**classical**' and '**operant**' conditioning.



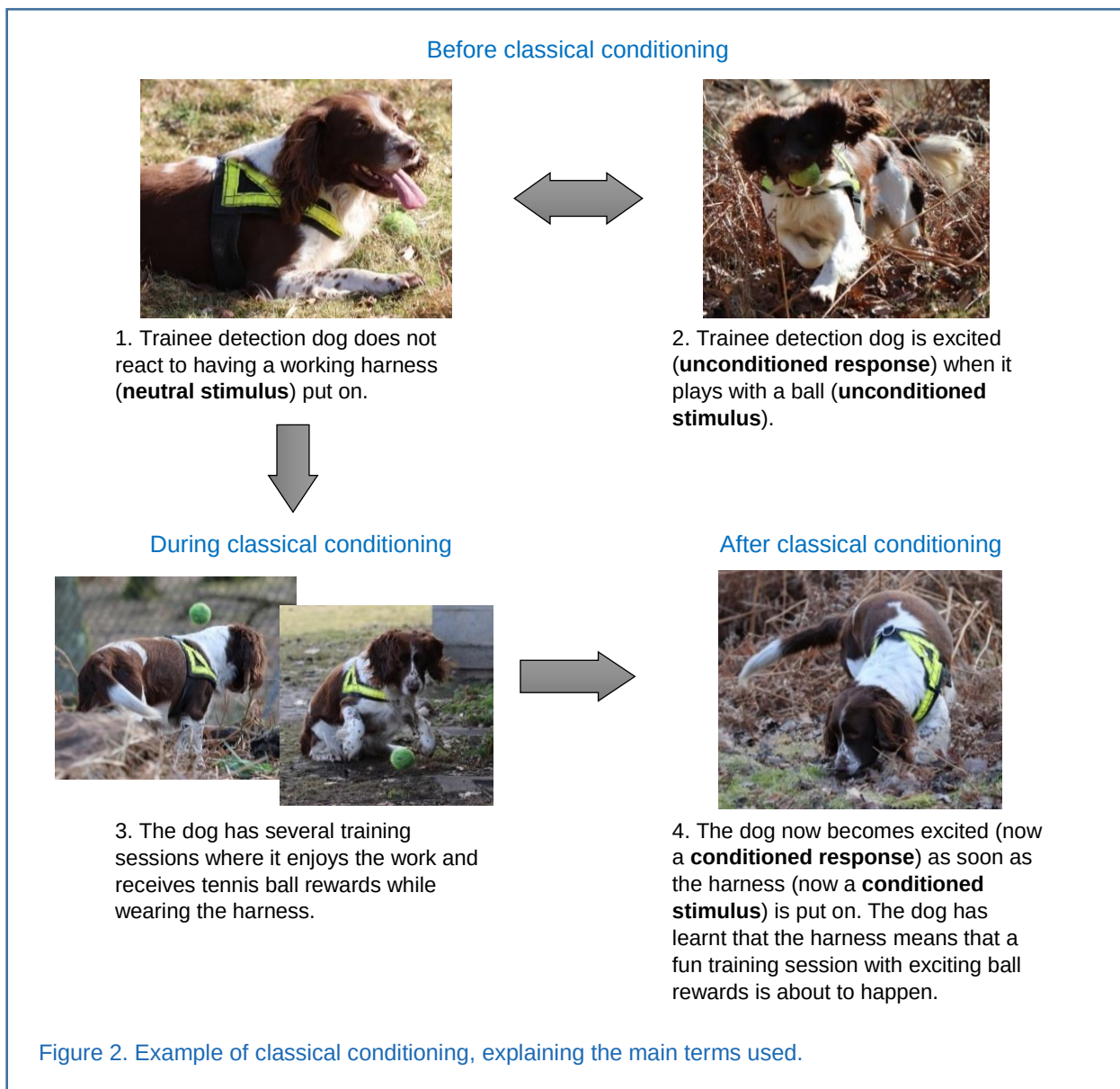
Figure 1. Learning involving imprinting is most obvious in animals such as water birds, where the young quickly learn to follow the mother very closely, but also occurs in puppies. *Third party images reproduced with permission of the owners.*

Classical conditioning

Classical conditioning, also known as 'Pavlovian conditioning', occurs when a dog learns that a normally unimportant ('neutral') stimulus reliably pre-empt or occurs together with another important stimulus that the dog already has natural response to. Once learning has occurred, the dog will react to the neutral stimulus with the same behaviours and/or physiological responses as to the important stimulus. The terms used for the different stages of classical conditioning are explained in **Figure 2**.

Working dogs form classically-conditioned associations all the time, and these can be both desirable and undesirable. Unlike operant conditioning (see next section), classical conditioning is involuntary - the process does not involve voluntary behaviours by the dog, and it has no control over the learning process. Examples may include:

- A detection dog does not react to a 'clicker' sound (**neutral stimulus**) when it first hears it. When being introduced to clicker training, the 'click' sound is quickly followed by a food reward (**unconditioned stimulus**), which tastes nice and makes the dog excited (**unconditioned response**). With repetition, the dog becomes



excited (**conditioned response**) when it hears the 'click' alone (**conditioned stimulus**) as it has learnt that it pre-emptes the arrival of food [2].

- A detection dog does not usually react to some odour ID test equipment (**neutral stimulus**). During a training session, there are some sudden loud vehicle noises (**unconditioned stimulus**) from a nearby warehouse, which scare the dog (**unconditioned response**). The dog learns to associate the odour ID test equipment (**conditioned stimulus**) with the loud, scary noises. The next training session, the dog reacts fearfully (**conditioned response**) to the odour ID test equipment even though there are no longer any vehicle noises.

Operant conditioning

'Operant conditioning', also known as 'instrumental conditioning' or 'trial and error learning', is probably the main type of learning used during working dog training (**Figure 3**). It is where a dog learns an association between its own voluntary actions and a consequence. The type of consequence affects the probability that the dog will repeat the behaviour (**Table 2**).

- If the consequence is something that the dog likes, the behaviour is reinforced/strengthened and they are more likely to do the same behaviour again.
- If the consequence is something the dog dislikes, the behaviour is weakened and they are less likely to repeat it.

The 'trial and error' aspect of the learning occurs because it relies on the dog trying out different behaviours and gradually noticing that certain behaviours lead to specific consequences. However, trainers often directly guide the behaviour to encourage the dog to learn the association more quickly, reducing the 'trial and error' element.

Reinforcement and punishment during operant conditioning

During operant conditioning the 'consequence' of the dog's behaviour determines how quickly learning occurs and whether the behaviour is more or less likely to be repeated. The terms used for different types of consequence are explained in **Table 2**.



Figure 3. The majority of working dog training involves reward-based operant conditioning.

Table 2. Summary of the different types of outcome that cause operant conditioning learning to take place. Green shading = recommended training technique, red shading = not recommended training technique, amber shading = requires advice from experienced practitioners before use.

	Positive Stimulus applied	+	Negative Stimulus removed	-
Reinforcement Increases the frequency or strength of the behaviour ↑	Positive Reinforcement A rewarding stimulus (something the dog enjoys or needs – e.g. food, play, praise) occurs/is gained in response to the dog carrying out a specific (usually desirable) behaviour. This increases the likelihood that the behaviour will be repeated in the future. <i>This is the recommended method for the majority of dog training.</i>		Negative Reinforcement An aversive stimulus (something the dog dislikes – e.g. a choke chain being tightened) stops or is removed when the dog performs a specific (usually desirable) behaviour (e.g. the pressure from the choke chain is released when the dog walks to heel). This increases the likelihood that the behaviour will be repeated in the future. <i>This method of reinforcement is strongly discouraged on ethical, welfare and performance grounds.</i>	
Punishment Decreases the frequency or strength of the behaviour ↓	Positive Punishment An aversive stimulus (something the dog dislikes – e.g. shouting at the dog, using a shock collar) occurs or is applied in response to the dog carrying out a specific (usually undesirable) behaviour. This decreases the likelihood that the behaviour will be repeated in the future. <i>This method of reinforcement is strongly discouraged on ethical, welfare and performance grounds.</i>		Negative Punishment A rewarding stimulus (something the dog enjoys or needs – e.g. a toy or human attention) stops or is removed when the dog performs a specific (usually undesirable) behaviour. This decreases the likelihood that the behaviour will be repeated in the future. <i>Any training involving this technique is best planned and used in agreement with an experienced trainer or certified animal behaviourist.</i>	

Dog training should primarily involve positive reinforcement (reward) based methods to encourage desirable behaviours. This is because a reward-based approach:

- Helps to meet ethical and legal animal welfare requirements.
- Is usually the most effective training method, in terms of speed of learning and sustainability of the trained behaviours.
- Is the clearest and least ambiguous approach for dogs to understand.
- Encourages dogs to try different behaviours, speeding up operant conditioning.
- Encourages the development of a better dog-handler working relationship.
- Produces more confident, motivated, predictable and effective working dogs.
- Enables any training issues to be resolved more easily.

Examples of operant conditioning

- A detection dog searching a training venue smells a new target odour and pauses next to it to investigate. The handler immediately throws a tennis ball to the dog, providing positive reinforcement. The next time the dog smells this odour during training, it tries pausing for longer and the handler again throws a tennis ball. With repetition, the dog learns that performing a freeze indication next to the odour leads to a ball reward.
- A trainee patrol dog sees a strange person running on the other side of a security fence and decides to bark at them. The handler immediately gives the dogs praise and attention, providing positive reinforcement. With repetition, the dog learns that barking at strangers approaching a security fence leads to positive attention and praise from the handler.

Choosing a positive reinforcer (reward)

Rewards used during operant conditioning can be anything the animal likes (e.g. toys/balls, play, food, praise and social contact). Different dogs will be motivated to different extents by different rewards. The 'value' of a reward to the dog will also change over time depending on the dog's needs (e.g. a bored dog may initially be highly motivated by play/toy rewards; later the same dog may be tired and hungry and more motivated by food rewards). Getting the best from training and operational sessions involves careful choice of rewards for the individual dog and circumstances.

- A detection dog searching a training venue is approaching an area containing a training sample, when it notices its handler getting a tennis ball ready to throw. The dog tries its freeze indication and the handler immediately throws the ball, reinforcing this behaviour. The next time the dog notices the handler getting the ball ready to throw, the dog again tries its freeze indication and immediately receives the ball reward. With repetition, the dog learns to perform a freeze indication as soon as it sees or hears the handler preparing the tennis ball. Note – this is an example of how positive reinforcement can be accidentally misused, as the handler is unintentionally reinforcing an undesirable behaviour (see the 'double blind training' guidance note [3] for advice on avoiding this 'cueing' issue).

Other important animal learning terminology

To get the most from training sessions and maximise operational capability, it is useful to understand a number of other learning terms/concepts. Further details on these are available in the other suggested guidance notes.

Reinforcement schedules are the frequency or the intervals with which desirable behaviours are rewarded. Different reinforcement schedules can be helpful to maintain detection dog operational performance (see 'maintaining operational performance' guidance note [4]).

Extinction occurs when a previously learnt association no longer has a consequence (e.g. is no longer rewarded), causing the dog to reduce its response and eventually stop doing the behaviour. This is important when attempting to reduce problematic behaviours. It is also important to avoid accidental extinction of desirable behaviours (e.g. if a detection dog is never rewarded operationally its detection behaviour in this environment may decline [4]).

Contextual cues can cause a dog to learn associations which are specific to the scenario or environment in which they occur. For example, dogs may use contextual cues in the training venue (the appearance of the room, presence of training equipment, presence of the instructor etc.) to learn that they are rewarded frequently in their training venue but not during operational searches, causing them to be more motivated to search effectively in the former. This is why it is important to train in many different environments and scenarios (e.g. different venues, weather, times of day, with different observers present). **Moveable cues**, such as a harness/lead that the dog associates with working, can help to reduce this issue [4].

Cue competition occurs if a dog learns to use different cues to get a reward, rather than the ones the handler/trainer wants it to use. Issues related to this are covered in the 'double-blind training' [3] and 'contamination control' [5] guidance notes.

Generalisation occurs when a dog's learned response to one stimulus also occurs in response to another stimulus that is similar but not identical. It is useful to train detection dogs so that they generalise to variations in target material odours (see the 'generalisation' guidance note [6]).

Contiguity refers to how strongly a stimulus and consequence are linked. Learning an association is more likely to occur if the stimulus and consequence occur close together, which is why timing and accuracy of rewards during detection dog training is very important.

Splitting, shaping and chaining are techniques to try to speed up and focus the process of operant conditioning, reducing the amount of 'trial and error' required by the animal.

Splitting: Breaking a training goal down into smaller component behaviours or training goals.

Shaping: Reinforcing any gradual step (change in behaviour) made by the animal towards the desired behaviour.

Chaining: Training each component behaviour separately and then joining these together to reach the desired training goal.

Examples of these techniques are provided in the 'marker training' guidance note [2].

Top tips

- ✓ Include a basic introduction to animal learning in handler training courses (with a particular focus on effective positive reinforcement training).
- ✓ During detection dog training and operational searches, try to keep in mind what the dog might be learning (about the odours it is detecting/cues in the environment etc.) and how this may affect its operational performance.
- ✓ Problem behaviours resulting from learnt associations can be difficult to overcome - consider seeking advice from a certified animal behaviour practitioner (particularly for fear and aggression related issues) [1].
- ✓ Learning and animal training is a complex subject. If, having read this note, you wish to explore the topics in more detail, consider reading additional information sources, some general introductions to animal training (e.g. [7, 8]) and/or undertake a recognised course in animal learning.

Associated guides and information

- [1] <https://abtc.org.uk/>
- [2] An introduction to marker training. Dstl/PUB127875
www.cpni.gov.uk/canine-detection-guidance-notes
- [3] Why you should train and test detection dogs 'double-blind'. DSTL/PUB104178
www.cpni.gov.uk/canine-detection-guidance-notes
- [4] Maintaining the operational performance of detection dogs. DSTL/PUB104771
www.cpni.gov.uk/canine-detection-guidance-notes
- [5] Why and how to control contamination. DSTL/PUB89644
www.cpni.gov.uk/canine-detection-guidance-notes
- [6] How to train your dog to generalise across varying types and sizes of targets. DSTL/PUB89074
www.cpni.gov.uk/canine-detection-guidance-notes
- [7] Pryor, K. (2006). Don't Shoot the Dog! The New Art of Teaching and Training, Revised Edition. Ringpress Books Ltd.
- [8] Bailey, B. (2006). The Fundamentals of Animal Training (DVD). Dog Sports Video

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An introduction to marker training

What is this note about?

This note provides an introduction to marker training. It includes a brief overview of what marker training is, in what circumstances it can be beneficial, and how it works in comparison to other reward-based training methods.

Who is this note relevant for?

All dog handlers and other personnel responsible for training and deploying detection dogs. It is particularly aimed at those considering using marker training for the first time, or who are investigating methods to reinforce behaviours of dogs working at a distance from the handler/trainer.

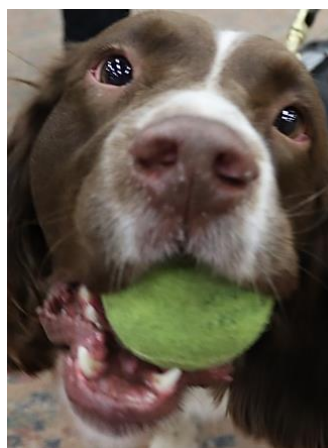
Introduction

What is marker training?

Marker training is a technique where the dog is given a signal (known as a marker) by the handler/trainer exactly when they perform a correct behaviour [1]. The marker is then followed, after a (usually short) delay, by the dog receiving a reward (something that they value such as food or playing with a toy). This means that the particular behaviour is positively reinforced and more likely to be repeated (**Figure 1**).

Marker training can be used to train new behaviours and to maintain trained behaviours. The technique is often used in combination with other common training methods such as 'shaping', where the dog is rewarded for each step in training it makes towards the desired behaviour (see 'a practical example of marker training' section below).

Note that, like other dog training methods, marker training offers a variety of benefits but also has some limitations (detailed in **Table 1** below).



Ask for a 'sit'

Dog sits

Use marker

Give reward

Figure 1: Using a marker to train a dog to sit.

What is a marker?

A marker can be anything the dog can hear, see, smell, taste or feel, provided:

- It does not mean something else to the dog (e.g. a doorbell sound may already cause some dogs to respond in a specific way, such as barking).
- It can be clearly experienced no matter what the dog is doing (e.g. if a sound is used, it needs to be loud enough for the dog to hear while it is busy doing an activity).
- It is unlikely to also occur naturally in the training or operational environment.

Sounds are usually chosen as markers because they can easily be delivered across a wide range of situations, including when the dog is unable to see the handler/trainer. Frequently used markers in dog training include a spoken word or sound (e.g. “nice” or a whistle), or a double click produced by using a hand-held mechanical clicker device (**Figure 2**).

Clicker devices are often favoured over other markers because:

- Clickers make a short, sharp and unemotional sound that is distinctive from other sounds.
- The sound made is always the same so it can be produced consistently across situations and by different trainers.



Figure 2: An example of a clicker.

The popularity of the clicker has led to the interchangeable use of the terms ‘marker training’ and ‘clicker training’ [1]. However, no differences have been shown between the use of different markers, such as a spoken phrase (e.g. “good dog”) or a clicker, in the amount of time taken to train dogs to perform simple behaviours such as a sit [2].

Why is marker training used?

Dogs are often trained to do things through operant conditioning, whereby they learn that if they perform a specific action in response to a signal, they will receive a reward such as food or play; this is known as positive reinforcement.

For dogs to effectively learn which action led to their reward, the reward needs to be given immediately when the action is performed. Even small time delays make it more difficult for dogs to learn the relationship between their action and the reward, which can slow down training progression and impact success.

However, it is not always possible to give a reward immediately for the correct behaviour, such as when the dog is working at a distance from the handler/trainer. The aim of using the marker is to help the dog to learn that the action that they were performing when the marker was given was correct, even if there is a delay before they receive a reward for it.

The increased precision in timing that can be achieved with a marker can lead to more effective training outcomes, by helping the dog to associate the delayed reward with the desired behaviour. These benefits mean that markers are now widely used across a range of training situations.

How does it work?

Marker training is popular in the dog training community and is successfully used to train dogs to perform a variety of tasks, including odour detection. However, there is no clear consensus on how or why marker training works, and there are currently several different theories (see information box for details). The lack of agreement on how markers work has led some trainers to use them differently to others.

However the marker is used, it must be followed by a reward to continue to be effective as a signal to the dog that their behaviour is correct. If rewards are no longer given after the marker, the marker will gradually stop working.

Marker training scientific theories

There are currently three main theories of how marker training works (for a scientific review of the theories see [3]):

- According to the **Reinforcing Hypothesis** the marker itself becomes positive for the dog because it tells them that a reward is coming. This can be compared to when people feel happy when they receive money, as they know that they can get something that they want with it.
- The **Marking Hypothesis** claims that the marker signals (or 'marks') the action that the dog is being rewarded for, making the action more distinctive and easier for the dog to remember.
- According to the **Bridging Hypothesis**, the marker fills (or 'bridges') the time delay between the correct behaviour and the reward by signalling that the reward is coming.

These theories are not mutually exclusive and tend to be used interchangeably by dog trainers to explain how marker training works. However, they each differ in the recommended qualities a marker should have and how it should be used to be most effective. For example, the Reinforcing Hypothesis states that the same marker should always be used during training, while the other theories state that different markers can or should be used. Overall, it is not yet clear how best to use markers for dog training.

A practical example of marker training

The following example is one suggested method of using a marker to teach a dog to indicate (alert) in response to the location of an odour source. As with other training methods, progress will be gradual over multiple training days and the amount of time taken to complete each step will vary between individual trainers and dogs. Dogs may also need to be given a refresher of each training stage in new environments or situations.

Step 1: 'charge' the marker

When some trainers first begin marker training, they start by teaching the dog that whenever the marker occurs, they will get a reward. This stage involves a form of classical conditioning, where the dog learns to associate the marker with a reward. In dog training this is often referred to as 'charging' the marker. For example, if using a clicker, click it once and give the dog a reward, such as a treat or toy. Start by clicking once and

delivering the reward immediately. Then gradually extend or change the time delay after the click before the dog is rewarded. Repeat this until the dog has learnt that hearing the clicker means they will get a reward, even if there is a delay.

Step 2: teach the dog to associate smelling the odour with a reward

Allow the dog to smell the odour source. Use the marker once immediately when the dog brings its nose near to the odour source and smells it, before the dog begins to move away. After the marker is used, allow the dog to move away from the odour source and give it a reward, such as food or play with a toy. Repeat this stage until the dog has learnt that smelling the odour source means that they will get a reward.

Step 3: teach the dog to stay at the odour source

Wait for the dog to smell the odour source for slightly longer before using the marker once and rewarding them. Delaying the marker in small increments will gradually increase the amount of time that the dog stays at the odour source.

Step 4: shape the indication response

Depending on the desired indication response (e.g. a sit and stare at the odour source), wait for the dog to do something similar to the indication behaviour, such as start to sit, and use the marker once. Allow the dog to move away from the odour source and reward them. Then repeat and refine the indication by rewarding behaviours as they become closer to the final desired indication response. It is important to precisely time when the marker is used so that the dog is not accidentally rewarded for other behaviours while they are near to the odour source, such as looking back at the handler/trainer or touching the odour source.

How does marker training compare to other training methods?

Marker training is popular among dog owners and professional dog trainers, who have reported that it helps dogs to learn faster and remember what they have learnt better, makes them more eager to learn and encourages problem solving. However, few objective scientific studies have directly compared marker training to other dog training methods (see information box for details).

Until more scientific evidence becomes available, the decision to use marker training should depend on the training circumstances and the trainer's/handler's preferences. Some of the potential advantages and disadvantages of marker training in comparison to other reward-based training methods are outlined in **Table 1**.

Table 1: Potential advantages and disadvantages of marker training in comparison to other reward-based training methods.

Advantages of marker training	Disadvantages of marker training and some tips for overcoming them
• Marker training can improve training precision as the dog receives feedback immediately when they perform the correct behaviour. • A marker can be used anywhere, including where it is not possible to directly deliver a reward (e.g. in a busy or hazardous environment). • A marker can be used when there is a time delay before the dog can receive a reward (e.g. if the dog is working at a distance from the trainer). • The same marker can be used by multiple trainers, improving the consistency of communication with the dog. • Markers may help to maintain trained behaviours if there are occasional instances where a reward cannot be given (e.g. if training in a busy or hazardous environment). • Marker training may help to reduce the influence of unintentional cues to the dog (e.g. the trainer does not need to get the reward ready to deliver in anticipation of a correct response). • Using a marker can prevent behaviours associated with receiving a reward from being unintentionally reinforced (e.g. preventing the dog from looking at the trainer during a correct behaviour because they are anticipating that they will catch a ball).	• Poor timing in giving the marker can cause dogs to learn to perform incorrect behaviours, or to associate getting the reward with something in the environment. The trainer needs to have good timing to give the marker precisely when the dog is performing the correct behaviour. • Using a clicker or other hand-held device can be unwieldy (e.g. if the trainer is holding a clicker, a reward and the dog's lead at the same time). To keep the hands free, a different marker such as a whistle or spoken word may be preferable. • Poorly chosen markers may cause dogs to either start responding to similar things (e.g. other clicking sounds if a clicker is used) or stop responding (e.g. if the word "yes" is used as a marker but is also said at other times). Markers should be carefully chosen so that they only occur when intended during training. • Dogs can become reliant on the marker to perform behaviours. To prevent over-reliance on the marker once a behaviour is learnt, its use can be gradually reduced. • If a marker is often used without giving the dog a reward, it will stop working. Where ever possible, a reward should always be given to the dog after the marker, even if there is a time delay (e.g. to move to a safe area to reward the dog). If the marker stops working, it may help to repeatedly use it and give the dog a reward each time to 're-charge' it.

Scientific research comparing marker training with food rewards versus training with food rewards alone

Marker training was originally developed to improve training efficiency when there is a delay in reward delivery (e.g. when the dog is working at distance from the handler). The benefits of using marker training when the reward is delayed have not yet been scientifically assessed. Studies have compared marker training to other methods to teach dogs to perform simple actions when there is no time delay before a reward was given. For example, three groups of dogs were trained using different methods to push a lever: a) a clicker and food reward; b) a spoken word ("bravo") and food reward; c) food reward alone. No differences were found between the groups in the amount of time taken to train the dogs to perform the task. The groups also showed no differences in their ability to generalise the trained behaviour to perform a new, related task [4]. This study shows that when training dogs to perform simple behaviours with no time delay before the reward, marker training may be equivalent to other reward-based methods in dog training speed.

Marker training may be better than food rewards alone in helping to maintain trained behaviours. When rewards were no longer given for correct responses after dogs were trained to nose-touch an object, dogs trained using a clicker with food reward continued to perform a trained behaviour for longer than dogs trained using food reward alone (although both groups stopped responding eventually) [5]. Markers might therefore help to maintain a trained behaviour in situations where it is not always possible to reward the dog (e.g. if training in a hazardous environment), as long as the dog is still rewarded the majority of the time. For further information on maintaining dog performance during operations, see the guidance note: 'Maintaining the operational performance of detection dogs' [6].

Top tips for marker training

- ✓ Choose a training method that is most appropriate to your training circumstances and which you are comfortable with.
- ✓ Consider using marker training if there is often an unavoidable delay before you can reward the dog, such as when they are working at a distance or you cannot reward at source.
- ✓ Choose a marker that makes a unique, easy to hear sound (e.g. a clicker).
- ✓ Ensure you use accurate timing by only giving the marker during the correct behaviour.
- ✓ Whenever possible, the marker should always be followed by a reward or it will stop working.
- ✓ Markers can potentially help to maintain learnt behaviours if there are a small number of occasions when it is not possible to give the dog a reward.
- ✓ Consider seeking training advice from a certified animal behaviourist if you are having trouble with reaching your desired training goals using markers, or other training techniques.

Associated guides and information

- [1] Pryor, K. (2006). *Don't Shoot the Dog! The New Art of Teaching and Training*, Revised Edition. Ringpress Books Ltd.
- [2] Thorn, J. M., Templeton, J. J., Van Winkle, K. M., Castillo, R. R. (2006). Conditioning shelter dogs to sit. *Journal of Applied Animal Welfare Science* 9(1), 25-39.
- [3] Dorey, N. R., Cox, D. J. (2018). Function matters: a review of terminological differences in applied and basic clicker training research. *PeerJ* 6, e5621.
- [4] Chiandetti, C., Avella, S., Fongaro, E., Cerri, F. (2016). Can clicker training facilitate conditioning in dogs? *Applied Animal Behaviour Science* 184, 109 – 116.
- [5] Smith, S. M., Davis, E. S. (2008). Clicker increases resistance to extinction but does not decrease training time of a simple operant task in domestic dogs (*Canis familiaris*). *Applied Animal Behaviour Science* 110(3-4), 318 - 329.
- [6] Maintaining the operational performance of detection dogs. DSTL/PUB104771
www.cpni.gov.uk/canine-detection-guidance-notes

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Understanding detection dog indications ('hits', 'misses', 'false alarms' and 'nuisance alarms')

What is this note about?

This note discusses detection dog indications including 'hits', 'misses', 'false alarms', 'nuisance alarms' and 'interest'. The note explains what these terms mean, why these responses may occur, and provides guidance on actions to maintain or improve the detection capability in each case.

Who is this note relevant for?

All dog handlers and other personnel responsible for training, accrediting and deploying detection dogs. It may also provide useful background information for those coordinating wider search or security operations involving detection dogs.

Introduction

Detection dogs are usually trained to perform a specific 'indication' or 'alert' behaviour, such as a sit or freeze, when they detect a training sample (**Figure 1**). In an ideal world, detection dogs would only indicate (and do so reliably) on the odours of their training samples and related target substances of operational interest. However, in the real world various factors influence whether or not dogs indicate in different situations. For example:

- Target substances encountered operationally have odours that may differ to some extent from training samples, affecting the likelihood of an indication.
- Other odours present in the operational environment may mask target odours, or distract the dog, reducing the chance of an indication.
- Some commonplace substances may have odours that resemble those of target substances, causing dogs to indicate on unexpected items.
- Trace (i.e. not obviously visible) quantities of a training sample or target odour may be present in the environment which may result in the dog indicating without an obvious odour source being present.
- Dogs may occasionally indicate unexpectedly due to training/behavioural issues unrelated to odour detection.

The following sections explain in more detail why dogs may or may not indicate in different circumstances, and terminology used to describe these different occurrences. Guidance is provided on possible next steps when dogs indicate on non-target substances, or fail to indicate on substances it is expected that they should detect.

Possible responses during a search

There are several possible responses that may occur during searches, depending on whether or not a detection dog indicates and whether or not a target odour is present (see **Table 1**). These are described in more detail the following sections.

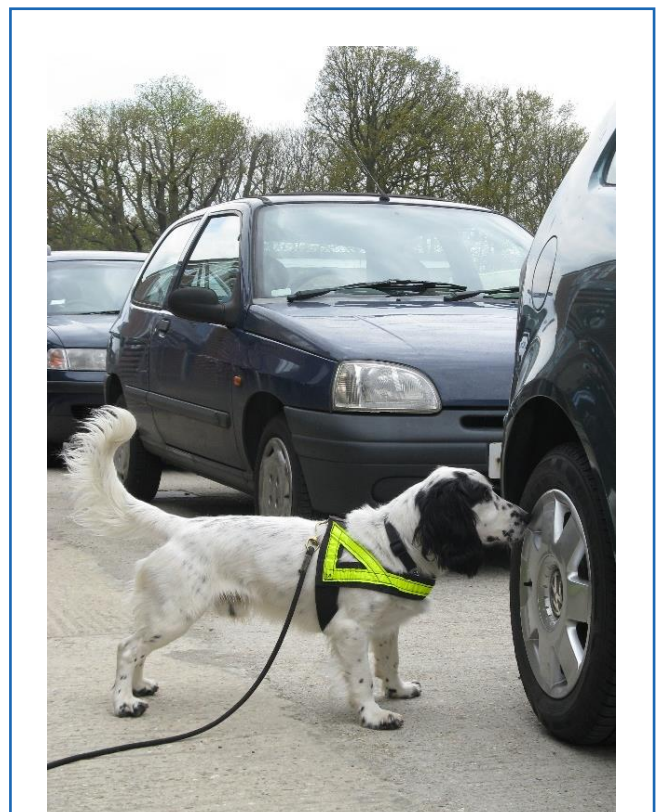


Figure 1: A detection dog performing a standing 'freeze' indication.

Table 1: Possible responses during a detection dog search and common terms used. Green boxes represent desirable outcomes, grey boxes represent neutral outcomes and red boxes represent undesirable outcomes.

	Indication	No indication	Interest
Target substance/odour present	'Hit' Correct indication True positive	'Miss' Incorrect non-indication False negative	Correct interest True positive
Material related to target substance/odour present	<i>'Nuisance alarm'</i>	<i>Non-indication</i>	<i>Interest</i>
No target substance/odour present*	'False alarm' Incorrect indication False positive	Correct non-indication Correct rejection True negative	Incorrect interest False positive

*Note that a dog may indicate on residual traces of a target substance without visible quantities being present.

'Hit'/correct indication/true positive

This is where a dog indicates when a training sample or target substance is present (e.g. explosives, narcotics etc.), suggesting the capability is working as expected. If this occurs during training, where the training substances are known, the dog's indication can be appropriately rewarded. During operations, where it may be unknown exactly what substance the dog has indicated on, it is usually not appropriate (and may not be feasible) to reward the dog. Advice on maintaining the dog's detection behaviour in these circumstances is available in the 'Maintaining the operational performance of detection dogs' guidance note [1].

It should be noted that a dog may correctly indicate on residual traces of a target substance without visible quantities being present (e.g. a bag that was recently used to carry narcotics).

Correct non-indication/correct rejection/true negative

This is where a detection dog correctly dismisses an item or search area that does not contain a target odour by not indicating. This outcome suggests that the dog is able to successfully discriminate the required target odours from background odours and the capability is working as expected.

The ability of dogs to correctly dismiss search areas or objects can be tested during training through effective use of hides containing blanks and interferents (objects/odours it is expected that dogs should ignore). Further advice is available in the 'Using blanks and interferents to ensure effective detection dog training' guidance note [2].

Interest

Where the dog senses an odour that it thinks has some similarity to a training sample – but not sufficient for it to indicate – it may show 'interest'. This is a (potentially subtle) change in behaviour, such as prolonged or more energetic interrogation of an area, that an observant handler who knows their dog should be able recognise and act upon. Like full indications, interest can be correct or incorrect, and the points discussed in this note relating to correct and incorrect indications also apply.

Where a dog shows interest during an operational search, it is usually appropriate for the handler to investigate and otherwise act as they would for an operational indication. If interest behaviour occurs frequently, the dog may require further training on the odours in question and increased generalisation training [2] to encourage full indications.

'False alarm'/incorrect indication/false positive

This is where a detection dog indicates when the target substance is not present. There are various reasons why a detection dog may give an incorrect indication, and further training may be needed to rectify possible causes. These may include:

- The dog has inadvertently been trained to detect a non-target odour as a result of contamination of training samples**

If training samples have become contaminated with everyday odours (e.g. from coffee, toiletries, packaging materials, etc.), due to poor handling or storage practices, dogs may learn these odours

during training and subsequently indicate on them during searches. Methods to avoid this problem include good contamination control of training kits [3] and appropriate use of 'blanks' and 'interferents' during training [2].

2. **The dog has learnt to indicate on areas of general disturbance or novel odours in the environment**

Dogs may occasionally indicate on areas of general human disturbance (e.g. newly dug ground) or objects/odours that are novel to the dog or seem out of context in the environment. Advice on reducing indications of this type (if required) is provided in the 'Blanks and interferents' guidance note [2].

3. **The handler or trainer is unintentionally cueing the dog to indicate in the wrong place**

There are a number of human behaviours that dogs may learn during training as signals that they should indicate, even if a training sample or target odour is not present. In many instances, handlers and trainers do not realise that their behaviour is influencing the dog to indicate. These cues are usually unintentional and can be difficult or impossible to avoid. Examples of cueing behaviours and advice on avoiding these issues are provided in the 'Why you should train and test detection dogs 'double-blind'' guidance note [4].

4. **The dog may be tired, frustrated or confused and has resorted to 'guessing'**

It is important that handlers learn to recognise when their dog is losing search motivation and either needs a break or some remedial training. Advice on building and maintaining search motivation/performance is provided in the 'Maintaining performance' guidance note [1].

It is important to note that apparent false alarms can occur when the search area, or an item within it, has been accidentally contaminated with training substance odours or invisible trace amounts. In these circumstances, the dog is technically indicating correctly, though it appears to be a false alarm to the handler/trainer. Methods to avoid this problem include good contamination control of training substance kits and training areas, such as use of barrier materials when placing out training substances [3].

Nuisance alarms

A nuisance alarm is when a dog indicates correctly on a material with an odour related to a training substance, but where the material is not itself of operational interest. For example, if a component of a target substance is also present in a cleaning product, the dog may indicate on the presence of the cleaning product. Another example is that some plastic explosives may contain small quantities of plasticisers (non-explosive chemicals

The effect of odour generalisation on dogs' indications

The ability to recognise and indicate on odours similar to those produced by training samples is known as 'generalisation'. Generalisation behaviour is very important, as it ensures that dogs will be able to detect real-world target substances that differ slightly from their training samples, for example, due to their origin/manufacture, formulation, age, packaging, storage conditions and history of use. Generalisation should be encouraged during training [5].

Because of this generalisation behaviour, detection dogs will occasionally indicate on:

- A wider range of target odours than those specifically included in their training sample kits.
- Certain common non-target substances in the environment that are chemically related to the training samples. These may be termed 'nuisance alarms' (see main text).

It is important that dog handlers, and those who coordinate detection dog searches, understand that it is normal and expected that dogs will indicate on a wider range of materials than those they have specifically trained on, some of which will be operationally relevant, and others less so.

that contribute to the explosive's flexibility) that are also found in some commonplace plastic items.

Nuisance alarms suggest that training has been conducted appropriately (i.e. the dog is correctly detecting a trained odour) which differs from false alarms, where training may not have been conducted appropriately (i.e. the dog is detecting an incorrect odour). Nuisance alarms are a necessary inconvenience, in that they require further investigation to fully determine that no targets/items of concern are present.

Attempting to train dogs to ignore nuisance alarm substances that are closely related to training substances may cause a reduction in generalisation and detection capability. Therefore, in many cases, it is best to accept that some nuisance alarms may occur and manage them by:

1. Ensuring handlers understand that nuisance alarms are to be occasionally expected, and are aware of possible nuisance alarm materials that their dogs might indicate on.
2. Encouraging the dog to move on following a suspected indication on a nuisance alarm material, without offering a reward.

3. Ensuring robust Standard Operating Procedures (SOPs) are in place to resolve any alarms by detection dogs (e.g. visual inspection and/or manual search of the area by the handler to the extent that it is safe to do so).
4. Keeping a record of any operational interest/indications.

The 'Maintaining performance' guidance note [2] provides advice on accustoming dogs to not receiving a reward for every correct indication during training, to reduce the impact of not being rewarded for every indication in the operational environment on subsequent detection performance.

'Miss'/incorrect non-indication/false negative

This is where the target substance is present, but the dog either does not detect the odour, or detects it but fails respond correctly by indicating. Reasons why this may occur include:

1. **The dog has not been effectively trained to detect the target substance and indicate, or has not been trained to generalise sufficiently**
Odour detection capability can be improved by following the advice in the other guidance notes in this series [1-7].
2. **The team (dog and handler) is not searching the area thoroughly**
The dog may have missed areas of the search and/or has not been tasked appropriately by the handler. This may require adjustment of search SOPs and remedial training of the team (dog and handler) to improve search thoroughness.
3. **The dog has lost search motivation in the operational environment**
The dog has learnt that it is unlikely to encounter target odours in an operational environment. Advice on this issue is provided in the 'Maintaining performance' guidance note [1].
4. **The dog may be distracted, tired, frustrated or confused**
It is important that handlers learn to recognise when their dog either needs a break from searching or remedial training to resolve specific issues (e.g. if the dog is easily distracted by certain environments or objects).

No detection dog is 100% accurate, and occasional misses are to be expected. For this reason, detection dogs should only ever be deployed as one element of a comprehensive and coordinated set of security measures that aim to manage the overall risks to the site/organisation.

Monitoring and recording indications, interest, false alarms, nuisance alarms and misses

It is important to keep careful records of all indications, interest, false alarms and misses during training and operational deployments, including details of any target and non-target substances that a dog indicates on.

These records can be used to monitor the dog's capability and highlight where remedial training is required. Further advice is provided in the 'Using training records to optimise detection dog performance' guidance note [7].

Summary of possible actions following detection dog indications

Table 2: Summary of possible actions following detection dog 'hits', 'misses', 'false alarms', and 'nuisance' alarms. Green boxes represent desirable responses from the dog, the grey box represents a neutral response and red boxes represent undesirable responses.

Response from dog	Possible action during training occurrence	Possible action during operational occurrence	Possible changes required to training or SOPs
'Hit' Correct indication	Reward dog appropriately	Do not reinforce dog if substance is unknown, resolve alarm using appropriate SOPs	No change, continuation training to maintain capability
Correct interest	No action required but can re-task to encourage full indication	Do not reinforce dog if substance unknown, resolve alarm using appropriate SOPs	Increase training on odour and generalisation training to encourage full indications
Correct non-indication	No action required. (N.B. Some handlers/trainers may choose to reward "clear runs")	No action required	No change, continuation training to maintain capability
Nuisance alarm	Do not reinforce dog, note substance dog has indicated on	Do not reinforce dog, note substance dog has indicated on, resolve alarm using appropriate SOPs	Factor in nuisance alarms to operational SOPs
'False alarm' Incorrect indication	Do not reinforce dog, note substance dog has indicated on, note actions of handler prior to indication, check records for possible residual contamination from previous use of training samples	Do not reinforce dog, note substance dog has indicated on, resolve alarm using appropriate SOPs, check environment for possible evidence of relevant contamination	Revision of training odours, improve contamination control practices, improve handler awareness of cueing, train dog to ignore relevant interferents and blanks
Incorrect interest	Do not reinforce dog, note substance dog has indicated on, note actions of handler prior to indication, check records for possible residual contamination from previous use of training samples	Do not reinforce dog, note substance dog has indicated on, resolve alarm using appropriate SOPs, check environment for possible evidence of relevant contamination	Revision of training odours, improve contamination control practices, improve handler awareness of cueing, train dog to ignore relevant interferents and blanks
'Miss' Incorrect non-indication	Present a second search opportunity of that area or review the miss with the handler at the end of the session	Investigate possible reasons for miss and record evidence for later review	Revision of training odours, improve contamination control practices, ensure dog recognises odours using odour identification tests [6], increase generalisation training, ensure appropriate overall suite of search capabilities for operational scenario

Top tips

- ✓ Ensure handlers are familiar with the terms defined in this note (e.g. indications, interest, false alarms, nuisance alarms and misses) and understand their meanings, possible reasons these responses might occur, and appropriate actions during both training and operations.
- ✓ Ensure handlers, and those responsible for deploying detection dog teams during security operations, understand that false alarms, nuisance alarms and misses may occasionally occur and should be factored in to the overall security/search strategy and associated protocols/SOPs.
- ✓ Ensure handlers have a good understanding of their dog's behaviour so that they recognise the dog's indications and more subtle interest.
- ✓ Ensure handlers have a good understanding of how their own behaviour may unintentionally cause false indications [4].
- ✓ Maximise the chance of correct indications and minimise the chance of incorrect indications through good generalisation training, use of blanks and interferents and techniques to maintain operational performance [1, 2, 5].
- ✓ Ensure training samples are handled in line with best practice to avoid odour contamination, both of the training substances themselves and training areas [3].
- ✓ Ensure appropriate SOPs are in place to resolve operational indications by dogs and determine whether they are correct indications, false alarms or nuisance alarms.
- ✓ Keep good training records to identify any patterns of false alarms, misses or nuisance alarms during training and operations that may require remedial training [7].

Associated guides and information

- [1] Maintaining the operational performance of detection dogs. DSTL/PUB104771
www.cpni.gov.uk/canine-detection-guidance-notes
- [2] Using blanks and interferents to ensure effective detection dog training. DSTL/PUB111065
www.cpni.gov.uk/canine-detection-guidance-notes
- [3] Why and how to control contamination. DSTL/PUB89644
www.cpni.gov.uk/canine-detection-guidance-notes
- [4] Why you should train and test detection dogs 'double-blind'. DSTL/PUB104178
www.cpni.gov.uk/canine-detection-guidance-notes
- [5] How to train your dog to generalise across varying types and sizes of targets. DSTL/PUB89074
www.cpni.gov.uk/canine-detection-guidance-notes
- [6] Canine Odour Discrimination Test DSTL/PUB89074
www.cpni.gov.uk/canine-detection-guidance-notes
- [7] Using training records to optimise detection dog performance. DSTL/PUB127957
www.cpni.gov.uk/canine-detection-guidance-notes

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Why and how to control contamination



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What is this note about?

This note provides guidance on controlling contamination by appropriate handling and storage of Training Samples (TSs).

Who is this note relevant for?

All dog handlers or instructors training and deploying detection dogs.

What is contamination?

Something from the environment that adds impurities or hazards to your TS. Or when odours or particles from your TS transfer to you, your dog or your working environment.

How contamination occurs and why is it important to control?

There are three main ways in which contamination can occur:

Contamination of your working environment

Also referred to as trace contamination. Trace contamination can occur by:

- using the same hands (with or without gloves) that have handled TSs, to touch other objects such as door handles
- placing explosives on a surface without using a barrier (such as clean paper or a clean clip seal bag)
- wearing clothes used during training, for other purposes and in other areas
- placing used gloves in pockets after use (therefore contaminating the inside of the pocket)



Care must always be taken to avoid trace contamination as dogs and/or detection equipment may alert on areas where trace contamination exists. Whilst this may appear as a false indication to the handler/equipment operator, there may be explosive traces present that are invisible to the naked eye.

Contamination of the TS by external odours



Also referred to as cross contamination. Cross contamination can occur by exposing TSs to vapours within the external environment including other TSs, odorous

packaging, odour scented perfumes, cigarettes, washing powders or odorous food.

Care should be taken to avoid cross contamination of TSs, as the odour of the TS can be altered by contaminant odours. This will affect the way the dog recognises the TS. Dogs may also learn to search for and indicate on the contaminant odour rather than the TS.

Contamination of the TS by external substances

TSs may become contaminated with external substances (such as soil, sand and detritus) if not protected by a barrier (such as clean paper or a clean clip seal bag).



Care should be taken to avoid contamination of the TS by external substances because the odour of the TS may change. However more importantly, the sensitivity of the TS may also increase, making it more likely to detonate on impact, or due to changes in temperature or pressure.

Many types of explosive are toxic:



- Never touch TS with your bare hands.
- Never allow your dog to come into direct contact with the TS.

Top tips for preventing contamination

1. Wear nitrile or polythene gloves whenever handling TSs. Keep handling to a minimum and change the gloves regularly.
2. Remove gloves immediately after handling TSs and change gloves in between handling different TSs.
3. Avoid wearing aftershave or perfumes when handling targets and do not place re-usable TSs near strong odours.
4. Do not place TSs directly onto a surface. Instead, place on a barrier. This will prevent dirt from contaminating the TS and prevent the TS from contaminating the surface. See examples of suitable barriers overleaf.
5. Keep a record of where TSs have been placed to identify potential causes of false positive alarms.
6. Carefully inspect TSs after use; safely dispose of any that may have become contaminated or are showing signs of age or damage.
7. Store different TSs in separate, airtight containers.

Which type of packaging should I use?

Training Sample (TS) packaging should:

- have a low odour and therefore prevent contamination of the TS from the packaging odour. It is therefore advisable to use forensic or laboratory grade containers where possible, as opposed to products designed for household use.
- have low permeability:
 - to prevent TS odour escape through the packaging.
 - to prevent the transfer of odours (from other TSs or any other contaminant) from the external environment into and through the packaging, contaminating the TS.
- provide physical protection to the TS.
- comply with relevant regulations for the safe storage and/or transport of the TS.

As one packaging type rarely serves all of these purposes, TSs are usually packaged using a combination of layers. Below is a suggested packaging method:

Clean packaging should be placed out during searches as a blank. Regardless of how odorous packaging is, dogs should be trained to ignore any packaging layer used; to ensure they are searching for the target odour only, not the packaging odour.

Research into the suitability of the packaging and seal types detailed on this page is ongoing; this guidance note will be updated as and when more suitable packaging methods are identified.

Inner Packaging Layer	Intermediate Packaging Layer	Outer Packaging Layer
 or ‘Certified clean’ glassware sealed with a PTFE-lined screw top lid ‘Certified clean’ glassware has a low odour; the TS is therefore unlikely to become contaminated with glassware odour. It is also impermeable; minimal external odours will pass through the glassware and contaminate the TS. The PTFE-lined screw top lid, when tightly secured, provides an adequate seal. Polythene seal-clip bags Polythene seal-clip bags help to maintain TS integrity and can also help to mitigate against gross contamination (dust, dirt and detritus). However they provide a poor barrier to potential contaminant odours. The TS therefore requires an additional packaging layer.	 Nylon 11 bags (swan necked) A Nylon 11 bag adds a second protective barrier to prevent TS contamination. Swan necking provides an adequate seal; it can be achieved by tightly twisting excess material at the top of a bag, looping the twist downwards and securing with an elastic band. Nylon 11 bags have a slight odour associated with them; therefore clean Nylon 11 bags must be placed out as blanks during training.	 Robust containers This packaging layer not only protects the TS when being stored and transported, it also provides a final protective barrier to prevent TS contamination.

What barrier should I use?

To prevent contamination, TSs should remain inside their inner packaging layer during searches. Samples of each layer of packaging should also be procured and retained for use as an interferent in training. However when a TS needs to be removed from its packaging and placed directly on a surface, the TS should be placed on a barrier. This will prevent contamination of the TS by external substances, as well as contamination of the training area itself. Barrier materials should be single-use and disposable. For example, card (as shown below) or waxed paper.



Clean barrier materials should also be placed out in searches as blanks.

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An introduction to odour

What is this note about?

This note provides an introduction to what odour is, how it is produced, and factors that may affect a dog's ability to smell, and therefore detect, an odour and its source.

Who is this note relevant for?

All dog handlers and other personnel responsible for training and deploying detection dogs.

Introduction

What is an odour?

An odour, also known as a smell or scent, is sensed when chemical molecules in the air (vapour) are detected by a person or animal. These molecules can be released by solid and liquid substances over time and diffuse (spread out) into the air. The extent to which molecules are released depends, among other factors, on how easily the substance evaporates and turns into vapour. A substance that readily produces a vapour is said to be **volatile**, and to have a **high vapour pressure**.

The molecules released by a substance fill the air space above and around it over time, which is sometimes known as the **headspace**. For example, imagine a fresh

cup of coffee. The coffee is the substance releasing the molecules. The headspace is the air around the coffee that contains the released molecules, which can be detected as the 'coffee smell' (**Figure 1**). The more molecules present in the headspace, the higher the odour concentration and the stronger the coffee smell.

How do dogs detect odours?

One of the reasons why dogs provide such a useful detection capability is because of their highly sensitive sense of smell. Smells are perceived by both humans and dogs through their olfactory systems. The olfactory system forms a network from the nose to the brain, enabling the brain to recognise odours based on molecules that are detected in the nose.

The process of smelling an odour starts when molecules enter the nose. There are many types of olfactory receptors inside the nose, which detect the presence of different molecules. Signals are sent from the olfactory receptors to specialised areas of the brain, collectively called the olfactory cortex, where the odour is interpreted and identified.

The canine olfactory system has a number of adaptations that give dogs a more powerful sense of smell than humans. For example, dogs have many more olfactory receptors than humans, making it more likely that molecules will be detected in the nose.

What can affect the odour of a substance?

The following sections introduce why substances have different odours, and some of the reasons why the odour of a substance may not always be the same. For further information on how to train dogs to detect substances despite changes in their odour, see the guidance note: 'How to train your dog to generalise across varying types and sizes of targets' [1].

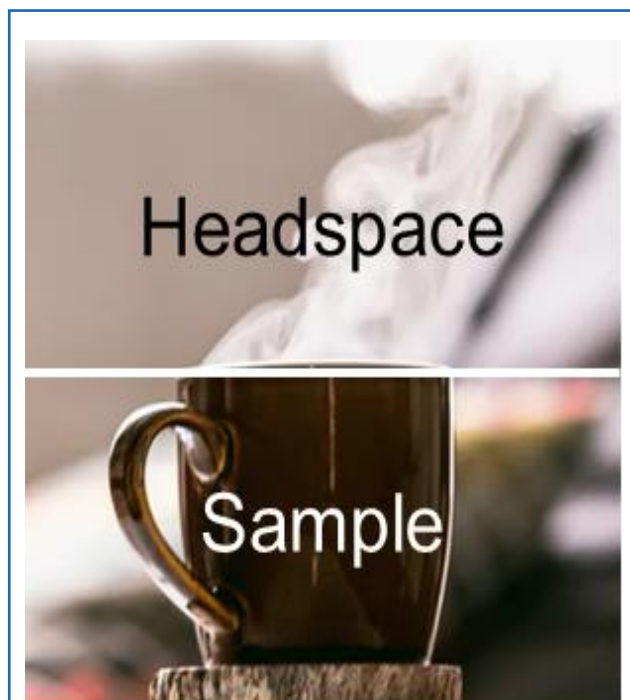


Figure 1: Coffee headspace. *Third party image reproduced with permission of the owner.*

The type of substance

How a substance smells depends on the chemicals that it releases into the air. For example, esters can often smell fruity, while amines can often smell fishy. The number of molecules released can also change the quality of the odour. For instance, in low concentrations (when there are a small number of molecules in the air), skatole has a floral smell to most people, while in larger concentrations it smells like faeces.

Some substances can be perceived as having a stronger, or more intense, odour than others. This may be because they are more volatile (more of their molecules are released into the air) or because the olfactory system is better at detecting their molecules. Although it can be difficult to determine how easily the olfactory system can detect different odours, it is sometimes possible to measure the amount of target substance available as vapour using chemical analysis techniques. This information can then be used to direct detection dog training, as substances that naturally release less vapour may require more intensive training.

It is important to note that the same vapour may not smell the same, either in quality or intensity, to different individuals. This can be due to a range of factors such as genetic differences and past experience.

Mixtures

While a pure substance made of a single chemical will produce a pure vapour, many substances encountered in the real world are chemically complex mixtures and so will have complex odours, made up of a combination of many different molecules. Some of these molecules will be more volatile or more easily detected by the olfactory system than others.

For example, while chicken makes up a large part of a chicken curry, the spices it is cooked in, whilst a smaller part of the overall dish, make up the main odour of the curry. The strongest identifying odour of a substance is not necessarily the part that is the largest proportionally (chicken in the curry) but may instead be the part with the most volatile or detectable molecules (spices in the curry).

The amount and surface area of the substance

The amount of substance present can affect the number of molecules released into the air. This is because molecules evaporate from the surface of the substance. If the surface area is larger, more molecules will be released and the odour concentration will be higher. A larger surface area may be created if a sample is bigger

or more spread out, or if it has an uneven surface structure (e.g. it is textured, rough or granular – see **Figure 2**)¹.

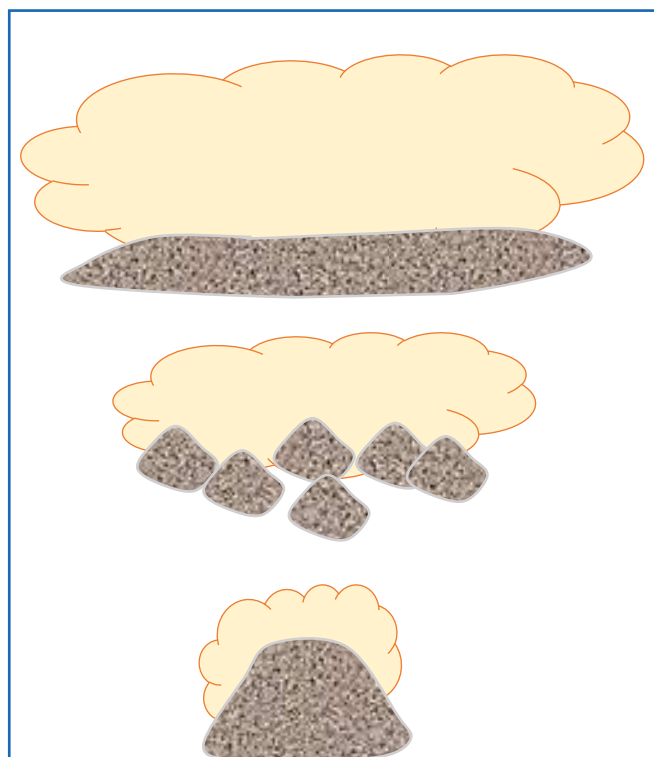


Figure 2: More odour will be released from the substance if it is spread out, as this increases the total surface area from which molecules can evaporate into the air¹.

The soak time and age of the substance

Some substances may undergo changes in their odour over time. Initially, the number of molecules released into the air builds up until a steady state of vapour release is reached (known as the equilibrium). As the more volatile components of a sample evaporate most easily, the total number of volatile components left in the sample, and therefore in the vapour, may then start to decrease over time. These changes can affect the odour, which is why it is important to vary the amount of time a training sample has been emplaced before the dog encounters it (the **soak time**).

Substances can also undergo physical and/or chemical degradation, changing the surface area and/or the types of chemicals that are released into the headspace over time. For example, milk has a mild sweet odour when fresh, but over time the odour changes and, once spoiled, milk has a distinctive rancid odour.

¹ Materials used in the training and deployment of detection dogs should be used in accordance with the instructions and safety information provided by the manufacturer, and in line with local rules and relevant legislation. It is not advised to diverge from any guidance (e.g. by breaking material up) without prior expert advice or manufacturer's approval. Note that explosives training samples should never be cut or otherwise divided or reshaped except by competent persons in an appropriately licenced explosives facility.

Contamination

When molecules are released from a substance as a vapour, they can then be adsorbed onto other nearby surfaces, causing contamination. Contamination can also occur by transfer through physical contact, either directly or indirectly (e.g. by handling two different substances). A contaminated substance can then release both its own molecules and the transferred molecules, potentially changing its odour. For example, perfume molecules may transfer from a person to a training sample, changing the target odour to include the smell of the perfume. If dogs are then trained on the sample, they may learn to detect the smell of the perfume rather than the target odour. For further information on how substances can become contaminated and measures to prevent contamination, see the guidance note: 'Why and how to control contamination' [2].

Packaging

The packaging of a substance impacts on the amount of odour available to detect. Packaging can act as a barrier that prevents some or all of the molecules from passing through. Molecules may escape through any openings or perforations in the barrier material. For example, blue cheese may not smell strongly in the supermarket because its packaging prevents molecules from being released into the air. However, once the packaging around the blue cheese is removed, the molecules are released, and can be detected as a strong blue cheese odour.

Different types of packaging will allow different amounts of molecules to pass through into the air. Factors which affect the number of molecules that pass through packaging include the type of material (its absorbency and permeability), the number of layers, the integrity of those layers, the seal, and how long the substance has been inside the packaging.

Temperature

Temperature affects the rate at which molecules evaporate and are released by substances. Both the temperature of the substance and the temperature of the environment can have an impact. At higher temperatures, a substance releases molecules at a greater rate, creating a stronger headspace. For example, a freshly made, hot cup of coffee will have a stronger odour that can be smelled from further away than a cold cup of coffee.

Air movement

The spread of molecules released from a substance is affected by the movement of the air around it. Where there is little air flow, such as in confined spaces, the molecules will build up around the substance until they fill the space. While a space that is filled with an odour can help dogs to detect that the odour is present, they

may have difficulty pinpointing where odour is coming from. This is because there is no longer a greater concentration of odour closer to the target which they can use to locate it.

If there is air flow, it will tend to carry molecules further away from the substance. As the odour molecules mix with the surrounding air, they will form an increasingly spread-out odour plume, reducing the concentration of the odour as the distance increases. This will provide a concentration gradient, allowing the dog to locate the source of the odour (where the concentration will normally be strongest).

Note however, that as air flow is usually turbulent, molecules may actually be dispersed as clouds or whisps, creating pockets of different odour concentrations, rather than a smooth concentration gradient (**Figure 3**). In some cases, air flow can move the highest concentration of molecules away from the substance itself, which could result in a dog indicating in an unexpected location away from the substance.

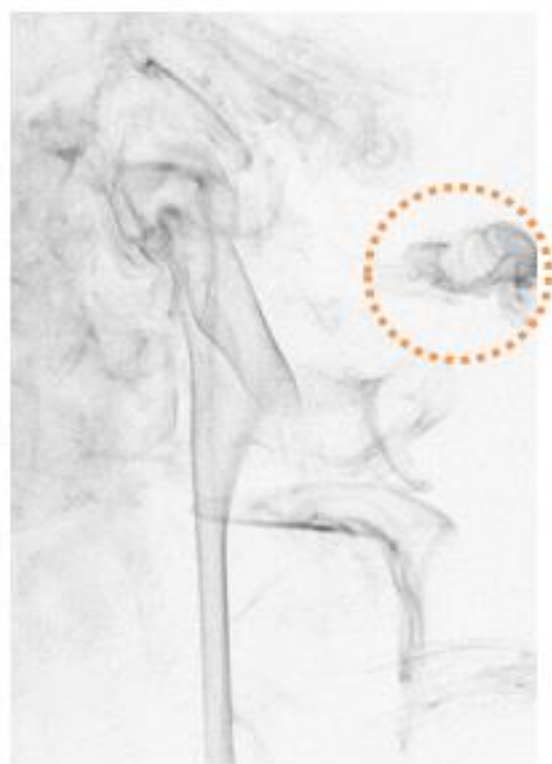


Figure 3. Molecules moving in turbulent air can create concentrated whisps (e.g. circled in orange) of odour away from the substance.

Air flow in buildings can be affected by factors including the construction and layout, air conditioning or heating, open windows or doors, draughts, the presence of electrical equipment, or the presence and movement of people. Outdoors, the air flow can be affected by weather conditions and geographical features.

Differences in air flow may require handlers to adapt their search pattern to ensure that dogs have the best opportunity to search effectively. For example, giving dogs the opportunity to search into the wind will allow the air flow to carry molecules towards them, increasing their likelihood of detection.

Masking odours

Odours of other substances within the search environment may mask target odours, making the target substance more difficult to detect.

Masking odours may be:

- Strong odours that cover weaker target odours.
- Eliminating odours that stop target odours from being detected.
- Distracting odours that cause the dog to miss or ignore target odours.

It is important to ensure that training sessions cover a wide range of background environmental odours, and that interferent odours are used, so that dogs can learn to ignore the presence of non-target odours. For further information on how to use non-target odours during training, see the guidance note: 'Using blanks and interferents to ensure effective detection dog training' [3].

Top tips

- ✓ Ensure detection dog handlers have a basic understanding of the main principles of odour (covered in this guidance note) to optimise their operational effectiveness.
- ✓ Dogs may require more intense and regular training on substances if they release fewer molecules into the air (have lower volatility) or if the molecules are not detected as well by the dog's olfactory system.
- ✓ Training dogs on different samples of a training substance (e.g. different batches, sample sizes and ages, in different packaging) will help them to generalise their responses [1].
- ✓ It is important to have good contamination control in place [2].
- ✓ Dogs may show interest or indicate in an unexpected location away from the target if the odour is stronger there (e.g. as a result of local air movement effects).
- ✓ Handlers may need to adapt their search to the environment, as it may affect odour availability (e.g. due to air flow).
- ✓ Include interferents and different environmental odours during training sessions so that dogs learn to ignore potentially masking odours [3].

Associated guides and information

- [1] How to train your dog to generalise across varying types and sizes of targets
DSTL/PUB89074
www.cpni.gov.uk/canine-detection-guidancenotes
- [2] Why and how to control contamination
DSTL/PUB89644
www.cpni.gov.uk/canine-detection-guidancenotes
- [3] Using blanks and interferents to ensure effective detection dog training DSTL/PUB111065
www.cpni.gov.uk/canine-detection-guidancenotes

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Use of concealments in detection dog training

What is this note about?

It is essential that detection dog teams are capable of detecting target materials that are 'concealed' – i.e. are hidden from view and/or have limited available odour. This note provides guidance on the optimal use of concealments for detection dog training. The note defines what a concealment is, considerations for using concealments, and examples of different types of concealment.

Who is this note relevant for?

All dog handlers or instructors training and deploying detection dogs.

Introduction

Detection dogs should be challenged at regular intervals to ensure the capability of the dog/handler team continues to develop following initial training. It is also important to ensure that training enables dogs to correctly identify target substances that are hidden in a wide range of different ways and in different scenarios.

Using concealments in training can not only make training more operationally relevant, but also develop a dog's ability to identify different concentrations of a target odour [1]. For example, a well-concealed target substance may release a level of odour that is similar to a less well concealed, smaller quantity of the same target substance [2].

Concealments can also be used to challenge handler perceptions as well as dog detection capability. This may include the use of 'Trojan' everyday objects to conceal the target 'in plain sight' or the use of obscure locations (Figure 1).



Use of concealments in training – if done correctly – can increase detection capability, develop the handler's ability to interpret their dog's behaviour, and build handler understanding of their dog's ability.

Specific concealments may be required depending on the operational role and area of deployment of the dog/handler team. Examples include:

- Teams working in an airport environment may be expected to screen large volumes of bags/suitcases.
- Teams working in a fast parcel or cargo setting may be expected to search envelopes, packages and boxes.
- Teams working in a commercial office environment may be expected to search filing cabinets and desk drawers routinely.

What is a concealment?

A concealment is any object or material which impacts on the ease of identifying the target for the dog/handler team. Concealments can be visual (with no impact on odour availability) or a combination of both visual and odour-concealing.

In the real-world, concealments may be used by perpetrators for a variety of reasons, two of which are key to detection dog teams:

1. To reduce the likelihood of the item being discovered through physical search (likely to focus on visual concealment).
2. To reduce the likelihood of a detection dog indicating on the presence of the target odour (likely to be a mix of visual and odour concealment).

In some cases, a concealment may simply involve hiding the target substance within an item in the environment. For example, placing the target substance within a desk drawer removes it from view, therefore conceals the item.

Whilst visual concealments should be utilised in training to challenge handler perceptions, dog training should primarily focus on odour concealment, or a combination of both visual and odour concealment.

Concealment considerations

There are a number of key factors that should be considered when identifying a concealment for use in detection dog training.

Where will the sample be concealed?

Using a concealment does not necessarily involve adding anything to the search environment other than hiding the target substance somewhere appropriate. The chosen training environment is likely to include various potential concealment locations, either in its structure (e.g. built-in cupboards, service hatches, suspended ceilings), or in typical objects already present (e.g. in desk drawers, bins, under seats, in cars). Another option is to add suitable concealments to the training environment (e.g. bags, boxes, items of furniture), but care should be taken to ensure that these don't appear to be out of the ordinary and hence obviously a hide location. Consideration should also be given to how challenging the concealment is intended to be to find.

What material(s) is the concealment made of?

The material(s) the concealment is made of will affect the amount of time it takes for odour to be released, and the amount of odour that is available for the dog to detect. In training, this may require the soak time to be adjusted to allow sufficient odour to be released.

How does the concealment affect odour release?

In addition to the choice of material, the design and construction of the concealment will affect the release of odour, therefore altering its 'difficulty'. A 'difficult' concealment may result in the dog showing signs of 'interest' rather than giving a full 'indication' [3].

Does the concealment itself have a strong odour?

If the concealment has its own strong odour, this may mask the target odour. Again, this may result in 'interest'. In addition, the concealment may contaminate the training sample with its own odour, making the target sample unsuitable for use in future training sessions [4].

Are you testing the dog or the handler? Or both?

It is important to conduct training 'blind' to prevent unintentional cues. For further information, refer to guidance notes relating to double-blind training [5] and maintaining performance [6]. However, it may not be possible to prevent the handler knowing the concealment type in every training scenario, especially where the primary focus is training and testing the dog.

For example, when training dogs to indicate concealment of a training sample in different types of luggage, then one stage of training may include groups of bags in a non-operational environment. In this type of training, the handler is likely to be aware that the target is concealed within the baggage rather than elsewhere in the room. However, in future training and testing phases (e.g. operationally-realistic area searches) the handler should not know the concealment type/location, as the training sample can be concealed anywhere within the environment.

As well as testing the dog's detection capability, some concealments may be used to develop the handler's ability to interpret their dog's behaviour. For example, obscure hide placements or unusual concealments can be used to ensure the whole area is searched, with the handler correctly tasking the dog and interpreting signs of 'interest', even if there does not appear to be an obvious target present.

The majority of training scenarios should be designed to test both the dog and handler, to develop the capability of the team to detect training samples in a range of concealments.

Introducing concealments in training

It is important to consider the dog's previous training experiences and current capability prior to introducing concealments to training sessions. This allows identification of realistic expectations for all involved.

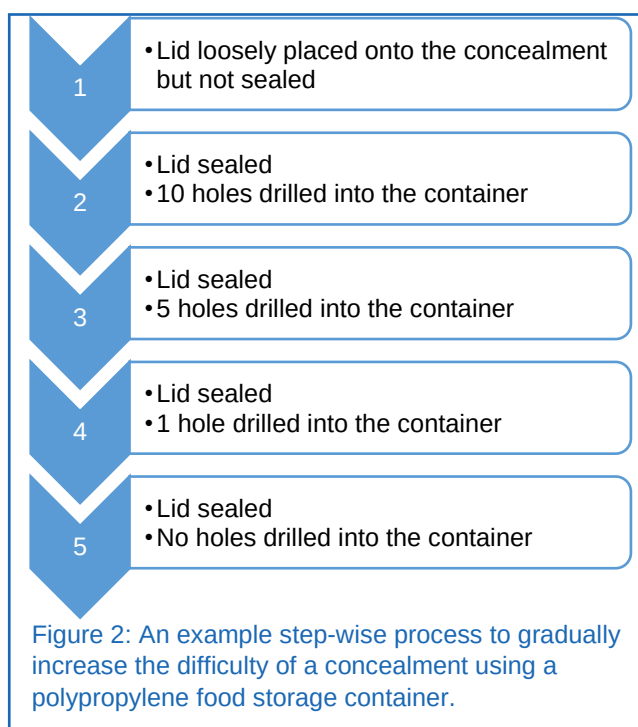
Examples of concealments

Concealments are often everyday items, available to purchase from shops or online suppliers, with uses not specific to dog training. Examples include:

- Polypropylene food storage containers.
- Envelopes (paper or bubble-lined).
- Cardboard boxes.
- Bags and suitcases.
- 'Trojan' hides (items that look like everyday items but have an internal space for concealments e.g. key storage stones;

Figure 1).

Concealments which appear 'simple' or 'easy' to humans may be much more complex for dogs to detect – and vice versa – so it is important to recognise when a concealment is too difficult, and alter training plans accordingly. This may involve returning to – and reinforcing – a previously successful training step or modifying the concealment to make it easier to detect in order to allow the dog's capability and/or confidence to increase. An example of how to gradually increase the complexity of a concealment utilising a polypropylene food storage box is shown in **Figure 2**.



It is important to recognise throughout training and testing whether an apparent lack of detection capability is due to the dog or the handler. Examples include:

- If the dog has encountered the concealment and not exhibited any behavioural change, then it is likely the dog requires further training on the concealment, potentially returning to a previously successful level of concealment. This is also an opportunity to educate the handler, to ensure they are aware of the nature and appearance of potential concealments, in case the odour release is not sufficient for the dog to detect the target substance in an operational search.
- If the dog has exhibited a behavioural change but the handler has not correctly identified it, then the handler may require further training to understand their dog's behaviour.
- If the dog has not encountered the concealment, it may be because the handler did not identify that the area had been missed, or the dog did not adequately search the whole area.

Identifying which reason(s) may have prevented the concealment being successfully detected is important, and can be achieved through communication between the handler and instructor as well as use of effective training records [7]. This allows future training to be appropriately focused to develop the team's capability.

It is also important to consider the quantity of training sample that the dog has previously been exposed to, as training on varied quantities can aid detection of concealed target substances as detailed in the generalisation guidance note [1].

Use of blanks

In all training and testing sessions, it is important to make sure 'blank' concealments are also included, to ensure the dog is indicating on the odour of the training sample and not the concealment item itself [8]. If the concealment has been modified to aid training, the blank concealment should also be modified (e.g. drilling holes, using an alternative seal). Blanks must be sourced from the same supplier, and be stored separately.

Concealment safety and security

Placement of targets within concealments, and subsequent emplacement of concealments within the search scenario, must avoid environmental contamination (e.g. grit, dirt, chemicals, or moisture). For explosives samples, sources of heat, ignition, and spark must also be avoided. This is important to ensure the safety of personnel and dogs within the search area, and to protect the target material from damage.

Selection of suitable concealments must ensure the target material is compatible with the concealment material and sealing mechanism. Care must be taken to prevent the target material becoming caught in the sealing mechanism (e.g. screw-thread or press-fit), and these aspects should be considered before a concealment approach is used. It is also important to ensure the concealment is not altered in any way whilst the sample is inside (e.g. drilling holes or applying pressure to alter the shape of the concealment).

The security of target samples is particularly pertinent when using concealments in detection dog training. Some concealments may be left in public view (e.g. bags, suitcases or 'Trojan' hides) and it is important that these are managed to avoid public interference leading to samples being lost, stolen, or displaced, or risk to individuals. Methods to ensure security is maintained include the use of personnel with eyes-on, GPS trackers, remote viewing through camera or video equipment, and keeping detailed hide records or maps to show concealment locations.

Contamination control

Contamination control is particularly important when using concealments. This helps to ensure the dog is detecting the target within the concealment rather than trace contamination of the target odour on the exterior of the concealment. Further information is available in the contamination control guidance note [4].

Barrier materials should also be used to prevent environmental contamination of the training sample and/or concealment. Gloves should be used to assemble and emplace concealments to avoid contamination, and clean gloves used to emplace other items and create environmental disturbance. Care should be taken to avoid placing concealments too near to odorous substances, to ensure the target sample remains representative of the required odour and does not get contaminated.

To prevent cross-contamination of odour, the same concealment item must not be used for different target substances. Concealments should either be disposable or clearly labelled to ensure they are not accidentally mixed up. If concealments are stored for repeated use, they should be packaged appropriately to prevent odour transfer causing cross-contamination during storage (e.g. four suitcases used for four different training samples should not be placed in the same store cupboard without additional packaging). The target substance should be removed from the concealment and stored in its original packaging between training sessions.

Top tips for using concealments in detection dog training

- ✓ Clearly define the aim of the training session in order to identify a suitable type and level of concealment.
- ✓ During training searches, ensure that blank concealments are always used to prevent the dog from learning to indicate on the concealment item itself, or any disturbance from placing the concealment.

- ✓ Use concealments to develop and stretch detection dog capability, but be prepared to reduce the complexity and/or consider alternative approaches if the dog does not succeed.
- ✓ Ensure that protocols are followed to maintain the security of training samples, particularly when they are deployed in concealments.
- ✓ Follow contamination control protocols to ensure the training sample does not get damaged, and to ensure the concealment remains fit for purpose.

Associated guides and information

- [1] How to train your dog to generalise across varying types and sizes of targets. DSTL/PUB89074
www.cpni.gov.uk/canine-detection-guidance-notes
- [2] An introduction to odour. DSTL/PUB127874
www.cpni.gov.uk/canine-detection-guidance-notes
- [3] Understanding detection dog indications. DSTL/PUB127861
www.cpni.gov.uk/canine-detection-guidance-notes
- [4] Why and how to control contamination. DSTL/PUB89644
www.cpni.gov.uk/canine-detection-guidance-notes
- [5] Why you should train and test detection dogs 'double blind'. DSTL/PUB104178
www.cpni.gov.uk/canine-detection-guidance-notes
- [6] Maintaining the operational performance of detection dogs. DSTL/PUB104771
www.cpni.gov.uk/canine-detection-guidance-notes
- [7] Using training records to ensure effective detection dog training. DSTL/PUB124176
www.cpni.gov.uk/canine-detection-guidance-notes
- [8] Use of blanks and interferents to ensure effective detection dog training. DSTL/PUB111065
www.cpni.gov.uk/canine-detection-guidance-notes

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Using blanks and interferents to ensure effective detection dog training

What is this note about?

This note provides guidance on how to maximise training efficiency and operational effectiveness through the appropriate use of blanks (non-target odours related to the training sample) and interferents (other non-target odours).

Who is this note relevant for?

All dog handlers or instructors training and deploying detection dogs.

Why use blanks and interferents?

Training samples for detection dogs should always contain the target odour of interest (e.g. explosives, drugs, firearms). However, many will also contain other non-target background odours relating to the preparation, packaging, handling and storage of the samples. Selecting high quality training samples and using good contamination control practices will help to minimise these unwanted background odours [1, 2], but it is almost impossible to avoid them entirely. When conducting any form of detection dog training, it is therefore vital to ensure the dog learns to reliably detect the target odour rather than any background/contaminant odours that might be associated with the samples.

Dogs will also encounter a wide range of other background odours in the environment when searching, some of which the dog may find particularly interesting. It is important that the dog does not indicate on non-target odours and is not overly distracted by them.

For these reasons, it is important to train regularly and effectively using 'blanks' and 'interferents' alongside training samples. Doing so:

- Helps ensure that the dog can reliably detect and indicate the target odour, and is not indicating only on packaging and/or other background odours associated with it (i.e. ensures your dog has a genuine detection capability). This is particularly important for low-odour targets.
- Ensures that the dog learns to ignore common non-target odours, therefore minimising the risk of false indications during operational searches (which are often costly and time consuming to resolve).

What are blanks?

Blanks are specifically designed to match the non-target background odours present on training samples. Blanks should be identical to the training sample in terms of the packaging and preparation process, but must not contain the training sample substance or any odour contamination from it.

Examples of training samples and their equivalent blanks are shown in Figure 1. The aim is to train the dog to indicate reliably on the training samples and not indicate on the blanks, therefore ensuring the dog is focusing on detection of the target odour substance only.

Use of blanks is particularly important:

- For low odour target substances, where other background odours may dominate.
- Where the target odour is on some sort of inert material (e.g. explosives on a filter paper), in which case separate uncontaminated samples of the inert material (filter paper in this example) should be used as blanks.



What are interferents?

Interferents (also known as distractors) are a range of other non-target odours that are likely to be encountered by dogs in training and/or operational environments. It is important to use a range of strong and weak interferent odours during training, to ensure the dog is adequately prepared to encounter (and correctly ignore) the wide range of distracting non-target odours of different types and strengths that they may encounter operationally. The aim is to train the dog to indicate reliably on the training samples and not indicate on the interferents.

Care should be taken to read the instructions and hazard warnings for any household chemicals that are used as interferents, to ensure they are presented safely (e.g. small quantities soaked onto a swab and contained in a manner to minimise risk of the dog accidentally ingesting it).

Examples of interferents (not an exhaustive or mandatory list):

'Strong' odours	'Weak' odours
Nitrile gloves	Handler odour (e.g. clothes)
Tennis ball/toy	Plastic bags
Odour of other dogs (e.g. bedding)	Plastic containers
Aftershave/perfume	Paper
Soap	Cotton wool
Hand wash	Sticky tape
Shower gel	Paper clips
Hand sanitiser alcohol gel	Soil
Deodorant	Sand
Baby wipes	Gravel
Shoe polish	Wood/MDF/chipboard
Bread	Filter papers
Herbs and spices	Elastic bands
Chewing gum	Cling film
Coffee	Tin foil
Tea	Fabric
Dishwasher tablets	Dish sponge
Washing powder	Uncooked pasta
Air freshener	Rice
Cleaning wipes	Leaves

It is important to use a wide variety of 'low odour' and 'high odour' substances as interferents. These should be stored in separate containers (to avoid cross contamination) and replaced regularly with both fresh samples and different odours (at least once every three months and more regularly if possible).

It is important to include interferent odours that are generally related to the preparation of the training

samples (e.g. clean gloves of the type used to handle samples), as well as odours that the dogs might closely associate with the training environment (e.g. tennis ball odour, handler/instructor odour).

How to introduce blanks and interferents during odour learning/recognition training

The following example of a training process can take place within a stand-based system such as the canine odour identification test (Figure 2) [3]. It may be necessary to conduct this training over several sessions/days depending on the needs of the individual dog and difficulty of target odour detection.

1. Train the dog to reliably detect the target odour

Over several short sessions, build the dog's association of the training sample with a reward. Do not use interferents or blanks at this stage. Use fast rewards or a 'bridge' (e.g. clicker) to reward any initial interest on the target odour. Once the dog is showing strong interest, encourage the dog to indicate if they do not do this of their own accord. Repeat until the dog can reliably indicate the target odour in a range of positions without assistance.

2. Introduce a blank once target odour recognition is established

Introduce the blank at least 1m away from the training sample to ensure their odours are kept separate. The dog may 'false alarm' on the blank at first and should be allowed to come away from the blank by itself and move back towards the training sample to then receive a reward. Continue this process, varying the position of the training sample and blank, until the dog is reliably indicating on the training sample and not on the blank. Conduct further training with the handler 'blind' (i.e. they do not know the location of the training sample so cannot inadvertently influence the dog).

3. Introduce additional blanks and a range of interferents

To ensure the dog has developed a reliable detection capability, training should continue (handler blind) with additional blanks and interferents present, in a range of positions. With repetition, the dog should learn to reliably indicate the target odour and ignore the blanks and interferents.

4. Expand search scenarios

Once the dog is performing as required in an odour identification test scenario, more realistic search scenarios can be conducted using training samples, blanks and interferents.

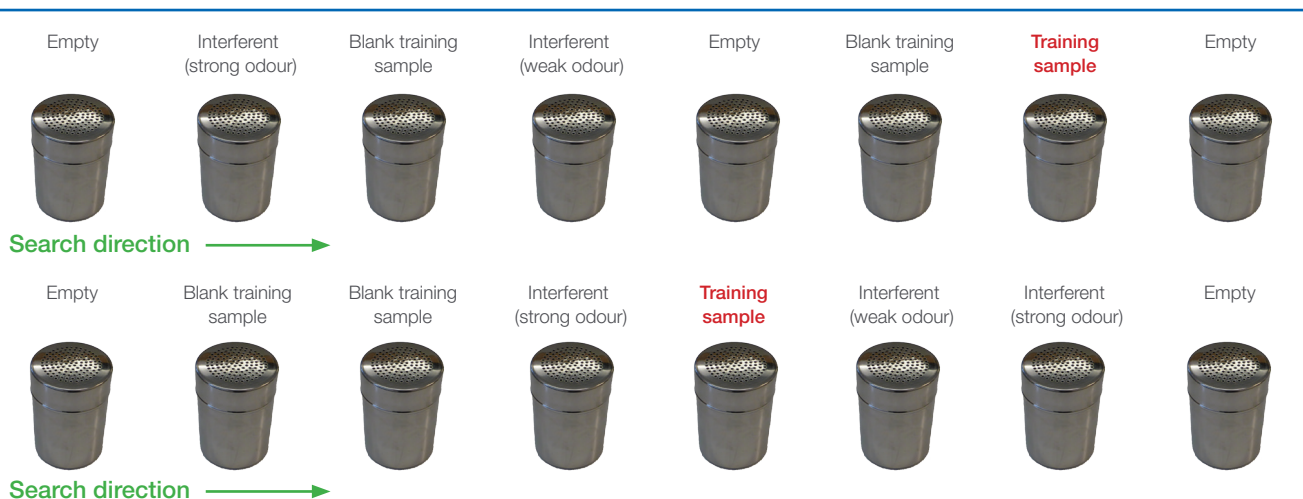


Figure 2: Two examples of odour identification test setups containing target, blank and interferent hides (N.B. the pots should be spaced more widely than illustrated above). The position of the samples should be varied with each run.

Placing out blanks and interferents during search training

Adding blank and interferent items to a search environment is important because it introduces trainer/instructor odours and disturbance to the venue in addition to the positive target odour. Some blanks or interferents should be concealed in a similar manner to the target odour. For example, if the target odour is concealed in a rucksack in a cupboard, it is good practice to include at least one blank or interferent concealed in a similar rucksack in a different, but similar, cupboard. An example of a realistic search setup using training samples, interferents and blanks is shown in Figure 3.

Environmental disturbance

In addition to placing out blanks and interferents, it is good practice for the instructor/trainer/assessor to add additional disturbance to the search area prior to training or assessment. This should involve touching or disturbing items already in the search area such as branches, stones, doorknobs, cupboards, chairs etc., to add additional human odour and footsteps. This is to ensure the dog learns to search for the target odour rather than relying on following disturbance created by the person who put them out.

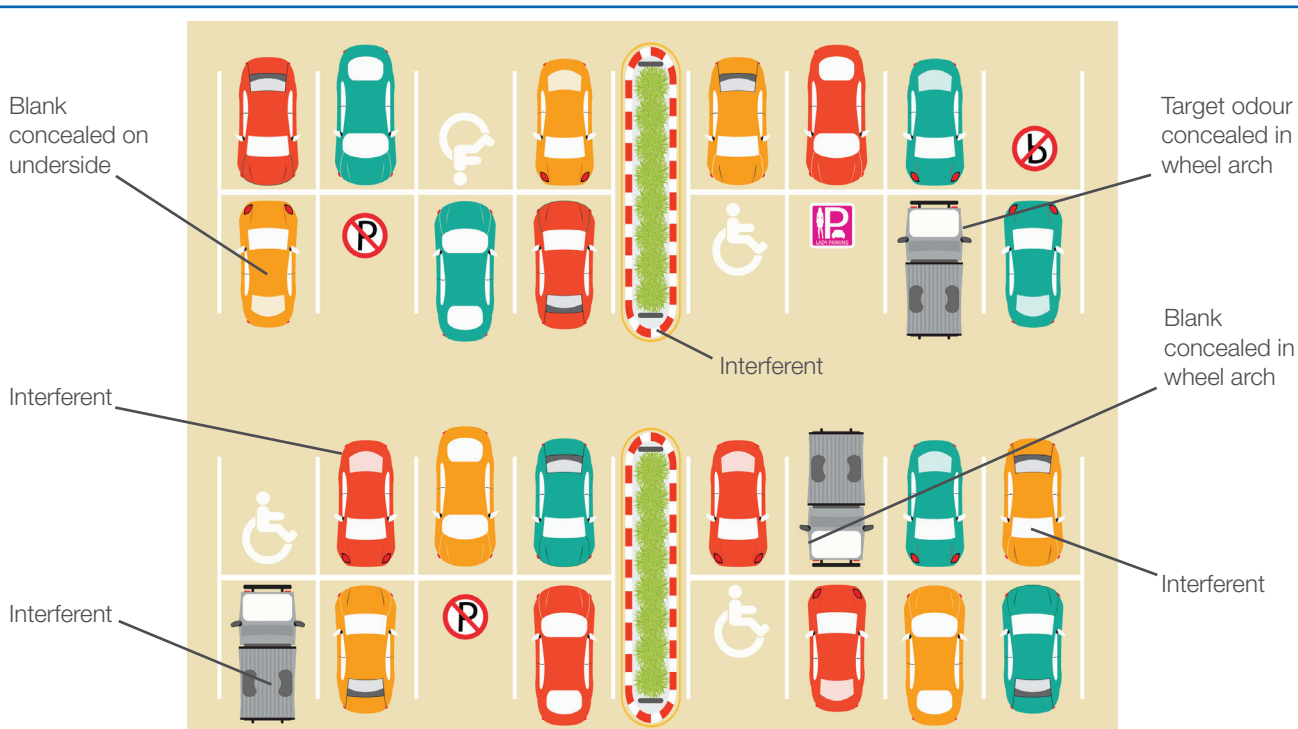


Figure 3: Example of a training search area containing target, blank and interferent hides.

Top tips for using blanks and interferents in training

- ✓ During training searches, ensure that some blanks and interferents are always used and that some are concealed in a similar manner to the training sample.
- ✓ Indications on blanks and interferents must never be rewarded. When the dog has been trained to reliably detect the target odour, there should be no or very few indications on the blank or interferents.
- ✓ Continually change the order in which blanks and interferents are encountered by the dog between each search and training session, to ensure the dog does not learn to expect a regular pattern.
- ✓ It is good practice to use some interferents that are often found in the training/operational environment, and some that are more unusual/out of place, so that the dog is less likely to indicate on odours because they are novel.
- ✓ As well as using blanks and interferents, ensure that additional human activity/disturbance is randomly added to a search area prior to training, to ensure that the dog does not learn to use this as a cue to locate the training samples.
- ✓ Minimise contamination as far as possible. Ensure that blanks and interferents never come into contact with the training samples. Do not store blanks and interferents with, or near to, the target odours. See the “Why and how to control contamination” guidance note for further information on contamination control. [1]
- ✓ Interferents should be replaced with different items regularly to ensure that dogs encounter a wide variety and the interferent samples do not begin to adopt a ‘corporate odour’ or cross-contaminate each other.

Associated guides and Information

- [1] Why and how to control contamination DSTL/ PUB89644
www.cpni.gov.uk/canine-detection-guidance-notes
- [2] Are your training samples giving you the capability you expect? DSTL/PUB104179
www.cpni.gov.uk/canine-detection-guidance-notes
- [3] Canine Odour Discrimination Test DSTL/ PUB89074
www.cpni.gov.uk/canine-detection-guidance-notes

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How to produce and use odour soaks as part of an effective detection dog training programme

What is this note about?

This note provides guidance on how to produce, store, use and dispose of odour 'soaks'. The note focuses primarily on producing effective explosives odour soaks, but the general principles can also be applied to other target materials. Soaks can be a useful tool to assist continuation training, particularly when the use of explosive samples is impractical for logistical, safety or contamination control reasons. However, in order to be effective, soaks must be produced in a way that ensures appropriate odours are captured on them.

Who is this note relevant for?

All dog handlers or instructors training and deploying detection dogs and any personnel involved in soak production.

Introduction

A soak is a training sample that has been made by exposing an absorbent material (called a soak matrix) next to, but not in direct contact with, a training sample such as an explosive, within a sealed container. The matrix becomes impregnated with the odour of the explosive and can therefore be used on its own as a training aid without the safety, logistical or contamination control issues associated with using actual explosive samples.

It is important to note that soaks may not replicate the full odour of the original explosive sample and are therefore not recommended for initial training or as the main component of continuation training. Soaks instead provide a convenient means of carrying out continuation training when the use of bulk explosives is impractical (e.g. training in an operational environment). These training aids also provide an opportunity for the dogs to search for a small/different odour plume, making them an effective part of a training aid suite to encourage generalisation [1]. Whenever soaks are used during training, it is essential to also place out 'blank' soaks (clean, uncontaminated samples of the matrix material) to ensure the dog learns to ignore any background contaminant odours arising from the manufacture, storage, and/or handling of the soaks. Further information about the production and use of blanks is available in a separate guidance note [2].

Soaks can theoretically be produced using any explosive sample (or other target material), though they are likely to be more appropriate for those that produce stronger odours.

Recommended materials/resources

- Explosive samples (approx. 5g of each – it is recommended these are sourced pre-cut from the explosives supplier)
- Matrix materials:
 - Recommended: laboratory-grade glass microfibre or cellulose filters (25mm diameter recommended)
 - Alternative: clean blank paper (approx. 25mm to 40mm diameter pieces recommended)
- Airtight glass jars with clamp-type lids (not screw threaded) and silicone seals
- Clean, small glass vials that fit easily inside the airtight jars
- Clean, disposable nitrile or polyethylene gloves
- Clean forceps (stainless steel or disposable)
- Clean worktop barrier (e.g. laboratory benchtop protection paper from laboratory suppliers or other clean paper sheets)
- Odour-proof sealable foil bags (available from laboratory suppliers)
- Secure, uncontaminated area to conduct soak production
- Storage and processing area/s that comply with the Explosives Regulations and any local requirements.

Preparation

The recommended materials for the soak matrices are glass microfibre or cellulose filters sourced from laboratory suppliers (25mm diameter is recommended). Laboratory-grade products are most suited to dog training as they are designed to have minimal contaminants and undergo strict quality control measures to ensure consistency between batches. If sourcing these products is difficult, clean blank paper (e.g. printer paper) can be used instead (approximately 25mm to 40mm diameter pieces recommended). When producing the soaks, airtight glass jars with clamp-type lids and silicone seals are recommended to ensure the explosives odour is contained within the jar to allow maximum uptake by the soak matrix. Glass containers should be used to minimise the potential for odours to be transferred between containers. For safety reasons, explosives should not be put in containers with screw-threaded lids.

It is recommended that small (e.g. 5g) samples of explosives are used, to make it easy to 'soak' the matrix material with the explosives in an airtight jar, without direct contact. It is easiest to source these small explosive samples pre-cut from the supplier (note that any dividing/cutting of explosives is considered explosives processing and requires appropriate licences, approvals and training to be in place).

Soaks should be made in a clean, uncluttered environment that contains as few noticeable background odours as possible.

Both the blank and explosives soaks should be made by the same person, on the same day, in the same environment with the blanks being made first. Blanks must not be prepared whilst wearing clothes that have been worn to handle explosives. The area chosen for preparation should not be contaminated with explosives to prevent the blank soaks absorbing background explosives odour. Members of staff making soaks should wear clean clothes (suitable for wearing when handling explosives) and avoid wearing any strong odour products e.g. perfume or aftershave. Identical soaks can be produced in batches at the same time; numbers per jar will vary depending on size of soak matrix and jar used.

Production protocol

1. Surfaces should be wiped down with clean water and dried before commencing work. Place new clean barrier material (e.g. laboratory benchtop protection paper) on the work surfaces.
2. Starting with the blanks, using new/uncontaminated forceps and wearing clean gloves, place the pieces of soak matrix around the edge of the inside of the airtight jar, making sure none of the pieces of matrix material are touching.
3. Once all the space around the edge of the jar has been filled by the pieces of matrix, place an empty glass vial (with no lid) in the centre of the airtight jar.
4. Close and secure the lid of the jar to prevent any new odours entering (as shown in [Figure 1b](#)).
5. Continue this process (using multiple airtight jars if necessary) until the required number of blanks have been emplaced.
6. Leave the jars in the room but away from the preparation area of the explosives soaks (e.g. on separate, identical tables spaced at least 2m apart).
7. Next, to produce the explosives soaks, change gloves and use the same method as steps 1 and 2 to place the pieces of soak matrix around the edge of an identical airtight glass jar(s).
8. Unpack the explosive sample(s) (one for each airtight jar of explosives soaks). Particular care should be paid to odour contamination control when handling the explosive samples (see separate guidance note [3]).
9. Using clean forceps, put each explosive sample into a small open glass vial (as shown in [Figure 1c](#)). Do not put a lid on the glass vial.
10. Place the glass vial into the centre of the airtight jar before closing and sealing it ([Figure 1d](#)). By placing the sample in the vial you eliminate the possibility of the pieces of matrix material coming into direct contact with the explosive sample.
11. Once the jars have been sealed, leave to soak, ideally for at least 24 hours at room temperature. Longer periods may be required for low-odour explosives and/or colder temperatures (if dogs consistently fail to detect the soaks, try longer soak times).

12. Following the completion of the soak period, open the jar/s containing the blank soaks first. Using clean forceps, place the blank soaks into an odour-proof bag (e.g. foil bag), seal tightly and label. Be careful that the odour-proof bag is not overfilled with blank soaks to ensure that the seal remains secure. Several bags can be used for large batches. Seal the empty blank jars again before opening the explosives soak jars to prevent cross-contamination.
13. Using forceps, place individual explosives soaks into the odour-proof bags. Use of small, individual foil bags (e.g. 70mm x 100mm) for each explosives soak is recommended, to preserve the odour of each individual soak until ready for use. Seal and label the odour-proof bags using the same method and materials as in step 12.
14. If more soaks are required using the same explosive sample, then the jars can be sealed and re-used. If soaks are required for different explosive targets, it is best practice to only ever use each jar and glass vial for just one particular type of explosive, and label it appropriately.
15. Jars and glass vials should be washed after completion of soak production, using a non-perfumed detergent, rinsed thoroughly with hot water and left to dry. Blank soak jars/vials should be washed first and water should be refreshed between explosive types. The same detergent brand should be used for washing blank and explosives soak jars/vials to ensure that the dog does not learn to indicate on the detergent odour.

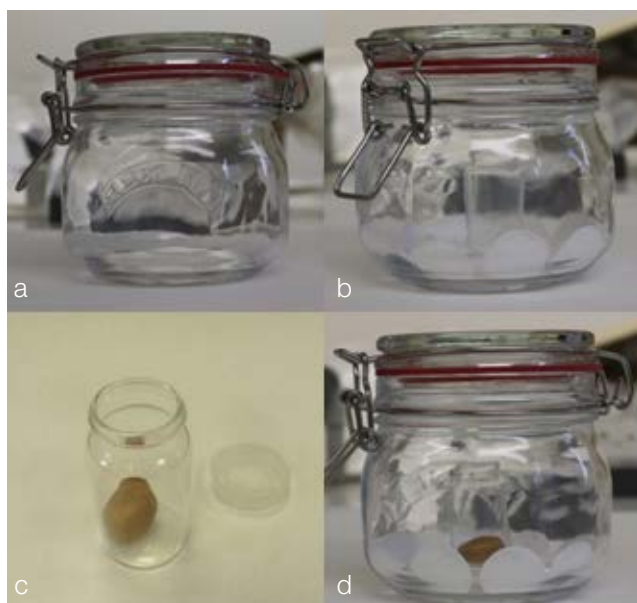


Figure 1: a. airtight jar with clamp type lid and silicone seal; b. blank jar containing no explosive sample (step 4, above); c. 5g explosive sample in glass vial (step 9); d. 5g explosive sample and glass fibre filters (note - not in direct contact) (step 10).

Storage and transport

- In order to avoid the soak matrix materials becoming tainted with unwanted odours prior to preparation, they must be stored in their original packaging in an environment where there are no strong background odours.
- Once prepared, storage and transport of odour soaks does not fall under the storage and transport of explosives regulations, providing there is only explosives odour on the material (i.e. no actual explosive present).
- Explosives and blank soaks may be stored in different environments as long as the packaging is tightly sealed. It is best practice to store them in a cool, dry place, out of direct sunlight.
- Soaks should be kept in their production packaging until they are ready to be used for training.
- As a guide, soaks should be used as soon as possible, and within 2 weeks of production. The exact shelf-life can be adjusted if required depending on how easily dogs detect them.
- If any soaks are thought to have been inadvertently contaminated, all soaks from the same jar/package must be disposed of and new soaks made.

Contamination control in the training environment

- Providing that the pieces of matrix do not come into contact with the explosive, the soaks produced have a low chance of contaminating the training environment. However, the potential for environmental contamination should be considered when concealing soaks for training purposes. Soaks produced from NG and EGDN-based explosives in particular can cause significant odour contamination.
 - A barrier (e.g. paper) should be placed between the soak and the environment to reduce potential for accidental environmental contamination.
- If the matrix material comes into direct contact with the explosive it becomes contaminated with explosive particles. Soaks produced in this way are likely to be inconsistent as training aids and are highly likely to cause long-term contamination of training venues due to the transfer of these explosive particles. *The production and use of soaks through direct contact with explosives is therefore not recommended.*
- Separate blank and explosives soak forceps must be used to handle soaks when placing them out in the training environment, and these should be kept apart from each other at all times. New plastic (or carefully washed stainless steel) forceps should be used each session.

Training using soaks

It is important to keep in mind that soaks may not fully represent the odour of real explosives. Therefore, real explosive samples (not soaks) should be used during:

- Initial odour learning.
- Licensing and accreditation activities to assess odour recognition.
- The majority of continuation training.

Soaks can be used for a proportion of continuation training including stand-based (odour ID) and all standard conventional searches. The following guidelines should be followed:

- Each soak should be used for up to 2 hours then discarded, or earlier if there is evidence dogs are consistently failing to detect them.
- Blank soaks must always be put out during soak training. This ensures the dog learns to detect the target odour only and ignore the blank matrix material (or any odour contamination arising from the preparation process).
- All soaks should be fully concealed so that dogs cannot see them.
- Dogs should be rewarded for correct indications on explosives soaks using the dog's standard rewarding technique and frequency. All indications on blank soaks must not be rewarded.
- All soaks should be collected following completion of a search and disposed of correctly at the end of the day (see below).
- Minimise handling of soaks during training as much as possible. Change gloves in between handling blank and explosives soaks, and soaks of different explosive types.

Health and Safety

Explosives odour soaks, when prepared as detailed in this guidance note, should not contain any particulate explosive materials and should therefore not pose an explosive hazard. The matrix material should be handled in accordance with the instructions and safety information provided by the manufacturer. Once prepared, soaks should be handled using clean forceps to avoid contamination and while wearing suitable disposable gloves (conforming to EN374 class 3). Dogs should not be allowed to come into direct contact with soaks at any point, to avoid them inhaling or ingesting the matrix material.

Explosives Regulations and soak production:

It is important to note that the processing and storage of explosives during the soak period is subject to the Explosives Regulations, and complying with these is the responsibility of the individual establishments producing the soaks [4].

Any building used to produce soaks must also meet the general requirements for explosives security [5].

Seek expert advice if you are in any doubt as to whether your planned soak production methods will comply with legal requirements.

Disposal

- Never re-use an old soak. They should be disposed of after use and never returned to the production jar or soak packaging. This is because environmental contaminants picked up on the soak during use will contaminate the remaining soaks.
- Blank soaks can be disposed of in conventional refuse, following the manufacturer's disposal advice.
- To prevent contamination, explosives soaks should be treated using the same procedures as explosives contaminated waste, e.g. explosives soaks should be disposed of in the same way as gloves used to handle explosives training kits.

Associated Guides and Information

[1] How to train your dog to generalise across varying types and sizes of targets. Dstl/PUB89074. <https://www.cpni.gov.uk/canine-detection-guidance-notes>

[2] Using blanks and interferences to ensure effective detection dog training. Dstl/PUB111065. <https://www.cpni.gov.uk/canine-detection-guidance-notes>

[3] Why and how to control contamination. Dstl/PUB89664. <https://www.cpni.gov.uk/canine-detection-guidance-notes>

[4] HSE website – explosives health and safety <http://www.hse.gov.uk/explosives/index.htm>

[5] HSE website – explosives security <http://www.hse.gov.uk/explosives/licensing/storage/storage-security.htm>

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How to train your dog to generalise across varying types and sizes of targets

What is this note about?

This note provides guidance on how to train a dog to “generalise” to detect targets that are similar to, but not exactly the same as, their training samples. This is important because the targets they encounter operationally are unlikely to be exactly the same as those they have trained on – they may differ “quantitatively” (i.e. amount present) or “qualitatively” (e.g. due to age, storage, batch-to-batch variation, or variation between comparable products from different manufacturers).

Who is this note relevant for?

All dog handlers or instructors training and deploying detection dogs.

Stimulus generalisation theory

Stimulus generalisation theory refers to when an animal's learned response to one stimulus is transferred to a similar stimulus. For example:

- Birds trained to peck for food rewards in response to a specific colour of light, will also peck in response to different shades of that specific colour [1].
- ‘Pavlov’s dogs’: Following the sounding of a bell every time dogs were fed, dogs began to salivate at the sound of a bell. These dogs would also salivate in response to bells of a different pitch [2].

Introduction

Detection dogs are trained to find a range of different targets during operational searches. However, targets that are encountered operationally are unlikely to be identical to the training samples detection dogs have been trained to find.

From the dog's perspective, operational targets may smell different to training samples because:

- **The operational target may be quantitatively different to the training sample.** The operational target may be present in a smaller or larger quantity than the training sample.
- **The operational target may be qualitatively different to the training sample.** The operational target could be a different age to the training sample or have been stored under different conditions. It could also be from a different batch, source or supplier.

It is therefore imperative that detection dogs are able to generalise beyond their training samples and detect other quantities, as well as qualitatively similar – *but not identical* – targets.

Prior to training your dog to generalise, you must ensure your dog is first of all trained on the correct odour you wish them to generalise from. The training samples you use must therefore be as free from contamination as possible. This is to ensure you are training your dog to detect the correct target odour and not the odour of contaminants which may have been absorbed by the training sample.

Quantitative generalisation (amount of odour)

There is scientific evidence that odour perception depends on odour concentration. For instance, the natural chemical skatole smells floral (to humans) at low concentrations and smells of faeces as the concentration gets higher [3]. (Figure 1)

This means that dogs might not recognise a target odour at concentrations that are much higher or lower than that which they were trained on. They therefore may be less likely to indicate the presence of a reduced or increased level of target odour.

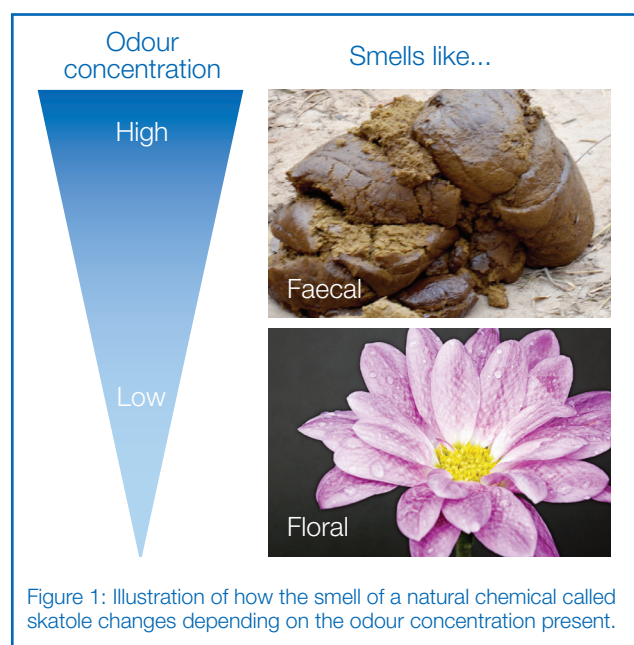
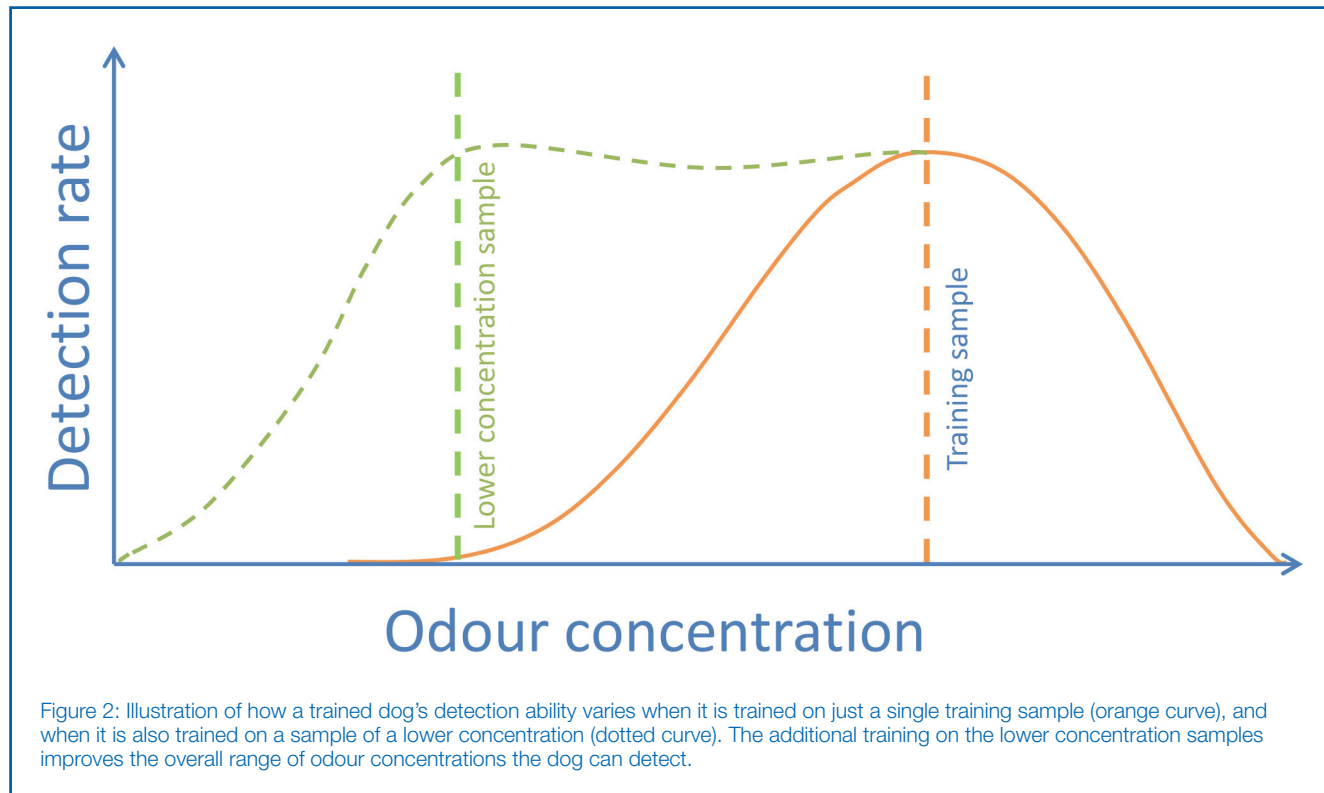


Figure 1: Illustration of how the smell of a natural chemical called skatole changes depending on the odour concentration present.

Equally, something well packaged may release very little odour and so the likelihood of a dog indicating on the odour may be reduced.

Work conducted by Dstl (Figure 2) has shown that when dogs are trained on only one size of target, they

may struggle to find much smaller quantities of the same odour. However, when dogs are also trained on lower concentration samples, their ability to find much smaller quantities of that odour improves significantly.



What can you do to increase quantitative generalisation?

In order to increase the ability of your dog to generalise to different quantities of a target substance, you should train on different amounts of sample. In order to do this you could:

- Wherever possible, train regularly on training samples of different sizes (milligrams, grams and tens of grams).
- Gradually increase the wrapping/concealment of your training samples to reduce the amount of vapour available to the dog.
- Wherever possible, train occasionally on larger quantities (hundreds of grams or kilograms). If this is not possible, try to increase the surface area of some of the existing training samples by carefully spreading them out (where safe and appropriate to do so).

Another option is to use “soaks”. A soak is a training sample that has been made by exposing an absorbent material called a soak matrix, next to – *but not in direct contact with* – a training sample such as an explosive, within a sealed container (Figure 3).

Recommended soak matrix materials

Glass microfibre filters and cellulose filters, sourced from laboratory suppliers, are recommended as suitable soak matrix materials. Laboratory-grade materials are ideal for dog training as they are designed to have minimal contaminants, and also undergo stringent quality control measures to ensure consistency from batch to batch.

If it is not possible to source laboratory-grade materials then blank paper, cotton wool pads or unscented fabric (such as undyed cotton/towelling) can instead be used. Whichever material is chosen, it is essential to also place out blank soaks (made using the same batch of material) during training. This is to ensure the dog learns to ignore any background contaminant odours arising from the manufacture/storage/handling of the matrix material.

It is imperative that blank soaks, made using identical matrix material and container type, are also prepared and used during training to ensure that dogs are being trained to detect the target odour as opposed to the odour of the matrix material or an odour arising from the production process. Blank soaks are produced following the same process used for positive soaks (including the same duration soak period) but without the training sample present.

Soaks may not replicate the odour of the original explosive sample and are therefore not recommended as suitable for initial training or as the main component of continuation training. Soaks instead provide a convenient means of additional training when the use of bulk explosives is impractical for logistical, safety or contamination control reasons (e.g. training in an operational environment).



Figure 3: Left: Airtight glass jar with clamp-type lid and silicone seal; Right: 5g explosive sample and soak matrix materials (note use of glass vial to prevent direct contact between explosive and soak matrix material). Clean disposable gloves must be worn at all times when making soaks. Soak matrix materials must always be handled using forceps/tweezers.

Qualitative generalisation (similar odours)

If you always use the same training samples, you are, in effect, teaching your dog to detect these specific samples only. Furthermore, these samples are likely to develop a specific 'corporate odour' if they are always stored in the same place and handled by the same people. Assuming they have been sourced together at the same time, they are also likely to be of similar age and/or from one batch or manufacturer. All of these factors affect the way the training sample smells.

If a dog then encounters the same type of training sample but from a different manufacturer, or one that has been stored in a different place, or is a different age, then the dog may not recognise it as a trained target and may fail to indicate on it.

What can you do to increase qualitative generalisation?

In order to increase the ability of your dog to generalise to a range of odours similar to your training sample, you should ideally train on as many different variants of the training sample as you can. These should include:

- Different brands of the substance from different manufacturers.
- Fresh and aged samples.

- Samples used by different trainers.
- Samples stored in different locations.

In reality, it is unlikely to be feasible to hold and train on a wide variety of samples at the same time, so practical approaches that can help maximise generalisation include:

- Replacing training samples regularly with similar, but not identical ones, e.g.:
 - A different batch of material.
 - A similar material from a different manufacturer.
- Conducting some training sessions with partner organisations/companies with access to different training samples.

Indication vs. interest

A dog may show interest rather than give a full indication on substances that are similar to, but not exactly the same as, samples they have encountered during training. It is therefore essential that handlers are alert to signs of interest as well as indication, and respond accordingly.

Associated guides and Information

- [1] Catania, A.C., Harnad, S. (Eds.). (1988). The selection of behavior: The operant behaviorism of B. F. Skinner: Comments and consequences. New York: Cambridge University Press.
- [2] Pavlov, I.P. (1927). Conditioned reflexes, Dover, New York.
- [3] Kotthoff, M., Nörenberg, S. (2016). Odor and nutrition. Part 2: traits of odors. Ernährungs Umschau 63(1), 22–30.

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Are your training samples giving you the capability you expect?

What is this note about?

This note provides key advice on how to ensure that training samples (odour samples used for training and/or assessment of detection dogs) are fit-for-purpose and actually facilitate the intended operational capability.

Who is this note relevant for?

- Anyone choosing training samples for the training and/or assessment of detection dogs.
- Anyone commissioning detection dog services.
- All detection dog trainers and assessors.

What is a Training Sample (TS)?

TSs are scent-emitting substances used to teach dogs to respond to particular targets. They may also be used for continuation training (ensuring that dogs do not forget the odour over time) and also to test dogs to ensure their suitability for operational deployment.

A TS might comprise:

A sample of the real target, representative of that likely to be encountered operationally:

- E.g. a sample of recovered drugs, commercial explosive or wildlife scat.

A sample of the real target contained in, or absorbed on, a low-odour matrix material:

- This can be a practical alternative where safety and/or legislative factors prevent use of the real target as it would be found in the field.
- Example low odour matrix materials include: wax, glass fibre filter papers, silica, or kieselguhr. Wherever such matrix-based training samples are used, a blank, but otherwise equivalent, sample should also be used in training and testing to ensure the dog is training on the target odour and not some other scent associated with the matrix or manufacturing process.

A simulant comprising a key component of the real target:

- E.g. benzocaine anaesthetic as a simulant for drugs mixed with benzocaine; ammonium nitrate selected as a non-explosive simulant for ammonium nitrate-based explosive mixtures.

N.B. "Pseudo-scents", i.e. simulants / TSs purportedly designed to smell like a target material or key component but not actually containing those materials, are not scientifically proven to be effective for detection dog training; their use is therefore **NOT** recommended.

Why is it important to assure and validate TSs?

In some instances, detection dogs are both trained and tested using exactly the same TSs rather than testing with a different sample. Such an approach to testing simply demonstrates that the dogs can find the specific TS they have trained on. No conclusions can be drawn as to whether the dogs would be likely to find other samples or the operational target material odour.

The dogs may be responding to contamination present in, or on, the TS rather than the target material/ odour. Alternatively, the TS may not be sufficiently representative of the target material/odour.

Problems with TSs arise from:

- a. Poor manufacturing or supply chain practices
- b. Inappropriate storage, handling and use by end-users resulting in contamination, ageing or degradation

Selecting and procuring TSs

Users should ensure that any TS selected for procurement has been:

- a. *validated* to confirm that training on it will contribute to ensuring that dogs can find the target in an operational search;
- b. *quality assured* by appropriate laboratory analysis to confirm it:
 - comprises the expected substances (and does not contain any unexpected substances)
 - is consistent within and between batches
 - ages / degrades consistently and as expected for specified shelf-life and storage regime
 - does not become contaminated during storage (e.g. due to inadequate/inappropriate packaging materials/containers)

Any blanks or controls should match the positive TSs in all respects, except they should be free from target odours.

When procuring a TS, it is good practise to ask suppliers to provide robust (preferably independently verified) evidence that the above validation and quality assurance testing has been completed.

A suggested protocol for validation testing of training samples is provided in Annex A. Conducting such testing to a scientifically rigorous standard may not be proportionate for an individual detection dog service provider but could be expected of a TS manufacturer.

Using TSs - how to ensure your TSs remain effective

Having procured TSs that are validated and quality assured, it is essential to ensure that their quality – and hence canine detection capability – is not compromised.

- Always follow manufacturer's instructions regarding storage, handling, use and shelf-life of TSs.
- Take appropriate and robust measures to prevent contamination during storage, handling and use. For example, use multiple layers of odour-impermeable packaging materials for storage; do not store particularly high odour TSs in the same container or in close proximity to others; change disposable gloves between handling different TSs; and / or use single-use disposable tongs as appropriate (see the "Why and How to Control Contamination" guidance note [1], available on the CPNI website, for more information about packaging and contamination control).
- If it is suspected that a TS has become contaminated, it should be safely disposed of and replaced.
- Use appropriate blanks and interferents frequently as part of the training regime and assessment process, e.g. to ensure that dogs are not simply responding to odour associated with packaging materials or disposable gloves worn when handling the TSs.
- Always assess dogs on different samples to those used for training. This may be a sample from the same type of material but should ideally be sourced from different batches and if possible stored in a different location.

Annex A.

A protocol for validation testing to confirm that a TS enables dogs to find the intended target

Whatever form a TS takes, users should ensure that it has been validated to confirm that training on it will contribute to ensuring that dogs can find the target in an operational search. Where possible, validation tests should be conducted with dogs that have never before been trained on any type of TS for the particular target.

It is advisable to use a minimum number of 6 dogs to validate a TS. However the more dogs that are used, the more confident you can be in the results (using more dogs accounts for individual differences that are likely to exist between dogs).

Each new TS should be presented to each dog at least five times [2]. Five repeats are necessary to ensure statistical validity of the results and ensure that each dog's detection rate did not occur by chance.

The timescales for training a dog on a specific target will in part be dependent on the material itself; some materials may have relatively low amounts of odour coming off them and therefore take longer, or be harder, to train a dog to detect. Timescales will also partly be dependent on the experience of the dog handler team. However, both the baseline and final testing detailed below typically takes approximately 1 hour per dog.

Ideally, validation tests of any TS should involve the following three stages:

1. **A baseline test:** to determine how dogs respond to the TS (and operational targets, if possible) before they have received any training on the samples.
 - Dogs should be tested on at least one sample of the real target to see whether they respond to it.
 - » This must not be the TS. If the TS is a sample of the real target, it is preferable to use a different variant, such as a sample obtained from a different source.
 - » Using as many different variants of the target as possible will give a better indication of how effective the TS is.
 - Dogs should be tested to see whether they respond to the TS.
 - Dogs should be tested to see whether they respond to any blank/control samples that are provided with the TS.
 - See the “Canine Odour Discrimination Test” guidance note [3] for advice on how to set up and run the test. See the “Why you should train and test detection dogs ‘double-blind’?” guidance note [4] for information on how to conduct double-blind testing and training.
2. **A training phase**
 - After the baseline test, dogs should be trained to respond to the TS.
 - Blanks/controls should be used frequently throughout to ensure that dogs learn to ignore odours associated with the packaging or make-up of the TS.
3. **A final test:** this should be a repeat of the baseline test. The dogs’ responses to the substances in the final test will be compared against their results from the baseline test to determine whether the training aid has been successful.
 - Dogs should be exposed to the TS (to confirm that they have successfully learned the TS odour).
 - Dogs should be exposed to any blank/control samples that were provided with the TS (to confirm that they have learned to respond to the target odour and not any odours associated with the packaging or make-up of the TS).
 - Dogs should be tested to see whether they respond to at least one sample of the real target.
 - » This must not be the TS. If the TS is a sample of the real target, it is preferable to use a slightly different variant, such as a sample obtained from a different source.
 - » Using as many different variants of the target as possible will give a better indication of how effective the TS is.
 - See the “Canine Odour Discrimination Test” guidance note [3] for advice on how to set up and run the test. See the “Why you should train and test detection dogs ‘double-blind’?” guidance note [4] for information on how to conduct double-blind testing and training.

The results of the final test (stage 3) conducted after training will be compared against the results of the baseline test (stage 1) to determine whether or not the TS has been successful.

The TS has been successful if:

- The dogs respond more reliably to the TSs and targets during the final test than the baseline test, and the dogs meet or exceed the required standard when detecting the targets.

The TS has been unsuccessful if:

- The dogs respond reliably to the TS but not the samples of real/operational targets:
 - » The TS may not be a valid representation of the real target odour.
 - » The TS may have become contaminated during use, leading to dogs recognising it by the contamination odour.
- The dogs respond to the TS but also respond to the blanks (items which match the positive TSs in all respects, except they should be free from target odours; e.g. clean target packaging layers):
 - » Further training may be required to ensure that they learn to differentiate between their TS and the blanks.
 - » The blanks samples could be contaminated with the TS odour.
- The dogs respond to neither the TS nor the samples of targets:
 - » It is likely that the dogs were not successfully trained on the TS and require further training time before a repeat of the final test.

Q. What if I can't get access to real target material recovered from the field?

A. You will not have the same level of confidence as testing on the real target; but you could test on fresh TSs or test on different brands of validated and quality assured TSs for the same target.

Associated Guides and Information

- [1] Why and how to control contamination DSTL/PUB89644
- [2] Porritt, F., Mansson, R., Berry, A., Cook, N., Sibbald, N., Nicklin, S. (2015). Validation of a short odour discrimination test for working dogs. *Applied Animal Behaviour Science*, 165, 133-142.
- [3] Canine Odour Discrimination Test DSTL/PUB89074
- [4] Why you should train and test detection dogs 'double-blind' DSTL/PUB104178

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Why you should train and test detection dogs ‘double-blind’

What is this note about?

This note provides advice about how to ensure that the detection dog is not responding to unintentional cues by training and/or testing using the double-blind technique.

Who is this note relevant for?

Personnel responsible for training and testing detection dog capability.

What are cues?

Cues are signs or ‘stimuli’ that let the dog know that something is about to happen.

E.g. If when you pick up your dog’s lead, the dog anticipates you are about to go for a walk, seeing you with the lead is a cue for a walk.

Introduction

- Trained detection dogs are extremely sensitive to subtle and unintentional cues from their handlers and observers. Often the handlers and observers are unaware that they are providing these cues.
- If detection dogs are always trained and tested under conditions where a handler/observer knows the location of a target item. The dog may become reliant upon following those cues rather than its nose. This may impact searches where handlers are unaware of target item locations for example, during operational deployments.

During training, we purposefully provide some cues to our dogs to get the response that we want. For instance, a dog can be taught to “sit” by learning that after you give the “sit” command, the dog can earn a reward for sitting.

Often during training, people also provide cues unintentionally. Dogs may learn to respond to them without people even realising they are providing them. A famous example of this is “Clever Hans”.

Clever Hans was a famous horse in Germany in the early 20th Century that appeared to be able to count by tapping his hoof on the floor. Double-blind testing, where the audience and handler did not know what the answer to a question should be, proved that Hans could not actually count but was relying on the handler and audience to find the correct answer. Hans was responding to very subtle cues (almost unnoticeable movements) that his handler and the audience provided when he had tapped his hoof the correct number of times. A psychologist called Oskar Pfungst discovered that people involuntarily provided these cues, even if they consciously tried to suppress them.



Clever Hans with his owner, William Von Osten (www.kryptozoologie.net)



Oskar Pfungst teaching Clever Hans (www.wikipedia.org)

What sort of unintentional cues might occur when training search dogs?

Similar effects can be seen when training search dogs if people in the area (the handler, instructor or other observers) know where training targets have been hidden.

Examples of unintentional cues

- Observers orientating their body or gaze direction towards where the target is hidden;
- Observers becoming quieter/more attentive when the dog is near the target;
- Observers getting nearer to the dog when it is near the target;
- Disturbance odours deposited around where the target is hidden;
- Observers reaching towards their dog toys/dog treats when the dog is near the target;
- Small (almost imperceptible) body movements, such as a relaxation of the shoulders.

It is common for observers to know where targets are hidden during the training or testing of search dogs, so that the dog can be rewarded immediately for correct indications.

How do unintentional cues affect the performance of search dogs?

If a search dog is always trained and tested in an environment where at least one person (the handler or somebody watching the search) knows where the target is hidden, the dog may begin to rely upon unintentional cues (such as those described above) to help him find the target. This will cause a problem when conducting operational searches for hidden targets where the dog and handler are searching alone. The handler does not know where the target is hidden and therefore the unintentional cues are no longer available.

What is single-blind training and testing?

Currently, most routine training is conducted using single-blind training or testing (SBT). SBT means that the **handler** does not know whether or where a target is hidden during training or testing searches but an observer (usually the person who set up the hide) does. If the dog indicates correctly, the observer will immediately let the handler know the dog is correct and the dog can be rewarded.

Single-blind training and testing	
Advantages	Disadvantages
Prevents dogs becoming reliant upon cues from their handler	Doesn't prevent the dog from receiving cues from observers
	Presence of observer can become a cue E.g. if training is always conducted with the same instructor the dog may not expect to find a target when the instructor is not present

What is double-blind training and testing?

Double-blind training or testing (DBT) means that the person who placed the target is not present during the search, and none of the observers or the handler knows whether/where a target is hidden. **DBT is the most effective way to train a dog to rely solely on its sense of smell to detect a hidden target.**

It may not be practical to train or test under double-blind conditions on every search, but it should be done whenever possible to ensure that the dog is relying on its sense of smell to find targets and not becoming reliant upon unintentional cues.

How do I train or test double-blind?

DBT is a standard part of odour ID testing (see the “Canine Odour Discrimination Test” [1] guidance note) where the observer must turn away from the search or can be hidden behind a screen. If dogs are not trained to conduct the odour ID test under double-blind conditions, they may fail when they are tested under double-blind conditions because they have become reliant on cues from their handler or the observer.

Achieve double-blind conditions by:

- Keeping observers out of sight, e.g. behind screens or in another room;
- Using video cameras;
- Using mobile phones or radios to confirm whether an indication from the dog is correct (provided their presence / use would be normal, i.e. not a clue in its own right);
- The handler confirming that the training target is there when the dog indicates (e.g. open cupboard door to visually check that the training aid is present before rewarding dog).

Associated Guides and Information

[1] Canine Odour Discrimination Test DSTL/ PUB89074

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Maintaining the operational performance of detection dogs

What is this note about?

This note provides guidance on how to maintain the same detection performance in operational searches as observed in training searches. The note focuses on applying good training and operational practices to maintain operational performance. It does not cover physiological effects on performance (e.g. illness, environmental conditions).

Who is this note relevant for?

This note is for all detection dog handlers and trainers. It is particularly relevant:

- For dog teams who do not encounter target odours regularly in the operational environment or are not able to regularly reward their dogs on operational finds.
- Where there are consistent differences between the training and operational environments that the dogs may notice.

Introduction

The likelihood of a detection dog indicating on a target odour in an operational search reduces significantly if they are not given frequent opportunities to find target odours and/or are not rewarded for indicating on them in the operational environment [1].

Dogs facing this problem may appear unmotivated to search or they may still appear to search actively. In both cases, these dogs may not be effectively sniffing for target odours and may not indicate on them if they are encountered in the operational environment.

This problem can be mitigated by:

- Matching the number of opportunities dogs have to detect target odours in training and operational environments.
- Making the training environment as similar as possible to the operational one(s).

It is therefore essential to understand why and how performance declines (see Section 1). This document also explains four approaches that can be used (preferably together) to maintain optimum operational performance of detection dogs:

- Increasing the frequency of operational reinforcement (Section 2).
- Introducing partial reinforcement during training (Section 3).
- Varying search lengths and including blank searches (Section 4)
- Increasing the similarity between contextual cues during training and operational searches (Section 5).

Research evidence of performance decline during repetitive, unrewarded searches

In a research study [1], detection dogs were trained to detect four target odours (three explosives, one non-explosive). They were then required to conduct a daily search of the same 'work' location for six weeks, where they did not encounter any target odours.

When all four target odours were reintroduced to the work location after six weeks, the dogs' detection rate on them had fallen to 23%. The majority of the missed target odours had been searched by the dogs; they appeared to be searching normally, but were actually not searching effectively.

During this six week period they also had two training days (during weeks three and five) at a different location. The dogs successfully indicated on all target odours during these training days, demonstrating that their performance decline in the work environment was not because they had forgotten the target odours or the indication behaviour.

It took six searches in the work location with target odours present before detection levels returned to the same levels as in training.

Section 1 - Why and how does performance decline?

During training, detection dogs learn to search for target odours and indicate (e.g. sit or freeze) when they encounter a target odour to get a reward. To train and maintain these behaviours, training sessions often involve multiple targets and provide frequent opportunities for dogs to be rewarded for correctly indicating. In contrast, in operational environments, dogs often search without encountering any target odours. If they do encounter a target odour operationally, they may not be rewarded for indicating (as dogs should not be rewarded for indications on unknown substances, and it may also not be logistically feasible or safe to reward dogs operationally).

Dogs can quickly learn whether there are any cues present during a search that let them know how likely they are to find any target odours, and also how likely they are to get a reward for indicating. This is similar to when a dog learns to predict when it is being taken for a walk from something as simple as the owner picking up their house keys or putting on a coat. If the cues are reliable enough, dogs can learn how likely they are to get their reward on any given search, and therefore how much effort they should put into searching and indicating. Because the cues are part of the search environment, or context, they are referred to as *contextual cues*.

Contextual cues that are usually present during training sessions let the dog know that they should try hard during these searches, as there is a good chance of finding a target and getting a reward for indicating. While anything can potentially become a contextual cue, some common examples that may normally be present during training sessions include:

- Sights, sounds, odours and routines of the training venue.
- The instructor being present.
- Different handler behaviour during training.
- The handler only carrying the reward (ball/toy) when training.
- The dog wearing a training harness.
- Other dogs, people or vehicles being present.

If these contextual cues are usually absent or different during operational searches, where the dog does not usually encounter target odours (or is not rewarded for indicating on them), then the dog will learn that they should only try their hardest during searches when the training-related contextual cues are present.

For example, if the dog is only ever rewarded when it encounters targets that the instructor has placed out, the dog will learn that it is worth searching and indicating when the instructor is around, but it is not

worth searching effectively when the instructor is not there. In this case the instructor has become a contextual cue.

It is particularly important to keep in mind that the presence of contextual cues during training could mean that the dog searches well and indicates on targets during training sessions, but performs less well in operational environments, when these contextual cues are absent. This does not mean that the dogs have forgotten what they have learnt in training; they simply learn that they will not be rewarded for exhibiting the behaviour in other contexts.

Two specific operational scenarios that will lead to reduced target detection if not addressed:

- **A dog encounters target odours operationally but is not rewarded for indicating on them**
 - The dog will rapidly learn to ignore operational targets, as indicating on them is not rewarded, but may continue to indicate during training.
- **A dog does not encounter target odours operationally and is therefore not given the opportunity to indicate**
 - Finding a target odour acts as reinforcement for active searching and allows indication to be rewarded. Without this opportunity dogs may continue to search, however, their attention to target odours and probability of indicating will reduce operationally over time.

The following sections cover different methods of countering the effect of contextual cues so that performance is maintained outside of training sessions. Although each approach can be applied separately, they are most effective if used together.

Section 2 - Increasing the frequency of operational reinforcement

By introducing opportunities for dogs to be rewarded for correct indications in operational environments, the level of difference between training sessions and operational searches is reduced. Detection performance can be maintained by allowing dogs to find and indicate on *any* trained target odour during their operational searches [1-3].

In many scenarios, placing out a real target material is inappropriate as it could cause security issues, potential false alarms by alternative detection equipment, or

uncertainty in any investigation of criminal activity (e.g. area contamination). To avoid these problems, dogs can be trained on an additional target odour that is not related to their training samples, and is not otherwise likely to be found in their search environment. These ‘**performance maintaining training aids**’ (PMTAs) can then be placed out in operational searches to allow dogs to receive reinforcement for indicating on them.

Research supporting performance maintaining training aids

Two additional groups of dogs completed the study detailed on page 1, but both groups were regularly exposed to target odours in the work location and were rewarded for indicating [1].

The first group encountered the three trained explosive targets, but not the fourth (non-explosive) target. The second group encountered only the non-explosive target in the work location.

At the end of six weeks when all four targets were introduced to the work location, both groups had better detection rates than at the start of the six weeks (>80%).

Crucially, the detection rate on the three explosives was the same for both groups despite one group not being exposed to the explosive targets for six weeks; exposure to one unrelated trained target had maintained (and improved) performance on all other trained targets [1].

Using performance maintaining training aids (PMTAs)

Use of a PMTA should be agreed with all parties involved in the operational search or response before the dog is deployed.

Placing PMTAs out during operational searches

- PMTAs should ideally be placed out prior to a search commencing. If this is not feasible, they can be placed out during a search, preferably in an area the dog has not yet searched.
- If possible, the PMTA should be placed out by someone other than the handler. This will optimise effectiveness by allowing the handler to work ‘blind’ to the PMTA location.
- The person placing out the PMTA should engage with/touch other parts of the search area so that their odour is not uniquely linked to the PMTA’s location.
- To enable the handler to work ‘blind’, the PMTA location can be written down and provided to the handler prior to the search (e.g. on folded paper that the handler doesn’t look at). Following an indication, the handler can check the paper to allow immediate confirmation of whether or not the dog has correctly indicated.
- The PMTA odour should be easily accessible to the dog (but the PMTA should not be visible). The intention is for the dog to maintain search motivation after receiving a reward, not to test the dog’s ability to find concealed targets.
- Once the dog has been rewarded after indicating on the PMTA, the PMTA should be removed to allow the dog to continue searching.
- Once removed, the PMTA’s location should be re-checked by the dog (after a suitable delay) or carefully checked by the handler to ensure any real threats haven’t been overlooked.

What to use as PMTAs

Research shows that a single PMTA odour is effective at maintaining performance [1-3]. *It is important to note the odour does not need to be related to a target odour in order for it to be effective.*

Suggested PMTA format

Other, similar containers (certified clean with tightly fitting lids) can be used if dropper bottles are not available.

PMTA: A few drops of chosen odour (e.g. essential oil) placed onto cotton wool.



Lid with airtight seal (e.g. PTFE-lined, screw top): to secure the bottle during storage (this lid should be removed before placing out the bottle).

‘Certified clean’ glass bottle that is robust and easy to conceal. The optional dropper insert allows odour release whilst preventing content spillage.

The most appropriate PMTA odour will depend on the location that individual dogs are required to search. The PMTA odour should be:

- Safe and easy to handle (e.g. non-toxic, not contraband).
- Not able to cause false positives on other detection equipment (e.g. not related to contraband, unless demonstrated not to cause false alarms, or there is no possibility of detection equipment being used in the venue).
- Unlikely to cause the dog to indicate on other common substances encountered during search.

As the same locations are likely to be searched on multiple occasions, it is also important that the PMTA odour does not contaminate the area, as this may cause false indications (or interest) on future searches. Therefore:

- Odours related to training rewards should not be used (e.g. toy/tennis ball pieces) because rewarding the dog following a find will leave odour 'contamination' on the floor/walls.
- There should be a clean barrier (e.g. clean paper) between the PMTA container and environment.

How often to use PMTAs

PMTAs are most effective if they are used on the same proportion of operational searches as dogs encounter training samples during training sessions. However, where this is not possible, any operational use of PMTAs is beneficial.

Training with PMTAs

To be effective, PMTAs must be trained using the same method as used for other targets, ideally on the same training days. Dogs must receive the same reward for indicating.

During training, 'blank' PMTAs (e.g. empty dropper bottles containing cotton wool) and blank barrier material (e.g. clean paper) should be placed out, and dogs not rewarded for indicating on them, to ensure the dog learns the correct odour. However, blank PMTAs should not be placed out operationally to avoid unnecessary operational false alarms.

Section 3 - Introduce partial reinforcement during training

If dogs cannot always be rewarded for correctly indicating during their operational searches, then it is important to build their resilience by not always rewarding correct indications during training. Only rewarding the dog's correct behaviour on a proportion of occasions is called *partial reinforcement*.

Why does partial reinforcement work?

Partial reinforcement teaches the dog that it is worth persevering with the same behaviour even if it is not rewarded on some occasions, as it may be rewarded next time. It also increases the similarity between training and operational contexts (where the dog might not always find a trained target and/or it may not be logistically possible to reward them immediately for correct indication behaviour), reducing the effect of contextual cues.

How to use partial reinforcement

During the initial training of a behaviour, dogs should always be rewarded for the correct response (e.g. a correct indication). This 'continuous reinforcement' encourages rapid learning. Once the desired behaviour is fully learned, a proportion of correct responses should not be rewarded (known as partial reinforcement). This proportion is gradually increased to build up the dogs' resilience to not always being rewarded for a learned response – the dogs do not expect a reward for every correct indication.

On occasions where dogs indicate correctly but are not rewarded (with ball, food etc.), they should be calmly praised and moved away from the target (clip on the lead if necessary). They should later be given the chance to indicate again on the same type of target (in a different location) where they should be rewarded as normal. This replicates the sequence of events that may occur on finding a real target during operations.

The proportion of instances when dogs are not rewarded should gradually increase until a desired proportion is reached. The best proportion to use will depend on a number of different factors, including each dog's training experience and how much they value their reward. Proportions of rewarded responses ranging from $\frac{1}{4}$ (25%) to $\frac{3}{4}$ (75%) have been used to effectively maintain behaviours in a range of different animal species, including explosives detection dogs. However, higher ratios of partial reinforcement (above $\frac{2}{3}$ (66%) rewarded indications) have been related to higher detection rates in explosives detection dogs [4].

In light of this, it is recommended that approximately $\frac{3}{4}$ (75%) of correct indications are rewarded, referred to as a 75% reinforcement schedule. This would mean that $\frac{1}{4}$ (25%) of correct indications would not be rewarded.

Partial reinforcement is more effective if it is unpredictable, so care should be taken to avoid any obvious patterns. Similarly, the ratio used should be changed between training sessions; for example, sometimes the dog is rewarded every time they indicate correctly, other times $\frac{3}{4}$ (75%) indications are rewarded correctly, other times only $\frac{2}{3}$ (66%) indications are rewarded, producing an overall reinforcement schedule of approximately 75% across all training sessions.

Section 4 - Varying search lengths and including blank searches

If dogs are always trained using the same length of search, they will be poorly prepared to perform effectively on the different lengths of searches they may encounter operationally. Training searches should therefore be varied to reduce the level of predictability and build resilience to unrewarded operational searches. It is important to vary the length of training searches, the time at which dogs find a target odour during the search (i.e. ensure dogs experience both early and late finds), and include some searches with several targets present and some with none.

Search length

Dogs given experience of long searches during training (before encountering a target) will search for longer on operational searches. This is because dogs learn that they sometimes need to search for longer periods before finding an odour/being rewarded. Longer searches also build their physical search stamina. Dogs should also experience short training searches where they encounter targets very quickly, so they learn to search intensively from the start.

Blank searches

The proportion of searches that contain a target odour during a training day should also be varied. Once trained to reliably find all target odours, dogs should be taught that some training searches (both long and short) will not contain a target.

An optimal training day should consist of at least one long search (prior to encountering a target odour) and multiple short searches, some of which do not contain any target odours. The relative lengths of the long and short searches should be determined based on operationally realistic scenarios and varied regularly.

Section 5 - Increasing the similarity between training and operational contextual cues

Increasing the similarity of contextual cues between training and operational scenarios helps to make it harder for dogs to tell the difference between the two settings, thereby helping to maintain operational performance [5]. It is essential that handlers understand the importance of minimising the differences between the training and operational contexts, and take all reasonable steps to do so. Some approaches to

increase training and operational similarity are outlined below.

Where possible:

1) Remove obvious training cues that will not be present during operations, for example:

- **Instructor presence:** Is the same instructor always present for training searches but never operationally? Does the instructor only walk behind on training searches?
 - Consider conducting a proportion of training searches, particularly the first search of the day, with no instructor present. The target location can be provided to the handler on folded paper, for immediate confirmation, or confirmed via phone or radio.
- **Training sample odour:** Are training samples handled by the handler at the start of the training day?
 - There is potential for the dog to smell targets prior to training searches and use this as a cue that targets will be present during the search.
 - Consider changing sample handling practices to reduce the likelihood of dogs smelling targets prior to training searches (e.g. samples are handled by a different person away from the dog) and ensure good contamination control (see 'Why and how to control contamination' guidance note [6] for further information).
- **Vehicle location:** Is the dog always on its own for operations but next to other dogs for training?
 - Consider parking the dog vehicle away from other dogs if this more closely replicates operations.
- **Training location:** Does training happen in a small number of specific locations?
 - Is it likely that the dog recognises the training locations?
 - Is it likely that there is contamination of the training area (by both targets and dogs)?
 - If possible, conduct training in operational areas, particularly if the dog only works in a small number of locations.
 - If the dog searches in multiple operational areas, ensure the dog trains in multiple training locations.
- **Morning routine:** Does this differ significantly between operations and training days?
 - Consider ways to make the morning routine more similar to allow the first training search of the day to be operationally realistic.
- **Number, duration and type of searches:** Does this differ significantly between operations and training days?
 - Consider changing the training searches to more closely match operations (see Section 4 above).

2) Introduce training cues into operational searches:

- **Moveable cues:** Do the dog and handler always wear/carry the same equipment for training and operations?
 - Ensure the dog has a specific working harness/collar that it always wears when training and working but not elsewhere.
 - Ensure that the handler always carries the same training reward and any other training equipment operationally.
 - Ensure that the handler doesn't wear noticeably different clothing/uniform during training and operations.
-

Key terms

Continuous reinforcement: Rewarding a behaviour every time the dog does it.

Partial reinforcement: Only rewarding a behaviour on some occasions rather than every time.

Reinforcement schedule: The proportion of correct indications on target odours that are rewarded (with ball/toy/food etc.).

Blank search: A search with no target odours present.

Contextual cues: Any aspect of the environment or people's behaviour that a dog might remember and use as a 'hint' about what is likely to happen next.

Moveable cues: are contextual cues (e.g. training harness) that are present in training and are moved into operational environments. These cues reduce the difference between the two contexts and help to transfer trained behaviour to the new context.

Top tips for maintaining operational performance of detection dogs

- ✓ Create opportunities for dogs to be rewarded for searching and correctly indicating in operational environments. This can be achieved through the use of non-hazardous Performance Maintaining Training Aids (see Section 2).
- ✓ Introduce partial reinforcement during training so that dogs learn that they are not always rewarded when they indicate correctly. Partial reinforcement builds up dogs' resilience if they cannot always be rewarded operationally (see Section 3).
- ✓ Vary the placement of targets and lengths of training searches, including some blank searches with no targets, to prepare dogs for different operational scenarios (see Section 4).
- ✓ Prevent dogs from learning how likely they are to encounter a target odour and be rewarded for indicating, by identifying contextual cues and ensuring that they do not differ between training and operational searches (see Section 5).

Associated Guides and Information

- [1] Porritt, F., Shapiro, M., Waggoner, P., Mitchell, E., Thomson, T., Nicklin, S., Kacelnik, A. (2015). Performance decline by search dogs in repetitive tasks, and mitigation strategies. *Applied Animal Behaviour Science* 166, 112-122.
- [2] Thrailkill, E., Porritt, F., Kacelnik, A., Bouton, M. (2018). Maintaining performance in searching dogs: Evidence from a rat model that training to detect a second (irrelevant) stimulus can maintain search and detection responding. *Applied Animal Behaviour Science* 157, 161-170.
- [3] Thrailkill, E., Kacelnik, A., Porritt, F., Bouton, M. (2016). Increasing the persistence of a heterogeneous behavior chain: Studies of extinction in a rat model of a search behavior of working dogs. *Behavioural Processes* 129, 44-53.
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- [5] Gazit, I., Goldblatt, A., Terkel, J. (2005). The role of context specificity in learning: the effects of training context on explosives detection in dogs. *Animal Cognition* 8, 143-150.
- [6] Why and how to control contamination DSTL/PUB89664 www.cpni.gov.uk/canine-detection-guidancenotes

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Using training records to optimise detection dog performance

What is this note about?

Keeping robust training records is essential to ensuring effective performance of detection dog teams. Not only do such records provide evidence of training undertaken (which may, for example, be required for accreditation purposes), but they also enable development needs to be captured and addressed in a systematic manner. This note provides guidance on how to collect information during detection dog training sessions and create training records. It covers how training records can be used to maximise training efficiency and ensure that each detection dog team provides an effective detection capability.

Who is this note relevant for?

All dog handlers, instructors and organisations involved in training and deploying detection dogs. It is also relevant for organisations that require evidence of detection dog teams' capabilities.

Introduction

What is a training record?

Every detection dog team should be able to provide evidence of all training undertaken. The most effective approach is to create a record of each training session – a *training session record* – for each dog team, capturing details of the training undertaken and the outcomes of the session. A dog team's overall training record should comprise the complete and up-to-date collection of these training session records.

Why are training records important?

Training session records capture key information about detection dog training sessions, such as:

- When a training session has been conducted.
- What the training session involved.
- The dog and handler's performance during the session against specific training objectives. Training objectives may cover the dog's ability to detect substances and to search in different environments or scenarios.

Each training session record can be used to show:

- If a dog has met the training objectives during a training session. Future training sessions can then be focused on addressing any objectives not met, improving the detection capability provided by the dog.
- The performance of a handler and dog as a team, including their ability to work together safely and efficiently to an operational standard.

If training session records are completed in a standardised format, they can capture training session

outcomes consistently over multiple sessions, and between different handler and dog teams.

Standardised training records can provide:

- The history of the training given to an individual dog throughout their working life. This can be used to monitor the dog's performance over time. It can also be used to provide evidence of the dog's capabilities, and that the required training has been undertaken, to inform deployment decisions or for regulatory/legal purposes.
- Consistency in the training objectives applied to each handler and dog team, allowing oversight of the strengths and weaknesses of each team across an organisation.
- Ease of use for different people to correctly interpret the training records, such as across trainers within an organisation or by regulatory bodies.

Designing training records

It is important to decide what information will be recorded during each training session before the training programme begins. This helps ensure that the information is captured in the same way over time.

During every training session a new training session record should be completed for each dog-handler team participating. The record should contain all relevant information from the training session. **Table 1** highlights some recommended details to be recorded during each training session for effective record keeping. The use of a standardised training session record template will help to maintain consistency in what information is recorded (see **Annex A** for an example template).

Table 1: Recommended training details to be recorded during each training session.

Training information	Handler details	Name Force/Unit/Organisation and Unique ID
	Trainer/instructor details	Name Force/Unit/Organisation and Unique ID
	Dog details	Name Age Sex Breed Microchip number
	Training session details	Date of the training session Time of day and total training duration Specific aims of training (e.g. improve indication) Type of search (e.g. scent recognition, building, area, route, vehicle) Search location (description and address) Environmental conditions (e.g. temperature, humidity, wind speed) Any unusual disturbances present (e.g. new people, machinery, wildlife)
	Substance details	Target substances used (e.g. type, quantity, container/wrapping/masking, concealment type) Hide locations (including height of target and distance from the search start point) Interferent (distractor) odours used (e.g. type, quantity, container/wrapping/masking, concealment type) Person who prepared and placed out the hides (e.g. instructor, handler, assistant) Soak time of target substances
Data entry	Dog responses to target odours (e.g. indication, interest, miss) Dog responses to non-target odours (i.e. false alarms, including details of any substances indicated on) Dog behavioural observations (e.g. fearful, intrusive, distracted, fatigued, responsive to handler) Handler observations (e.g. safe system of search, fitness, control of the dog, tasking, indication correctly called, action on a find, reward recovery)	
Additional information	Trainer/instructor present Observers present Extent to which training is conducted 'blind' (i.e. not blind, single blind, double blind - for further information, see the 'Why you should train and test detection dogs 'double blind'' guidance note [1])	

How training records can be used

Standardised training records can help to create focused training plans, optimising how time is spent during training sessions to improve performance, by:

- Monitoring performance during the introduction of new training samples or scenarios.
- Identifying time since initial or recent training using a specific training sample or scenario.
- Allowing early identification of behavioural changes.
- Encouraging handlers to share best practice to overcome training challenges and actively seek advice from trainers/instructors.
- Identifying common training trends across an organisation.
- Assisting continual monitoring of individual detection dog capability/performance.
- Providing historical training documentation of a detection dog throughout their working life, which can be accessible even if transferring to a new force/unit/organisation.

Using training records to optimise detection dog performance

To be most effective, training records should be used together with training plans. Each training session should have a training plan, which details the goals of the training session (both in general terms, and with regard to any specific needs of particular dog and handler pairings), along with how the session will be run to achieve the goals. A training session record, which logs the outcomes of the training session, should also be completed for each dog and handler team.

When developing future training plans, training records provide important information about where to focus training effort based on previous training session outcomes. This could be by identifying where further training is required, such as resolving:

- Issues with the detection of specific target substances (low or inconsistent detection rates).
- Patterns of false indications on interferents (e.g. packaging materials that target substances are stored in, the odour of the trainer or unrelated substances such as coffee).
- Poor performance due to environmental factors (e.g. dogs performing poorly in particular venues or when certain distractions are present).

Together, training plans and records can ensure efficient use of training time, by identifying areas to focus on where improvement is needed.

Collecting information and storing training records

Training information can be recorded in a number of different formats. Choosing the most suitable format is important to ensure a balance between reliability, efficiency, cost and security. Historically, paper based handwritten training records have been used which are simple and reliable. More recently, digital methods have been applied to create and/or store training records. Potential benefits and limitations of handwritten or digital training records are outlined in **Table 2**.

Security of training records

When considering how training is recorded, the security and integrity of the information should be considered. Training data can provide sensitive information about capability to detect materials such as drugs, firearms and explosives. Therefore, it is important that training records are handled and stored securely. It is also important to note that personal information relating to handlers and trainers may fall under General Data Protection Regulation (GDPR) and appropriate steps may be required to protect the data under this legislation [2].

The following security steps are recommended:

- Use simple codes to refer to training substances (e.g. Substance A, Substance B, Substance C) and other sensitive information on training records where possible.
- Ensure the security of training records while in use (e.g. for digital records, consider the use of appropriate encryption software).
- Store digital training records on a secure IT system, and paper training records in a locked cabinet.
- Prevent the loss of training records by storing a copy in a different, secure location.

Further guidance on protecting sensitive information is available on the CPNI website [3].

Canine Odour Discrimination Setup Tool

To assist in developing training schedules and documenting training records, the Canine Odour Discrimination Setup Tool helps to generate training data sheets, for both training and testing days. This tool is freely available from the CPNI website [4] and is relevant for all users responsible for training and testing detection dogs.

For further information and instructions on using the Canine Odour Discrimination Test Setup Tool, please see the Software User Instructions [5].

Table 2: Benefits and limitations of different training record formats (NB: both require commitment, effort and attention to detail)

Training record		Benefits	Limitations
Handwritten document	Creation and completion	• Low cost to produce • Requires no/limited computer skills • Easily adapted for different purposes • Easy to capture complex information (e.g. description of the dog's behaviour)	• Time consuming to record all of the training session outcomes • May be difficult to use during training sessions (e.g. if paper becomes wet or multiple sheets are required) • Handwriting could be illegible • May be difficult to standardise the information recorded between sessions, across people or organisations
	Storage and use	• Can provide a permanent record as a hard copy	• Requires physical storage space • Difficult to identify trends between training records, or make links with other sources of information, without reformatting or transferring to a digital database
Digital (e.g. spreadsheets, specialist software, videos)	Creation and completion	• May be easier to record outcomes on a digital device during training sessions • Increased efficiency when inputting information (e.g. by selecting options) • Can be tailored for user's specific requirements • Can input a wider range of data types (e.g. videos of training) • Can contain prompts or guidance on information input • Easy to standardise the information recorded between sessions, across people or organisations	• Requires computer skills • Requires access to a digital device (e.g. tablet or computer) • May rely on a particular software provider • May not be adaptable for different purposes • Potential for devices to fail or for information to be lost during training sessions
	Storage and use	• Does not require physical storage space • Legible to everyone able to view the record • Easy to search and view historical records • All types of data can be viewed and compared in one place • Data can be analysed quickly to assess progress or trends in training • May be easier to share information contained in the training records (e.g. with regulatory bodies)	• Requires suitably secure digital storage space (including back-up, and adequate controls regarding who can read and/or write what) • Potential for information to become inaccessible due to changes in software or hardware • May be difficult to share training records if using specialist software

Top tips for using training records to ensure effective detection dog training

- ✓ Decide what information will be recorded before any training begins.
- ✓ Use a standardised training record template to maintain consistency across the organisation and over time.
- ✓ Ensure training session records are completed for every training session and that these are added to the detection dog team's overall training record; this supports effective monitoring of the performance of individual detection dog teams and can help identify future training requirements.
- ✓ Remember that training records may include sensitive information and should be stored and handled securely.

Associated guides and information

- [1] Why you should train and test detection dogs 'double blind'. DSTL/PUB1041781
www.cpni.gov.uk/canine-detection-guidance-notes
- [2] Guide to the General Data Protection Regulation (GDPR)
<https://ico.org.uk/for-organisations/guide-to-data-protection/guide-to-the-general-data-protection-regulation-gdpr/>
- [3] Protection of Sensitive Information and Assets.
<https://www.cpni.gov.uk/protection-sensitive-information-and-assets>
- [4] Canine Odour Discrimination Test DSTL/PUB89074
www.cpni.gov.uk/canine-detection-guidance-notes
- [5] Canine Odour Discrimination Test Setup Tool - User instructions DSTL/PUB89154
www.cpni.gov.uk/canine-detection-guidance-notes

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HM Government

CPNI

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Annex A: Example detection dog training session record

Handler	A. Smith, 001122	Dog Name/Breed/Sex	Jerry Labrador Male
Date	01/01/2020	Microchip	0122333444455555
Instructor	B. Jones, 334455	Force/Organisation	Dog Ltd.
Search location	Training warehouse		
Search scenario	Stand-based odour recognition		
Observers	Two handlers		
Environmental conditions	Inside building, 21°C, sunny conditions outside		
Specific aims of training (e.g. to improve scent detection, search stamina)	To improve dog's identification of target X whilst being able to ignore matched blanks		
Interferents used (specify type and amount)	1 x nitrile glove, 5g coffee, 1 x baby wipe, 1 x empty clip seal bag, 5g salt, 1 x cotton ball, 5cm washing line, 1 x ball of foil		
Soak time of targets	Held in the tins for 20 minutes prior to starting training		
Items prepared and placed out by	B. Jones		
Handler Competencies			
Handler standard observed	Competent (Y/N)	Further training required (Y/N)	Instructor comments
Systematic search	Y	N	Handler to improve reading the dog's indication and recall
Identify and adapt to dangers	Y	N	
Fitness	Y	N	
Control of dog	Y	N	
Indication	N	Y	
Dog recall	Y	N	
Reward recovery	Y	N	
Action on a find	Y	N	

Detection Dog Competencies						
Dog standard observed		Competent (Y/N)	Further training required (Y/N)	Instructor comments		
Odour recognition		Y	N	Dog easily picked up the scent and correctly identified target X during stand-based odour recognition test.		
Temperament		Y	N			
Timings		09:45 to 11:30		Contact time	1hr 45mins	
Substance	Quantity of substance (g / cm)	Hide location (including height)	Concealment type	Dog indication / false alarm / miss	Handler miss, dog indication / interest	Handler blind to hide location (Y/N)
Example: Target X	5g	Stand based	N/A (within stand-based tin)	Indication	N/A	Y
Handler comments						
Continue working dog on target X						
Areas to focus on next training session						
To progress training, use target X during a conventional search when not concealed. When successful, initiate some concealments.						
Instructor	B. Jones		Handler		A. Smith	
Signature	XXX		Signature		XXX	

Canine Odour Discrimination Test

What is this note about?

This note outlines the procedure used to conduct an odour discrimination test to confirm acceptable odour recognition by detection dogs. The test aims to identify whether a dog is able to reliably identify trained (target) odours and discriminate against untrained odours.

Who is this note relevant for?

Personnel responsible for training and testing detection dog capability.

Test Introduction

- This test has been designed to balance speed and ease of use with operational viability and is underpinned by peer reviewed statistical analysis and experimental work [1].
- The test, set-up and necessary components have been designed to be low cost, accessible and easy to use, transport and store.
- The test takes approximately six minutes per target odour type and gives a documented history of individual dog performance.
- The test forms part of UK police explosives detection dog licensing requirements and is suitable for use with detection dogs working in government or the private sector.
- The test is based on a linear or curved-line set-up involving eight stands. However, the test can also be applied to other stand-based systems with eight stands, such as the carousel.
- The odour discrimination test does NOT confirm that a dog is able to locate emplaced hides or conduct a safe search; a search based test must be conducted in an operationally relevant scenario to confirm these capabilities. Equally, a dog's ability to perform in particular circumstances is always subject to variation, and passing the test is not a guarantee of performance.

Each test comprises six "runs". On each run, the dog must search eight identical sample pots and discriminate the target odour from the non-target "interferent" odours.

Figure 1: A trained dog works on-lead down a line of plastic stands with stainless steel sample pots.



Test Outline

Each test must be carried out by two people: the person running the test (assessor) and the dog handler. The test is conducted “blind” i.e. the dog handler does not know the location of the target and the person running the test does not watch while the dog works.

Tests can be conducted indoors or outdoors.

If the assessor watches the search they may affect the test result by providing inadvertent cues to the dog or handler; this is known as the “Clever Hans Effect”.

- Eight identical sample pots are placed in stands. Each “run” of eight stands is set up according to a Trial Plan generated from the Canine Odour Discrimination Test Setup Tool [2] (available on the CPNI website – along with user instructions [3]). The Tool is a Microsoft Excel spreadsheet which quasi-randomises the order and location of targets:
 - On positive runs, one sample pot contains a target odour sample; for testing this specific sample must be one that the dog has not previously been trained on.
 - All other sample pots contain “interferent” odours, which are non-target odours that the dog should ignore.
- The dog should search the stands in order, preferably on-lead. To pass the test, the dog is required to ignore the interferents and indicate on the trained target odour samples.
- The dog searches six runs per target type (five containing a target and one “blank” run with no target); if more than one target type is being tested, targets are randomised across blocks so the dog encounters several target types in each block of six runs.
- The Tool standardises target location and number of interferents searched such that all dogs search an average of 22.5 interferents per target type (range 20-25).
- The Tool allows dogs to end each run following a correct indication rather than searching the remaining samples, whilst maintaining standardisation. This speeds up testing, while still ensuring that there is less than 1% chance of a dog passing the test by chance (i.e. by guessing).
- Once one dog has finished six runs, the next dog conducts the test using different target locations.

Test Equipment

The following equipment is required:

- Eight stands (stand types are detailed under “Equipment Maintenance”).
- 30-40 identical sample pots that fit into the stands (pot types are detailed under “Equipment Maintenance”).
- Test table, to place the sample pots on.
- Disposable gloves.
- Training samples (which for testing, should be different to those used for training). Best practice is to use the smallest samples available; note that training samples should not be cut up.
- For test sessions, include one sample of a target that the dog is not being tested on that day from the dog’s training kit to allow for training runs.

Training samples may absorb local contaminants during storage and use which could alter their odour. Therefore, different training samples to those used for training should be used wherever possible. Different samples must also be used during any formal assessment / accreditation activity.

- A range of interferent odours including “low odour” substances (e.g. soil, grass, cotton wool, paper, wood) and “high odour” substances (e.g. scented products, food flavouring on cotton wool).
- Interferent odours related to training samples (e.g. clean bags, pots and gloves).

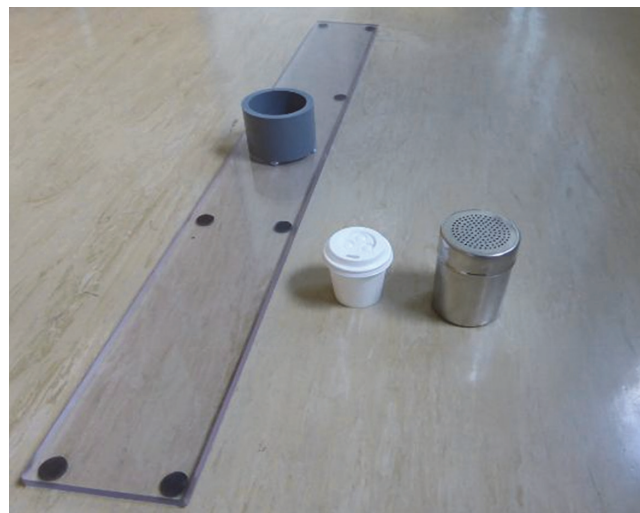


Figure 2: A plastic stand with two examples of sample pots: a disposable sample pot (a paper cup) and a re-usable sample pot (a stainless steel container with a perforated lid).

Equipment Maintenance

Stands

Stands can be made from hard materials such as plastic, stainless steel or wood. Materials which can be more readily cleaned, such as plastic, can reduce the likelihood of contamination. Stands should be wiped clean regularly using clean paper towel, warm water and washing up liquid. Stands should measure 1 m in length; this ensures each sample is presented at a suitable distance from the other samples. Example stand manufacture drawings are available on the CPNI website [4].

Pots

Either stainless steel or disposable pots (e.g. paper cups) can be used. Whilst stainless steel pots can be more expensive to purchase than disposable pots, stainless steel pots are re-usable and can be readily cleaned, therefore reducing the likelihood of contamination. Stainless steel pots may be used if the following washing protocols are adhered to:

- Re-usable pots should be washed at the end of each day of testing/training.
 - All pots should be washed on an intensive wash programme of a domestic dishwasher (used only for washing test equipment and not items which will come into contact with food).
 - Interferents and targets may be washed together but it is good practice to place the target pots on the bottom shelf.
- If a dishwasher is not available pots may be washed by hand as follows:
 - Fill a washing up bowl with warm water and washing up liquid.
 - Place all blank and interferent pots in the solution.
- For each pot/lid:
 - Rub the outside for 5 seconds with a cloth.
 - Rub the inside for 5 seconds with a cloth.
 - Hold the item under running water and rub inside and out for 5 seconds with a clean paper towel (one per pot).
- Repeat the washing procedures with the target pots:
 - Washing cloths will retain some contamination; do not use them for domestic purposes.
 - Washing cloths should be regularly replaced or washed in a washing machine.

Re-useable pots should be replaced every 6 months to prevent dogs learning individual target pots, or sooner if they become identifiable (e.g. dented or marked).

Disposable pots (target and interferent pots) and lids must be disposed of at the end of each day of testing/training. A new complete set of disposable sample pots must then be used during the next testing/training session. Consideration should be given to the impact on the environment when using disposable pots.

Sample Set-up

Sample preparation should occur away from the search area to prevent contamination of the working area.

- Sample pots should be prepared for each target type to be tested.
- Clean gloves should be worn to prepare each target type, where possible avoid touching the outside of pots with “dirty” gloves.
- Twenty interferent sample pots should be made up to present operationally relevant strong and weak odours as well as interferents associated with training samples (e.g. clean packaging). Gloves do not need to be changed between interferents.
- Additionally, five empty pots should be marked as “blank”; these should be treated as interferents.
- To be able to quickly identify the content of each pot during the test, without the need to open it, all pots should be marked (e.g. with “target A” or “interferent” stickers) on their base, where the mark is not visible during testing. It is important that the marking method is consistent across all pots; in order to prevent dogs and handlers from differentiating between interferent and target pots.
- Once set up, the same substances will remain in the pots for the duration of the day’s tests.
- One training pot should be set up using a known training sample of a non-test target.
- A clean pair of gloves should be put on at the end of set up.

Area Set-up

All setting up should be completed by the assessor prior to dog teams entering the area.

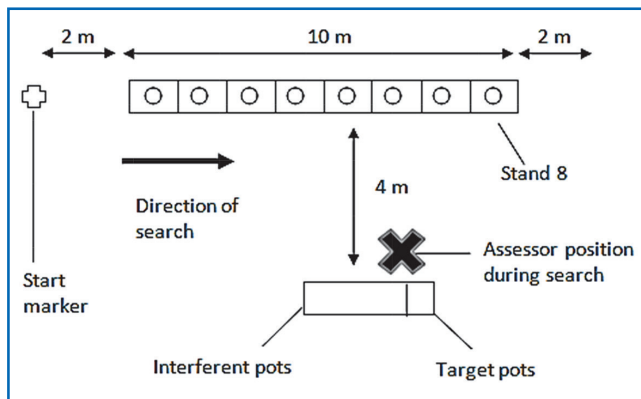


Figure 3: Area set up showing sample table with interferent and target sample pots, stands, start marker and location of the assessor during testing.

The area lay out should be as follows:

- Numbered stands should be set up with a start marker at least 2 m in front of the first stand. The start marker aligns dogs and allows them time to search the first stand.
 - Fig. 3 shows a linear set up however a curved line can be used as long as dogs are trained in a curved configuration.
 - A circular set up such as a carousel can be used, in this instance there is no start marker.
- The table should be set up approximately 4 m from the stands to ensure that dogs are not drawn to the odour emanating from the targets on the table. It is good practice to set up the targets out of the direct line of sight of handlers where possible.
- The sample pots for each target type should be placed on clearly labelled pieces of paper on one side of the table.
- Twenty interferent sample pots and five blank pots should be pooled together on the other side of the table. An additional area on the table should be defined where used interferent pots can be placed.
- A mark should be placed on the floor by the table. The assessor should return to this mark throughout each search run and should face the table (so that they are facing away from the stands). This ensures that the assessor does not unintentionally affect the outcome of the test.

Handler Briefing

Prior to starting a test, all handlers should be informed about the correct actions following an indication (as outlined in the test procedure section on the next page) and they should be briefed as follows:

1. Dogs will be given a training run at the start of their first search each day and at the start of their first search after a long break (e.g. after lunch).
2. Dog to begin at the start marker on each run.
3. Dogs should interrogate each sample pot in turn and not return to previously cleared pots; dogs should be worked on-lead.
4. The assessor will not watch the dog searching, therefore handlers must declare all indications AND any interest that their dog shows by stating the stand number without prompting (e.g. by stating "indication stand five" or "interest stand three").
5. The assessor will not respond to declarations of interest. The assessor will confirm or deny declarations of indication, after which a reward can be given for correct indications.
6. Some runs will be blank (i.e. will not contain a target sample pot).
7. Stands one and eight will not contain target sample pots during testing. False alarms on these stands will not count against the dog as they may be procedural training issues rather than odour discrimination issues:
 - Stand one acts as an "overlap" stand and ensures that dogs have settled into the search prior to encountering the first potential target.
 - Stand eight addresses indications given by dogs that have failed to find a target and take the chance of getting rewarded at the last stand. The absence of targets allows handlers to address false alarms as a procedural training issue.

Trial Plan

Prior to conducting a test, the assessor should generate and print a copy of the Trial Plan using the Tool [2] (available on the CPNI website – along with user instructions [3]). The Tool is a Microsoft Excel spreadsheet which can also be used for an eight stand carousel.

The Trial Plan generated by the spreadsheet will dictate the order and location of targets. It should also be used to record results as the test is conducted.

Trial Plans should be generated separately for all dogs being tested; up to three dogs can be included on one print-out. If more than three dogs are being tested, multiple tests should be generated rather than using duplicate copies of the same Trial Plan.

Test Procedure

See flow chart for test procedure (page 8).

1. One clean pair of gloves is worn by the assessor.
2. A training run is set up and the handler is told where the hide is.
3. The dog may complete the training run multiple times until it has indicated on the training target once without assistance.
4. The handler and dog leave the room or turn away from the search area.
5. The first run is set up as dictated by the Trial Plan.
6. The dog team enters the room and searches the run on-lead:

If the dog indicates, the handler declares the stand number and waits for a response from the assessor:

- **Correct indication:** The assessor will inform the handler that the dog is correct and the dog will be rewarded; this will complete the run. The team will leave the search area until recalled to commence the next run.
- **Incorrect indication (false alarm):** The assessor will inform the handler that the dog is incorrect. The team will leave the search area and the line is reset as follows:
 - All of the sample pots up to and including the pot where the false alarm was declared are temporarily removed.
- The handler and dog team are recalled and asked to re-search the entire run including the empty stands.
- False alarms on stand eight finish the run and the dog moves on to the next run.

The pot on which a false alarm was given should be removed from use and disposed of (if disposable) or given a thorough clean at the end of the day of testing (if non-disposable).

If the dog does not indicate but the handler believes that they showed significant interest in one or more samples, the handler must state "interest" and identify the stand in question.

- **Interest declared:** Interest will be scored according to the assessment criteria; handlers will not be informed whether they were correct or not. The run will continue as if no indication has been declared.
- **No declaration:** If no declaration is made during a run the team will leave the room until recalled to commence the next search.

7. Next run set up as follows:
 - Refer to paperwork and select next target.
 - Select one interferent sample pot at random.
 - Remove previous target from line and replace with the selected interferent.
 - Place next selected target substance in correct position in the line.
 - Return previous target substance to labelled paper and return used interferent to the designated "used interferent" area.
 - Select two new interferents from table and swap them into the line in any non-target position; place the old interferents in the "used interferent" area.
8. Repeat steps 6-7 until dog has completed six consecutive runs.
9. Change gloves for a new pair at the end of the 6-run block.
10. Rest the dog for a minimum of 5 minutes or whilst other dogs complete their first 6-run blocks.
11. Once all interferents have been moved to the "used interferent" area, they can be moved back to the general interferent pool and cycled through again.
 - It is not necessary for all dogs to see all interferents; however it is good practice to ensure that all interferents have similar usage.

Detection Scoring Criteria

Target detection scoring:

- Each correct indication is scored as 1.0.
- Each correct "interest" is scored as 0.5.

Dogs are scored **separately** for each target type.

The pass rate of dogs should always be determined in consultation with the end user (e.g. the individual requesting canine detection services). The test was validated using dogs proven to have good general search ability. For these dogs, the validation showed that:

- The majority of dogs (between 71-100%) that score 1 to 2.5 on a target in the test will find less than 80% of the same target type on an equivalent building search.
- The majority (between 62-98%) of dogs that score 4 to 5 on the test will find at least 80% of the same target type on an equivalent building search.
- A score of 3 to 3.5 on the test is inconclusive; as such it is advisable to repeat.

False Alarm Scoring Criteria

False alarm scoring:

- Each incorrect indication is scored as 1.0 FA.
- Each incorrect “interest” is scored as 0.5 FA.
- False alarms on stands one and eight do not count towards the FA score and are ignored for scoring.

A single false alarm score (FAS) is calculated as an average across the number of targets tested as follows:

Average false alarm score (FAS) = total FA score/ number of targets tested.

When run using the odour ID software, each dog will encounter a minimum of 20 interferences per target type.

The average FAS therefore correspond to the following false alarm rates:

- FAS 0.5 = 2.5%
- FAS 1 = 5%
- FAS 1.5 = 7.5%
- FAS 2 = 10%
- FAS 2.5 = 12.5%

The acceptable false alarm rate should be determined in consultation with the end user.

Preparing Dogs for the Test

The following procedure has been shown to be effective in preparing dogs for the odour discrimination test:

1. A pot containing a target is placed at position one, no other pots are placed in the line.
2. The dog is tasked to the pot and immediately rewarded on any indication behaviour.
3. The pot is moved half way down the line; the dog is worked to the pot along the empty holes and again rewarded on source indication.

False indications are addressed by waiting for the dog to move on to the next pot voluntarily.

Dogs are never corrected, punished or pulled off pots that they false indicate on, this ensures that the dog learns the task required of it rather than learning to rely on handler intervention to find the correct sample.

4. Empty pots are placed in the first holes, with the target at approximately position three; the dog is worked down the line and given a prompt reward at target.
5. Several runs are completed including empty pots and a target at different locations until the dog has successfully not indicated on the empty pots and indicated on the target on two consecutive runs.

6. A line of empty pots is placed out for the dog to search; this is repeated until the dog searches the line once without false indicating.
7. An interferent odour is placed at position one and a target at position two; the number of interferent pots is gradually increased until the dog has successfully searched one complete run.
8. Handlers work blind for all future training runs.
9. The target position is varied; once the dog has completed three successful consecutive runs a new target odour is introduced.
10. Training continues using all targets and introducing new interferent odours. During training, targets are often present in stands one and eight, although these stands do not contain a target during testing.

Trouble Shooting

- Dog missing the target in pots :
 - If this occurs early in training ensure that the dog is able to identify the target by placing the target out in a “normal” search hide and rewarding indication.
 - Give early reinforcement on the target in the odour line up using empty pots for all non-target holes.
- Dogs not searching the first stands – ensure that handlers are starting from the start marker and conduct several runs with the target at position one.
- Dogs giving multiple false indications stands 1-7–
 - Ensure that training has not progressed too rapidly, return to an earlier step if required.
 - Set up a line of 4-8 interferences and work the dog along the line repeatedly until it completes it once without false indicating. Reward the dog at the end of that run. Place a target early in the next run and then maintain a high proportion of blank runs in training, praising or rewarding the dog at the end of blank runs.
- Dogs false indicating on stand eight
 - Conduct several blank runs, rewarding the dog for not indicating on stand eight.

These training methods have been shown to be effective previously and are offered as advice only. It is accepted that there are multiple training approaches that may be as effective or more effective depending on the dog and trainer’s previous experience.

Associated Guides and Information

- [1] Scientific validation of the odour discrimination procedure for use with detection dogs:
Porritt et al. (2015) Validation of a short odour discrimination test for working dogs, Applied Animal Behaviour Science, vol. 165, pp. 133-142
<http://www.sciencedirect.com/science/article/pii/S0168159114003086>
- [2] Canine Odour Discrimination Test Setup Tool
DSTL/PUB89157
- [3] Canine Odour Discrimination Test Setup Tool –
Software User Instructions DSTL/PUB89154
- [4] Canine Odour Discrimination Test - Stand
Manufacture Drawings DSTL/PUB103695

Guide Author:

caninesupport@dstl.gov.uk

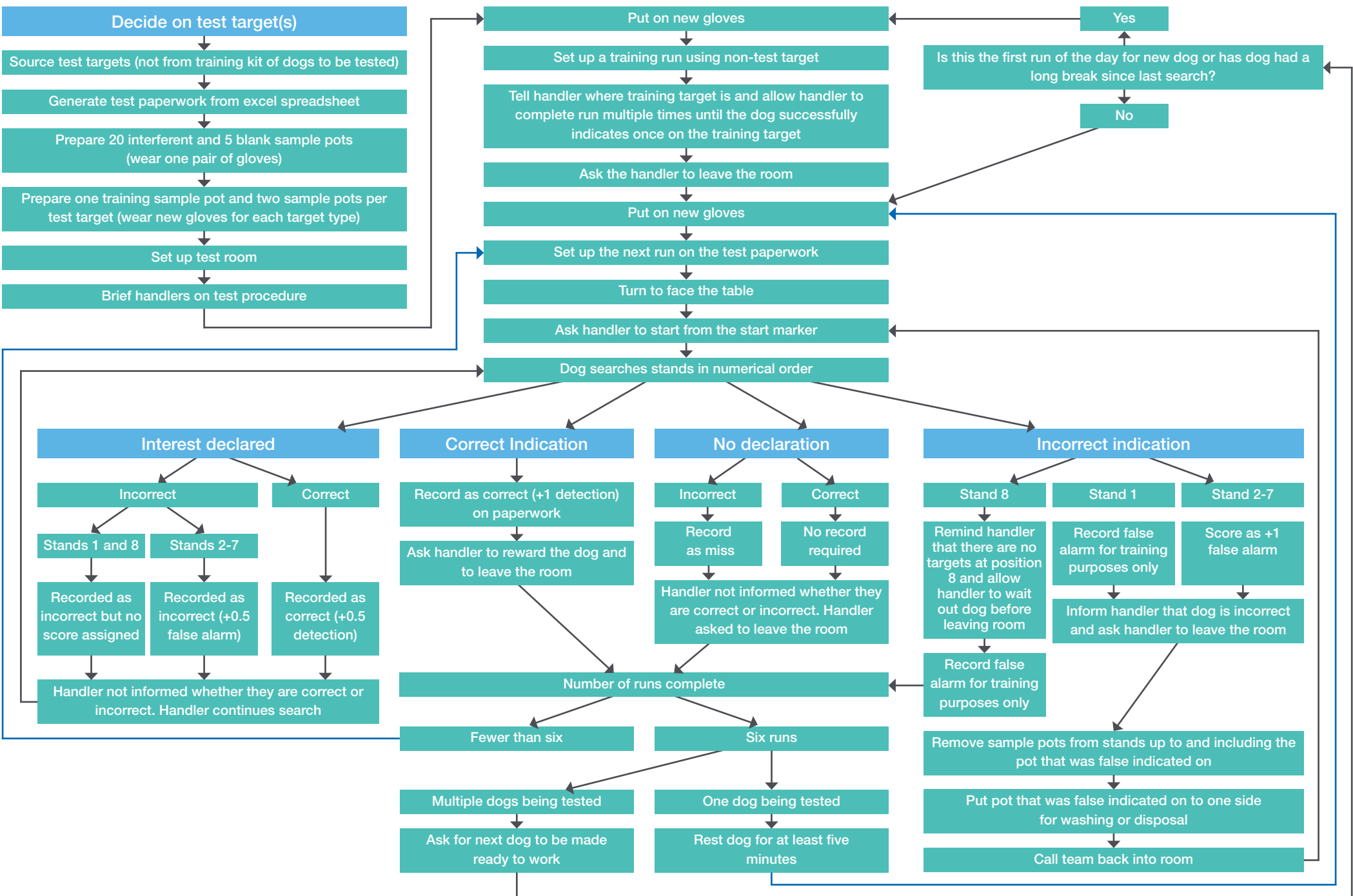
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Canine Odour Identification Setup Tool – Software User Instructions

What is this note about?

This note should be read in conjunction with the Canine Odour Discrimination Test guidance note (Dstl/PUB89074).

This note provides guidance on the use of the Canine Odour Identification Setup Tool (version 1.0). This tool is designed to create training and accreditation plans for detection dogs.

Who is this note relevant for?

All personnel responsible for training and testing detection dog capability.

Introduction

The Odour Identification (Odour ID) Setup Tool is designed to create training and accreditation plans for detection dogs. These plans can be prepared in advance and then printed out for use during training sessions. The tool allows the user to create bespoke plans, by entering the number of target substances, number of target positions and number of repeats per target substance required for the training session or accreditation.

The tool is licenced under the terms of the Open Government Licence. Links to further details can be found on the tool home screen.

Download and Installation

The tool can be downloaded from the [CPNI website](#). It is under 1MB in total (unzipped) size and should not take more than a few seconds to download. It should be saved to an appropriate folder within a local network or on a local drive. The tool will create PDFs which will be saved in the folder where the tool itself is stored.

Open the workbook

Open in the normal manner (double click from the folder in which it is stored). Users should see the home screen shown below in Figure 1. If prompted to, enable macros. If the system administrator has disabled the macro settings, consult them to enable this function. If macros have been enabled and the home screen is still not visible, please contact caninesupport@dstl.gov.uk with a screenshot or description of any error messages.

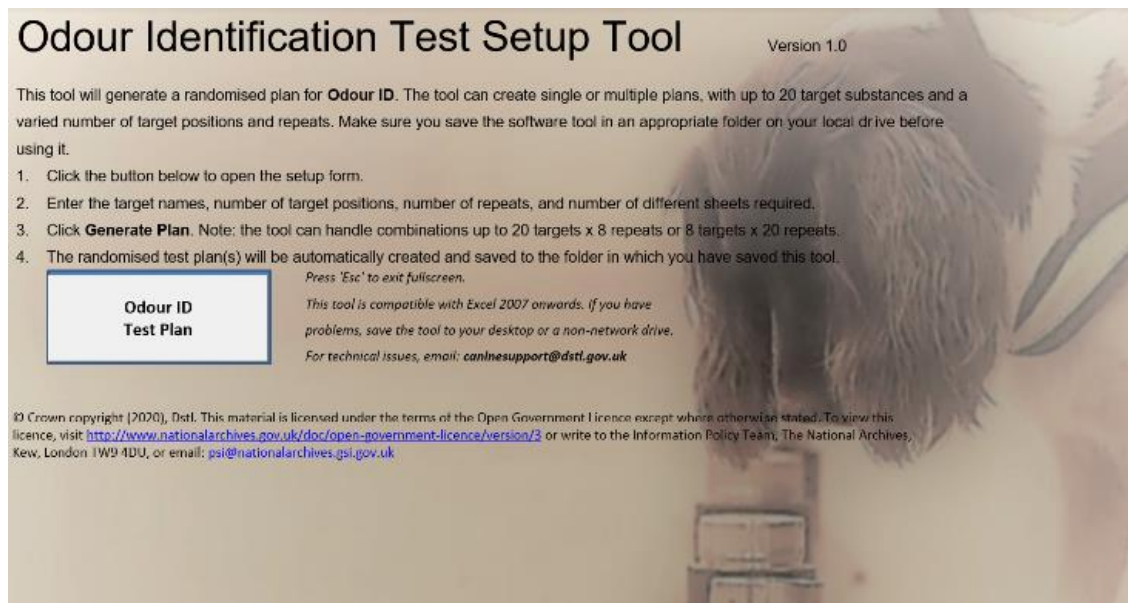


Figure 1. Home Screen of the Odour ID Test Setup Tool

Odour ID Test Plan

This function will produce an Odour ID Test Plan, fully randomised to include the specified targets and number of repeats, in accordance with the information inputted by the user.

Randomisation

Please note that true randomisation can sometimes result in a target order that does not appear at first sight to be random (i.e. three or more of the same target one after the other). This tool has been constructed to be truly random, not pseudo-random so users are encouraged to follow the generated plan, regardless of how it looks.

Interferents

The software defaults to a format of eight target positions and five repeats per target. If the software is used for accreditation, five repeats must be selected.

If the tool is used in an accreditation with more than eight target positions (e.g. if using an odour carousel), dogs will search a greater number of interferents than required to satisfy the validation assumptions of the accreditation.

If the software is used for training with fewer than five repeats per target, dogs may not search enough interferents to satisfy the validation assumptions of Odour ID accreditation, reducing the level of confidence in the results.

Limitations

The tool can produce plans with up to 198 runs. This means the maximum number of target runs is 165 to allow for the inclusion of blank runs. Whether a proposed plan is achievable can be checked by multiplying the number of targets by the number of repeats:

- Acceptable: 20 targets x 8 repeats = 160 target runs
- Unacceptable: 20 targets x 10 repeats = 200 target runs

Generating an Odour ID Plan

Generating an Odour ID Plan requires the user to set the test parameters and – if required – alter the advanced settings as detailed below.

Set Parameters

1. Click the **Odour ID Test Plan** button. The window shown in Figure 2 is displayed.

Figure 2. Odour ID Test Plan window.

2. **Scroll Bar.** Note the scroll bar at the right. Users will need to scroll all the way down to find the **Generate** button.
3. **Targets.** The tool can generate plans with up to 20 target substances. Use the inner scroll to continue to enter target names. There are a few rules to follow when entering targets:
 - a. Do not use duplicate target names.
 - b. Do not use illegal characters (*, <, >, =, ?, ', ')
 - c. Do not leave blank rows within the target list (e.g. if training with four targets input the information into Targets 1-4)
4. **Dog's Name.** It is not necessary to enter a dog's name – simply leave the field blank. If a dog's name is entered, it will be carried through to the generated test plan unless more than one randomisation is selected (see [Advanced Settings](#) below).
5. **Date.** This field is intended for the date that the training/test is due to take place. This field is not required to be completed, but if a date is entered it will be carried through to the generated test plan. Use a normal (UK) date format (e.g. 1 Jan 20, 01/01/2020) as described in Figure 2. If the tool cannot convert the date format then an empty space will be shown on the generated plan.

Advanced Settings

As shown in Figure 3, advanced settings are present in the tool to adapt the test set up and plan generation.

1. **Number of Target Positions.** This defaults to eight but can be altered using the left and right arrows. The first and last positions are never populated with a target as this tool may also be used for detection dog accreditation. It is important to ensure that these positions are still utilised during training so the dog continues to search all positions.
2. **Number of Randomisations.** This defaults to one but can be altered using the left and right arrows. This allows plans for multiple dogs and/or training sessions to be generated at the same time. If more than one randomisation is chosen, the dog name will not be carried over, and all plans will be saved in the same PDF.
3. **Number of Repeats per Target.** This defaults to five repeats (in accordance with Odour ID accreditation requirements) but can be altered using the left and right arrows.
4. **Colour / Black & White.** If the colour output is difficult to read or print, a black and white alternative is available.
5. **Header and Footer.** If text is entered in the Header and/or Footer box, it will appear on every page of the generated plan.

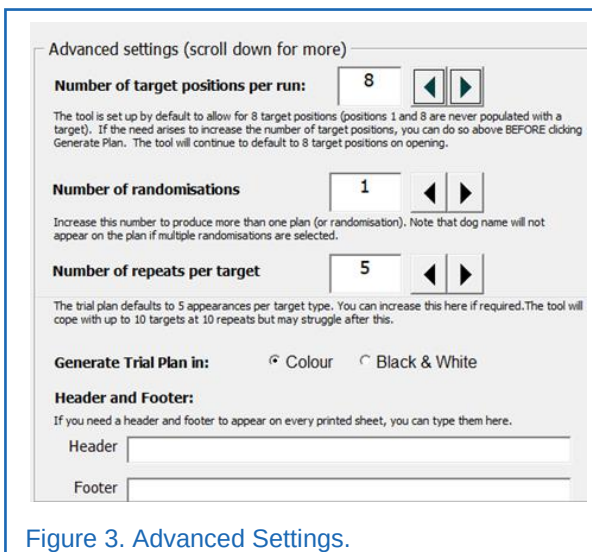


Figure 3. Advanced Settings.

Cancel / Reset Parameters / Generate Plan

1. **Cancel.** This will close the window but should keep settings and target names.
2. **Reset Parameters.** This will return all fields to their original, un-amended values. This will include targets, dog name, and date, which will return to blank.
3. **Generate Plan.** Click on 'Generate Plan' when the settings have been entered. The tool will take several seconds to create the PDF whilst it

randomises, checks requirements, generates a PDF, and saves the PDF in the folder where the tool is located.

Error Messages

If the plan generation is not successful users may receive one of the following messages:

1. **Duplicate filename.** Each test plan will be generated with a filename including today's date and the dog name as entered by the user. The tool will not over-write any files so, if a user enters the same dog's name again, the tool will request the user to add a suffix (e.g. "2" for the second test plan) to create a unique filename. The error message will repeat until the user enters a unique suffix or clicks 'Cancel'. If the user cancels the test plan setup will be aborted.
2. **You have a blank target within the target list.** A target name has been left blank within the target list (e.g. Targets 1-3 and 5-7 are populated, but Target 4 does not have a name). The window will remain open so this can be addressed. Click 'Generate Plan' again once this has been amended.
3. **You have a duplicate target name.** Two or more targets have the same name – this will affect the tool's ability to generate a plan. The window will remain open so this can be addressed. Click 'Generate Plan' again once this has been amended.
4. **You have used an illegal character.** In one or more targets, the user has entered an asterisk (*), less than (<), more than (>), equals (=), apostrophe (') or question mark (?) symbol. These characters will cause the tool problems so they are not permitted. The window will remain open so this can be addressed.. Click 'Generate Plan' again once this has been amended.
5. **The test parameters cannot be met.** The tool has not been able to satisfy the validation assumptions of the Odour ID test or the number of runs is greater than 198. Users can either retry by clicking 'Generate Plan' again, or amend the requirements by splitting targets across multiple plans or reducing the number of randomisations required.

Name and Date

Dog's name and date are contained within the title or (if no dog name and/or date entered) represented with empty square brackets as shown in Figure 4.

Targets

The targets as entered are shown in the table at top left. The number to the right of each target is the number of times that target appears in the test plan.

There is space on the left of the plan for the result for each target to be entered.

Plan Generation Details

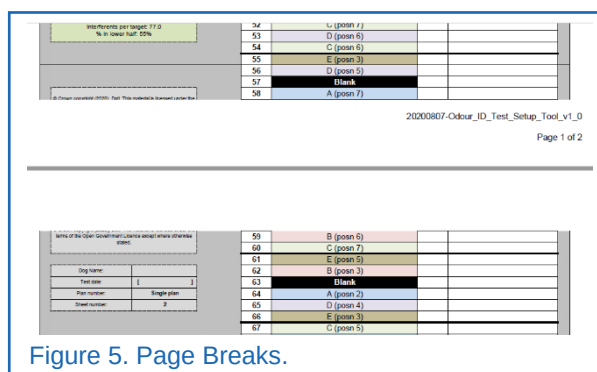
The document contains details of when it was generated, followed by information on the number of interferences per target and the distribution of runs.

Plan Setup

The test plan is arranged in groups of six runs; each group contains one blank run (i.e. no target). All runs are colour-coded (in the colour export) for ease of viewing. Each run names the target to be used and the target position to place it at.

Page Breaks

If the plan runs over multiple pages, the page number is shown alongside dog name and test date at the top of each subsequent page. The tool has been developed to export plans to PDF at default Windows scaling. If the page breaks do not appear as expected, reset the screen scaling to 125% (Windows Default) and restart the computer. Figure 5 shows how page breaks may appear if the scaling is not set to 125%.



Saving the Plan

The file is already saved – if the PDF viewer is closed the plan can be found by its filename which will be in the following format:

20200101-[dog name]_Odour_ID_Trial_Plan.pdf

Associated guides and information

- [1] Canine Odour Discrimination Test
DSTL/PUB89074
www.cpni.gov.uk/canine-detection-guidancenotes

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An introduction to how dogs hear

What is this note about?

This note provides an introduction to how dogs hear in comparison to humans.

Who is this note relevant for?

All dog handlers, trainers, care staff and personnel involved with working dogs.

Introduction

Hearing is used to detect, find and identify sounds. Dogs have better hearing than humans in many ways, and this is important for communication between dogs and their handlers.

Hearing development

Human babies can hear from birth, although it takes around a year to fully develop. Puppies, on the other hand, are born with their ear channels closed, so are largely deaf. The ears open at around day 12-14, and after that hearing quickly develops to adult levels by day 20 (Figure 1).



Figure 1: Puppies' ears open at around day 12-14.

Physical differences

The most noticeable physical difference in hearing between dogs and humans is that dogs have large outer ears called 'pinnae'.

The pinna acts like a funnel, amplifying sound into the ear. The size and shape of the pinnae differ depending on the breed – funnelling more or less sound or even acting like a sound barrier if folded down.

Inside the ear, the ear canal is longer, wider and more flexible in dogs than in humans. It also has a vertical section, which makes dogs more prone to foreign objects entering the ear (Figure 2).

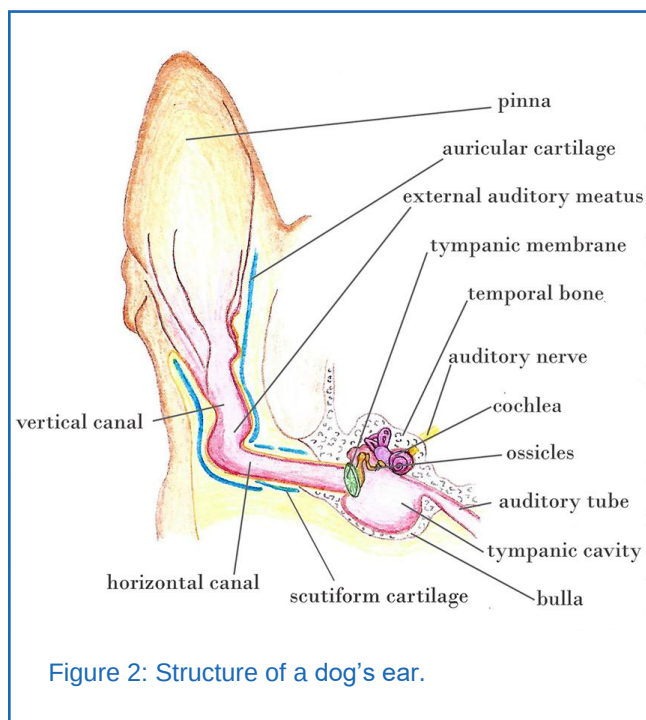


Figure 2: Structure of a dog's ear.

How hearing works

After being funnelled into the ear by the pinna, sound waves travel through the ear canal and vibrate through the eardrum. The vibrations are then amplified by tiny bones through to the inner ear. In dogs, these bones are shaped to amplify sounds better than in humans, giving dogs greater sound sensitivity. Therefore, dogs will perceive some sounds to be louder than humans. Sound vibrations then travel through the inner ear, to a spiral bony chamber called the cochlea. Here sound vibrations are converted into electrical signals that the brain can interpret (Figure 2).

Sound perception

The ability to hear a sound depends on three things:

- How high or low the pitch is (frequency);
- How loud or quiet the sound is (amplitude);
- How long the sound lasts (duration).

The human hearing range is between 20-20,000 Hz, while the dog's hearing range is 65-45,000 Hz. This means that dogs are able to hear sounds that are higher in pitch than humans, including ultrasounds (>20,000 Hz) produced by some rodents and insects. Therefore, dogs may respond to sounds that their handler cannot hear. However, dogs' sensitivity to low pitch sounds does not differ much from humans' (Figure 3).

Humans find it easiest to hear frequencies between 128-4,000 Hz, while dogs are most sensitive to higher frequencies between 200-15,000 Hz. This could partly explain why dogs may respond more to high pitched voices.

Small dogs are more sensitive to higher frequency sounds because of their smaller heads with proportionally bigger outer ears, and greater amplification abilities of the small bones in the middle ear. This means that they can hear quieter sound levels than humans can.

Sounds also need to last at least 100-200 ms to be heard by a dog or a human. More detailed information about sound perception by dogs can be found in a recent review of canine hearing [1].

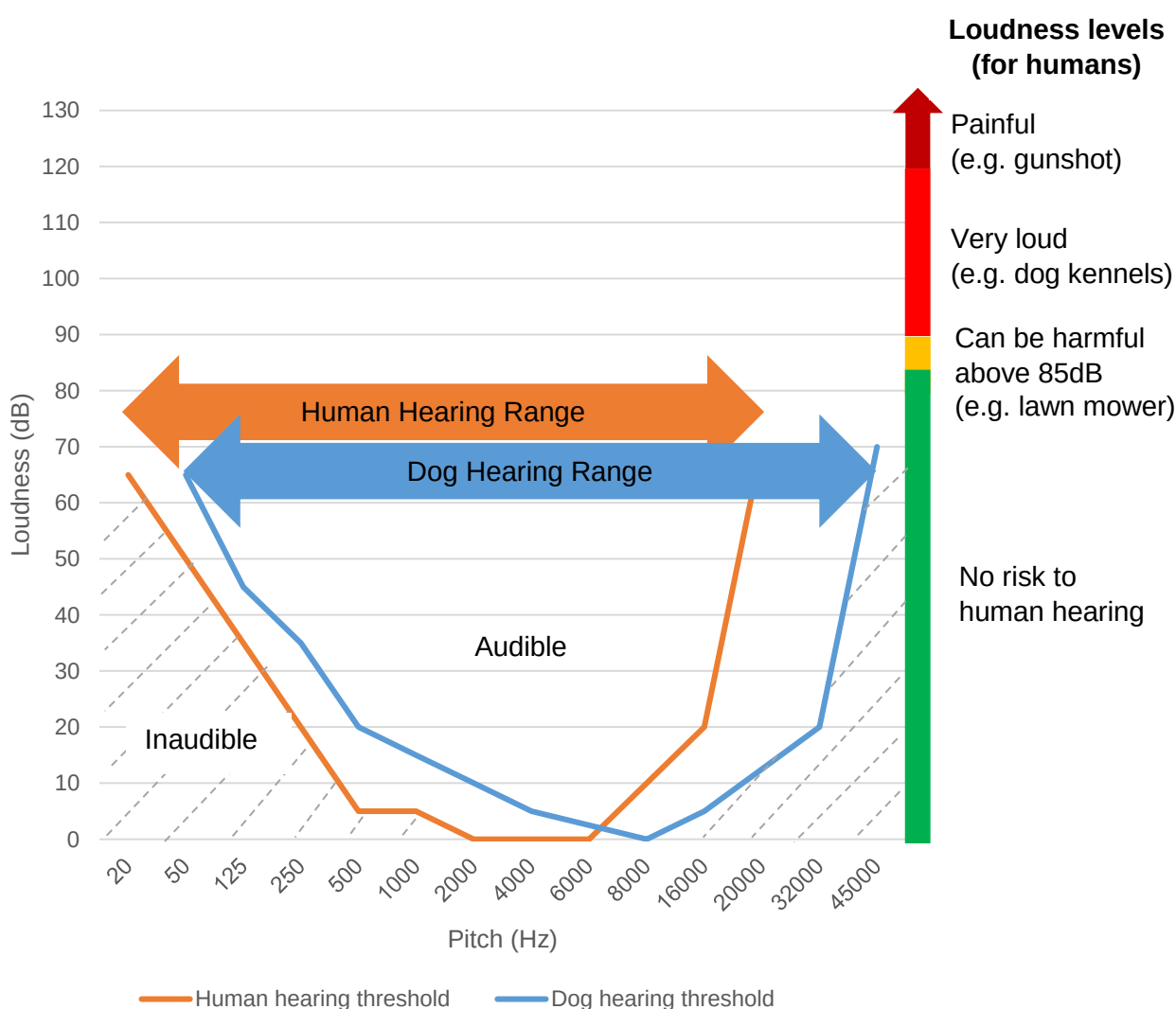


Figure 3: Sounds that can be heard by humans (area above the orange line) and dogs (area above the blue line) depending on their loudness (amplitude) and pitch (frequency). The green/red indicator arrow on the right shows human loudness levels (dog loudness levels are not known).

Direction

To find out where a sound is coming from in the environment, the brain compares the arrival time of the sound at each ear. There will also be slight differences in the loudness of the sound between the two ears, as the loudness drops the further the sound travels (Figure 4).



The outer ears play a key role in locating where a sound is coming from, due to their funnelling. For this reason, dogs with large erect ears are especially good at locating where distant noises are coming from. Although, when making fine differentiations, dogs can only localise the precise position of a sound source with an accuracy of 4° compared to humans' 1-2°.

Distance

Sound provides animals with important information about how far away the source is. This is because the loudness of a sound decreases by 6 dB every time the distance doubles. It is thought that dogs can hear some sounds that are up to 4 times quieter than humans can hear, so in some situations handlers might not be able to hear what their dog can.

Dog hearing vs. human hearing

Compared to humans, dogs have:

- Better detection of some quieter sounds from further away;
- Better high frequency hearing;
- Similar low frequency hearing;
- Better sense of which direction a sound has come from;
- Similar hearing injuries, but are more susceptible at lower loudness levels.

Hearing damage

Like humans, dog hearing injury and loss can be caused by very loud noises and can be temporary or permanent, partial or complete. The louder the sound, the shorter the amount of exposure it takes to damage hearing.

The loudness at which human hearing is immediately damaged is above 120 dB, and for every 3 dB increase in loudness over 85 dB, the allowable exposure time reduces by half to prevent hearing damage. Dog noise exposure limits are not currently known, but because their hearing is more sensitive, it is possible that dogs' hearing could be damaged at lower levels than humans, especially for high pitch sounds. For this reason, it is important to consider providing dogs with hearing protection when working in very noisy environments. It is recommended that dogs' hearing is protected to at least the same levels as their handlers' wherever possible. Consult a qualified veterinarian for further advice about working dogs in noisy environments.

A single very loud burst of sound, such as an explosion, can damage hearing immediately by rupturing the eardrum or damaging the tiny bones. However, more often hearing is damaged as the result of repeated exposure to loud sounds, such as a noisy kennel environment. Listening to loud sounds, such as other dogs barking in their kennels, can overwork hair cells inside the cochlea which causes them to die – this particularly affects the high pitch area of the cochlea, so the ability to hear high pitch sounds is most often affected. Exposure to loud noises can also cause tinnitus, which is hearing a ringing or roaring sound that can be temporary or permanent.

Taking steps to ensure that dogs' hearing is not damaged by a noisy kennel environment is required to meet three of the 'Five Needs' under the Animal Welfare Act (2006), by:

- Protecting dogs from pain, suffering and injury caused by hearing damage;
- Providing a suitable environment with comfortable noise levels;
- Allowing dogs to exhibit normal behaviour patterns, such as resting in a quiet area.

Further information can be found in the 'working dog welfare during kennelling' guidance note [2].

Deafness

Deafness can affect one ear or both ears. It also varies in severity from slight hearing loss (16-24 dB worse than normal) to profound (>91 dB worse) and can be temporary or permanent. Causes of deafness include exposure to loud noises, congenital or caused by disease. Deafness is more common in some dog breeds (e.g. Dalmation) and is also linked to the Merle colour.

Top tips for considering dogs' hearing

- ✓ Dogs may respond to quieter or high-pitched sounds that handlers cannot hear.
- ✓ Dogs' hearing may be more susceptible to damage by loud sounds than humans' hearing. It is recommended that dogs' hearing is protected from exposure to loud noises at least to the same level as people wherever possible.
- ✓ Very loud sounds like gunshots and explosions may immediately damage dogs' hearing, while longer exposure to loud sounds such as noisy kennels can also be harmful to dogs' hearing over time. Hearing health should be considered to ensure that there is good provision for dog welfare.
- ✓ If dogs' hearing is damaged by noise exposure, they may not be able to effectively hear their handler or other environmental sounds. This may be specific to certain sounds that they cannot hear (depending on the sound's pitch and loudness), and the effects can be either temporary or permanent depending on the level of damage.
- ✓ If you have any concerns about your dogs' hearing, consult a qualified veterinarian.

Associated guides and information

- [1] Barber, A.L.A., Wilkinson, A., Montealegre-Z, F., Ratcliffe, V.F., Guo, K., Mills, D.S. (2020). A Comparison of Hearing and Auditory Functioning Between Dogs and Humans. *Comparative Cognition & Behavior Reviews*, 15. DOI:10.3819/CCBR.2020.150005E
- [2] Working Dog welfare during kennelling DSTL/PUB104181
www.cpni.gov.uk/canine-detection-guidancenotes

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An introduction to how dogs see

What is this note about?

This note provides guidance on how dogs see in comparison to humans, including suggestions about how these differences might affect dog handling and training.

Who is this note relevant for?

All dog handlers, trainers, care staff and personnel involved with working dogs.

Introduction

There is a common acceptance that, in most situations, dogs have 3-8 times poorer vision than humans. This note covers the main ways that dog vision differs from human vision, and how this may affect their responses. For a more detailed review of dogs' vision, see [1].

Low-light vision

One situation in which dogs' vision outperforms humans' is under low-light levels. To do this, dogs have a number of adaptations:

- A larger pupil size (up to 10 mm compared to humans' 8 mm), allowing more light to enter the eye.
- A larger number of rod cells in their retina. Rods are a type of light sensitive cell that work in low-light levels, and are important for seeing size, shape and brightness.
- A tapetum lucidum, which reflects more light into the eye and enhances low-light vision (Figure 1).

These adaptations mean that dogs can see in darker conditions than humans.



Figure 1: The tapetum lucidum is visible as a greenish reflective area in the centre of the eye, helping the dog to see better in darker environments. Third party image reproduced with permission from P. Baumber.

Dog vision vs. human vision

Compared to humans, dogs have:

- Better low-light level vision;
- Slower adaptation to changing light;
- Worse visual acuity (sharpness);
- Less colour vision;
- Limited depth perception;
- A different visual perspective;
- Potentially better motion perception abilities.

Adapting to changing light

Light adaptation is the ability to become used to different brightness levels, including the time taken to see clearly when moving from dark to bright light conditions, or vice versa. When exposed to a bright light, all of the most light-sensitive cells (rods) in the eye temporarily stop working, and other cells (cones) take over. However, this takes some time, causing dazzling. This can be temporary, but if the light is too bright it can cause permanent damage to vision. Since dogs have more rods and fewer cones in their retina than humans, dazzling may be stronger in dogs. The time taken for the rods to work normally again after dazzling is also less in humans (20-30 mins) than in dogs (70 mins). When moving between extreme lighting conditions, dog's vision will be more strongly affected than humans and they may need more time to adapt.

Visual acuity

Dogs have fewer cones in their retina than humans (5% vs. 14%). The number of cones is important for seeing detail in daylight, meaning that dogs' visual acuity (sharpness) is worse – up to 15 times poorer than humans'. Dogs' visual acuity is further reduced by the tapetum lucidum in the retina, which scatters light and

makes their vision blurrier. Dogs will not be able to see things as clearly as their handler, especially in daylight.

Across dog breeds, the cones and rods are positioned differently in the retina. This means that long-skulled dogs such as German Shepherds have better visual acuity along the horizon, resulting in better movement detection. However, their visual acuity in the central area is poorer which might impact their ability to see things directly in front of them. Although this is not guaranteed as the positions of the rods and cones can vary even within dogs from the same litter. This means that one dog will see things differently to another dog.

Colour vision

Dogs' retinas contain two types of cone pigments which makes them dichromatic, whilst humans are trichromatic because they have three cone pigments. In dogs, one type of cone reacts to long/medium light wavelengths which are yellow hues. The other type of cone reacts to shorter wavelengths which are blue hues (Figure 2). This means that dogs have poor resolution of what humans see as the colours green and red. Instead, dogs see both red and green as yellowish hues, although they can still tell them apart from other colours. Therefore, some colours which appear very different to humans, like green and red, appear very similar to dogs. If different colours are needed for training purposes, blue and yellow are the best to use as dogs can more easily tell them apart.

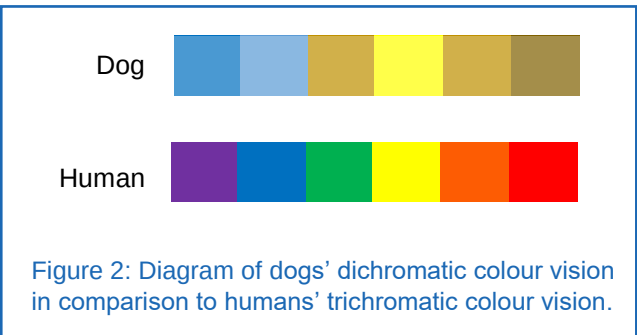


Figure 2: Diagram of dogs' dichromatic colour vision in comparison to humans' trichromatic colour vision.

Depth perception

The area that a dog can see without turning its head (its visual field) is determined by the position of its eyes, ears, snout length and length of fur. Overall, dogs have wider visual fields than humans, and can see between 150-240°, which allows them to more effectively scan the horizon. However, dogs have less binocular overlap between the left and right eye, which is needed for depth perception (Figure 3).

Depth perception is important for calculating the position and distance of objects. Some dog breeds have better depth perception than others, depending on the position of their eyes and skull shape. This means that some dogs may be more likely to misjudge distances.

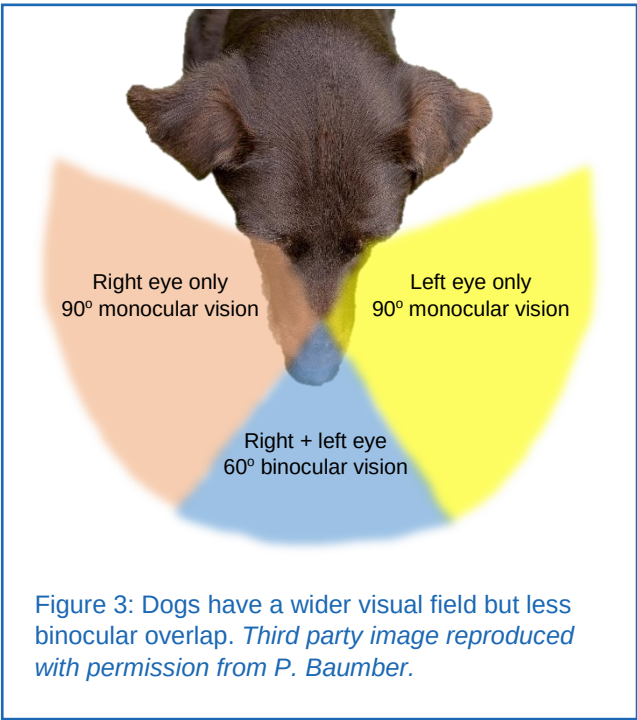


Figure 3: Dogs have a wider visual field but less binocular overlap. *Third party image reproduced with permission from P. Baumber.*

Motion perception

Motion perception is important for dogs. They can detect a moving target from further away (900 m) than a stationary one (585 m).

Visual perspective

The average height of a human is between 165-180 cm, whilst dogs' height to the shoulder varies between 15-110 cm. This means that dogs' vision is orientated more at ground-level than humans, and this size difference may be problematic when navigating through tall vegetation.

Long-skulled dogs may also be more restricted than humans when looking down because their snout can block their vision. To overcome this, dogs need to move their whole head downwards to see the ground.

Aging

Dog eyes appear to age faster than humans. Like humans, they experience lens thickening, hardening and clouding, possibly caused by damage from ultraviolet sunlight. This can make vision become blurrier with age. In addition, dogs' eyes can suffer from a range of diseases including, cataracts, macula degeneration and glaucoma.

While humans tend to become more long-sighted as they age (close objects become blurry), dogs become more near-sighted (distant objects become blurry).

Top tips for considering dogs' vision

- ✓ Ensure that dogs have enough time to adjust to changes in light levels before working.
- ✓ Avoid dazzling dogs with bright lights such as torches.
- ✓ Ensure that dogs are given enough time to navigate obstacles or gaps, as they may be more likely to misjudge distances.
- ✓ Consider that dogs will be able to see some things that a person can't in darker environments.
- ✓ Consider that dogs may not be able to see some things that a person can in brighter environments. Older dogs in particular may struggle to see things that are further away.
- ✓ To improve the chances of a dog seeing something, move it around and use blue or yellow colours.

Associated guides and information

- [1] Barber, A.L.A., Mills, D.S., Montealegre-Z, F., Ratcliffe, V.F., Guo, K. & Wilkinson, A. (2020). Functional Performance of the Visual System in Dogs and Humans: A Comparative Perspective. *Comparative Cognition & Behavior Reviews*, 15. doi:10.3819/CCBR.2020.150002E

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Working dog welfare during kennelling

What is this note about?

This note provides guidance on how to enhance the welfare of working dogs during kennelling. It brings together information from scientific literature, including the Practitioner's Guide to Working Dog Welfare [1] and government guidelines, such as the Department for Environment, Food and Rural Affairs (DEFRA) Code of Practice for the Welfare of Dogs [2]. Although this note focuses on kennelling, it is also important to consider dog welfare during training, transport and when working. Further guidelines relating to dog welfare can be found in the 'Associated guides and information' section.

Who is this note relevant for?

All dog handlers, trainers, kennel staff and personnel involved with, and managers responsible for, the care of working dogs. This note applies to both working dogs kennelled in a home environment (e.g. within a kennel at their handler's home) or at a centralised location.

What is animal welfare?

Animal welfare is generally defined as animal wellbeing, which incorporates two equally important components: mental and physical health. A more detailed discussion of animal welfare can be found on the World Organisation for Animal Health website [3].

Why is working dog welfare important?

All dog handlers, trainers, kennel staff and personnel involved with the training, transport and care of working dogs must be adequately trained and competent in ensuring that there is good provision for canine welfare and safe handling, for the following reasons:

- **To prevent animal suffering**
We have a moral obligation to prevent animal suffering, and it is widely acknowledged within scientific literature that many dogs do not adapt well to being kennelled [4].
- **To comply with the Animal Welfare Act (2006) [5]; the principal UK animal welfare legislation**
Section 9 of the Animal Welfare Act places a 'duty of care' on people to ensure that they take reasonable steps to meet the welfare needs of their animals.
- **To maintain an effective working capability**
Dogs with a good state of welfare tend to perform better during training, and may have a better ability to learn certain tasks. Fear and aggression caused by poor welfare can also lead to withdrawal from working roles which can have a detrimental operational impact [6].

How can I monitor working dog welfare?

Animal welfare is difficult to measure; no single physiological or behavioural measure can be used alone to accurately assess a dog's welfare. However, there are several signs of good and poor welfare which can be used as general indicators; examples are provided in the sections below.

Several factors can also impact welfare. For example, fear and anxiety in working dogs can result from inherited characteristics, environmental influences (e.g. handler relationship) and/or previous life experience; all of which will vary from dog to dog. It is therefore important to consider the following points when monitoring working dog welfare:

- The suitability of the individual dog's environment and daily routine and whether these fulfil the dog's needs.
- The individual dog's life history (e.g. assessing prior training records and speaking with previous handlers/owners).
- The individual dog's physical health (veterinary advice should be sought to effectively monitor this).

How can I ensure working dogs have a good standard of welfare?

A useful framework to help ensure working dogs have a good standard of welfare in kennels is to meet the '[Five Needs](#)' throughout their lives, as required by the Animal Welfare Act (2006) [5]:

1. [Need for a suitable environment](#)
Including sufficient space, shelter, appropriate environmental temperature/humidity and a comfortable resting and sleeping area.
2. [Need for a suitable diet](#)
Including ready access to fresh water and a diet to maintain full health and vigour.
3. [Need to be able to exhibit normal behaviour patterns](#)
Space, facilities and opportunity to carry out normal behaviours including movement, feeding, play, socialising and resting, and be mentally stimulated.
4. [Need to be housed with, or apart, from other animals](#)
Appropriate amounts of social companionship as required by the individual animal.
5. [Need to be protected from pain, suffering, injury and disease](#)
By prevention, rapid diagnosis and treatment of health issues and by ensuring conditions and treatment avoid mental suffering.

What are key signs of poor welfare in kennelled dogs?

If one or more of the '[Five Needs](#)' is not adequately provided for, dogs may show signs of poor welfare. Observing dogs for specific stress-related behaviours and any changes in their usual behavioural routines and repertoire can be a useful and relatively simple way to assess welfare. Some behavioural changes can also indicate underlying health problems. DEFRA's Code of Practice suggests a minimum of daily observations [2].

Behavioural observations can take place during kennelling, exercising, training sessions, operations and/or during transport. Identifying key places and times when particular behaviours occur may aid in understanding what is causing them. As human presence/absence can influence the presentation of some welfare indicators, remote monitoring using video cameras can be a useful way to observe dog behaviour in the absence of people. A range of behaviours that indicate poor welfare (based on scientific research) are summarised in [Table 1](#).

Abnormal behaviour	Description
Pace	Dog repeatedly (more than 3 times consecutively) paces around kennel in a fixed route.
Wall bounce	Dog repeatedly (more than 3 times consecutively) jumps up kennel wall from side to side.
Tail chase	Dog chases tail repeatedly (more than 3 times consecutively) for reasons other than discomfort or grooming.
Circling	Dog walks around in small circle repeatedly (more than 3 times consecutively).
Play bow	Dog repeatedly (more than 3 times consecutively) displays the play bow posture (i.e. dog lays front paws on ground as if to initiate play)
Chew bedding	Dog chews its own bedding.
Self-lick	Dog licks its own body repeatedly (over 5 minutes per session). Licking may be related to an injury or as a psychological coping mechanism
Lip-lick	Dog licks lips repeatedly (over 5 minutes per session).
Pant	Dog pants for reasons other than physical exertion or a warm ambient temperature (only recorded if temperature is less than 25°C).
Hide	Dog attempts to escape from the view of kennel staff behind its bed or other kennel furniture for prolonged periods when not asleep (over 2 minutes); may be accompanied by a low posture or trembling.
Chew bars	Dog repeatedly chews and bites at the wire of the kennel (over 20 seconds).
Self-bite	Dog repeatedly bites its own body (over 10 seconds).
Yawn	Dog opens mouth wide while taking a deep inhalation. Occurs frequently (even when the dog is active/alert), or more often than is usual for the individual dog, or mainly in specific circumstances.
Paw lift	Dog raises one forelimb off the ground for a prolonged period of time (over 5 seconds).
Body shake	Dog's entire body shakes (similar to when a wet dog dries off).
Startle	Dog jumps and shows concern by looking around and being alert to the surroundings.
Polydipsia	Dog drinks large volumes of water in excess of what is normal.
Lack of appetite	Dog does not eat more than 50% of the food that is presented.
Excessive vocalization	Dog barks for prolonged periods (over 1 minute) in the visual and auditory absence of people and other dogs.
Listless	Dog is withdrawn and unresponsive to commands.
Escape attempt	Dog attempts to escape kennel in a forceful manner whenever the kennel door is opened and closed.

Table 1: Examples of behaviours that may indicate poor welfare, adapted from Stephen and Ledger (2005) [7]

Figure 1 illustrates some examples of behaviours indicative of poor welfare (stress/anxiety) that have been observed in kennelled working dogs and which may be related to inappropriate kennelling [7]. These behaviours can occur in both the presence and absence of people.



Figure 1: Some examples of behaviours observed in kennelled dogs that indicate stress.

The behaviours shown in Figure 2, often referred to as ‘stereotypies’, are highly repetitive and appear to serve no obvious purpose (though they may be a way in which the dog attempts to cope with an unsuitable kennel environment) [4, 7]. They typically occur in the presence of people but can also occur when people are absent.



Figure 2: Examples of repetitive behaviours observed in kennelled working dogs.

Whilst these behaviours are typically regarded as signs of frustration due to an inadequate environment, scientific research has highlighted that there may be a distinction between dogs showing repetitive behaviours only when people are present (or at times of high arousal, e.g. when other dogs in an exercise area/training session are in view of kennelled dogs), and dogs performing repetitive behaviour when people are absent. Dogs that exhibit repetitive behaviour in the absence of high arousal events may be experiencing chronic stress. This emphasises the value of observing dog behaviour using video cameras, to identify how dogs behave in the absence of high arousal events including the presence of people [8].

Fearful behaviour can also indicate poor welfare and is sometimes less obvious than the repetitive or destructive behaviours described above. Fearful behaviours can include withdrawal (Figure 3), hiding, trembling and low body posture [7]. Fearful behaviours can occur both in the presence and absence of people.



Figure 3: Withdrawal behaviour

What are some key signs of good welfare?

Despite extensive research into the signs of poor welfare in dogs, there has been considerably less investigation into signs of good welfare (i.e. signs that dogs are happy and showing positive emotions).

Signs of good welfare include play behaviour, active exploration of the environment and friendly social interaction with other dogs and/or people. Resting is also sometimes used as a good welfare indicator [9]. However, excessive resting can also indicate poor welfare, for example if the dog's environment is insufficiently stimulating or if they are feeling unwell.

How can I ensure that kennelled working dogs' welfare is good?

Listed below for each of the '**Five Needs**' are suggestions to help meet these. These methods:

- Are based on recommendations within scientific literature and the DEFRA Code of Practice for the Welfare of Dogs [2].
- Are divided into 'quick wins' (low-cost methods which can be implemented relatively easily) and 'policy and design' methods (requiring longer-term planning such as kennel building enhancements).

1. Need for a suitable environment

There are three main pieces of UK legislation that apply to kennelling: the Animal Welfare Act 2006 [5], the Animal Boarding Establishments Act 1963 [10] and the Animal Welfare (Licensing of Activities Involving Animals) (England) Regulations 2018 [11]. The latter two documents apply to all boarding establishments that require licencing under the local authority. The Animal Boarding Establishments Act 1963 requires that "accommodation is suitable as respects construction, size, number of occupants, exercising facilities, temperature, lighting, ventilation and cleanliness".

Kennels should also be "safe, secure and free from hazards, and minimise the risk of injury to a dog, or escape of a dog" [12]. Further sources of guidance and advice on good kennel design include the Chartered Institute of Environmental Health (CIEH) Model Licence Conditions, Guidance for Dog Boarding Establishments 2016 [12], the Animal Welfare (Licensing of Activities Involving Animals) (England) Regulations 2018 Guidance notes for conditions for providing boarding in kennels for dogs [13] and an RSPCA guide covering the kennelling of seized dogs [14].

Quick wins

Protect from weather extremes

Dogs are particularly vulnerable to heat stress. Kennelled dogs should therefore be protected from hot weather and cold temperatures; kennels should have effective ventilation and temperature control systems. The ambient temperature

in the sleeping area of the kennel should be kept between 10°C and 26°C [12]. To protect kennelled dogs from wind and rain, part of their kennel should be weatherproof, allowing dogs to shelter in a dry, draught free and comfortable area.

Provide comfortable bedding

It is important for working dogs to sleep comfortably at night and rest comfortably during the day. The use of bedding, such as veterinary bedding (industry standard bedding for veterinary practices, groomers and boarding kennels), can increase comfort, as well as provide warmth during the colder months. Scientific literature highlights that bedding materials, such as straw [1], can also be used to provide mental stimulation in the kennel, because it provides a new odour and novel material for dogs to explore.

Bedding should be a suitable material that is safe for dogs. Some dogs may destroy their bedding (and potentially eat it). The condition of the bedding should be regularly monitored and changed if the material becomes hazardous. These dogs may be particularly in need of additional stimulation so, rather than removing the bedding, additional forms of enrichment (as discussed elsewhere in this guidance note, e.g. toys, raised platforms, access to enriched free runs) should also be considered and trialled.

Provide relaxing audio in kennels

Dogs have more sensitive hearing than humans and can be disturbed by noises, including other barking dogs. Therefore it is important that the kennel environment is as calm and quiet as possible. The playing of audiobooks [15] and calming classical music [16] has been found to increase resting behaviour amongst kennelled dogs and also decrease vocalisations (including barking, howling or whining). During one study, it was found to be most effective if played between the hours of 0900 and 1200. Sessions of audio may also have a beneficial effect at other times of day but, in the absence of specific scientific evidence, should not be used at night-time to avoid disturbing the dogs.

Built-in sound systems can provide good sound quality throughout a kennel block and within each individual kennel. Portable sound systems can alternatively be used to provide audio enrichment. Consideration should be given to sound quality and whether the volume is appropriate in each kennel (not too loud or quiet). Portable sound systems need to be placed in a dry part of the kennel block to prevent the equipment getting wet during cleaning. Any equipment (including cables) should also be placed in an area which is inaccessible to the dogs.

Accessing kennels from one side only

Whilst not tested scientifically, single side access is practiced in some UK rescue shelters with anecdotal positive effects on welfare. Typically, kennels are made up of two compartments, inner and outer, which are each accessed by a door. Accessing a kennel using one of these doors only can allow dogs to rest more fully in the non-accessed compartment.

Policy and design

Avoidance of kennelling large numbers of individually-housed dogs in a row

In large kennel blocks, each time a dog is taken out of a kennel a number of other dogs are disturbed, resulting in vocalisations and what is interpreted as distress/frustration in other dogs. Designing the layout of kennel blocks in such a way that fewer dogs are disturbed each time the block is accessed can therefore be beneficial [17].

Gradual introduction to kennel environment

Many dogs find the initial introduction to the kennel environment challenging. Dogs that are used to living in a home environment are likely to find a sudden move to living in kennels particularly stressful. It is therefore strongly recommended that, starting at an early age, dogs are gradually and carefully introduced to the kennel environment, using positive reinforcement techniques in order to encourage them to associate the kennel with pleasant experiences.

Example of a kennel habituation programme

In one study [18], puppy walkers initially accustomed the puppies (8 weeks of age) to spending short periods in a puppy crate kept in a room in their house. The crate was used as the puppy's bed, and provided an intermediate phase between indoor and kennelled living, allowing the puppies to become gradually accustomed to the restricted access to space and people. The crate was furnished to appeal to the puppies by providing comfortable bedding, as well as being covered on the back and sides with a sheet to make it a safe, secure, 'den-like' place for the puppy to retreat to. Within their first week, they were encouraged to enter the crate 6 times a day, including for their 4 meals. This process used positive reinforcement (i.e. a treat) to encourage them to calmly enter the crate. Initially at night, the crate door was left open to allow the puppy free access around the room, but any doors within the room were shut to prevent access to the rest of the house.

The next step was to accustom the puppies to being left alone in the closed crate. Once inside the crate, they were left for 30 seconds before being rewarded and allowed out. This step was repeated 5 times throughout the day. As they became calmer in the crate, the puppy walker gradually moved further away from the puppies and left them for progressively longer periods of time in the closed crate.

Once settled and able to spend longer periods in the crate (approximately 4 hours during the day and all night), the puppies were moved to an outdoor kennel with an attached run. They were introduced to the outdoor kennels using a similar gradual process to the crate introduction.

Throughout the process, it was at the discretion of the puppy walker to assess when the puppy was ready to be moved on to the next stage. After 11 months, all of the puppies could spend at least 8 hours calmly in a kennel during the day and sleep there all night. Dogs that were gradually habituated to kennel living in this way were found to have lower levels of stress-related hormones than non-habituated puppies that were placed straight into kennels.

2. Need for a suitable diet

Quick Wins

Provision of suitable diet

Most working dogs will be fed a diet authorised by their employing organisation, or prescribed by their veterinarian. The quantity of diet fed should be correct for the target weight of the dog (not their actual weight if they are, for example, slightly overweight or underweight). Food storage areas must be kept clean and free from pests. Food should be stored according to manufacturer recommendations and use-by dates adhered to. Changes to the diet should only occur if approved by the appropriate person. Training treats should be agreed by the organisation, or approved by the veterinarian if the dog is on a specific diet for a health condition. Dogs must also have access to fresh, clean drinking water at all times when kennelled.

Provision of feed via robust chew toys and anti-gulp bowls

Providing all or a proportion of feed in this manner, as opposed to giving all feed via a standard bowl, can help to improve digestion and provide a more mentally-stimulating feeding experience [1] (Figure 4).

Regularly changing the type of robust toy can help to maintain the dog's interest in using toys. Toys need to be suitably robust, of a size appropriate to the dog and non-toxic.

It is important to note that the provision of suitable toys in kennels has previously been shown to have no measurable negative impact on the working ability of dogs [19].



Figure 4: Kennelled working dog using a food toy

3. Need to be able to exhibit normal behaviour patterns

The way that dogs behave can indicate their physical and psychological welfare, including how well they are coping in the environment. Giving dogs access to objects or structures can provide them with opportunities to exhibit normal behaviour patterns. There are a wide range of commercial products specifically designed for dogs to interact with and some examples of product types which have been shown to improve welfare are included in this section. Any objects or structures used should be suitable for dogs and should not present a risk of injury to them.

Quick Wins

Provide platforms as permanent kennel furniture

The addition of raised platforms is a very good, simple way to enrich the kennel environment and improve dog welfare by encouraging natural behaviours and providing more options for resting and movement (Figure 5). Platforms have been found to be beneficial in a range of kennel environments [4, 20].



Figure 5: Kennel platform

Platforms are typically used as beds within the sleeping compartments of working dog kennels. Placing an additional platform within the external kennel compartment can:

- Encourage resting behaviour in the part of the kennel where many working dogs typically show behavioural signs of poor welfare.
- Allow dogs to make a choice about their resting location.
- Provide a small physical challenge that maintains strength.
- Allow dogs to carry out natural 'look out' behaviours.
- Provide protection from a cold floor.

Two-tiered platforms provide dogs with the choice to rest at two different heights. Care should be taken to ensure dogs can access and leave the top tier safely.

Allow dogs to urinate/defecate in a separate area to their kennel

Dogs must be taken out of kennels regularly and given regular opportunities to use a toilet area. Dogs naturally prefer not to urinate or defecate within their kennel and can become distressed if they have to do so.

Policy and design

Minimise time spent in the kennel

DEFRA's Code of Practice states that 'dogs need regular exercise and regular opportunities to walk, run, explore, play, sniff and investigate' [2]. This is best achieved through regular and sufficient time outside of the kennel unit. Training sessions and walking on and off the lead are good examples of activities within this category. However, if you are undertaking an activity that reasonably allows your dog to accompany you then all opportunities should be considered. The benefits include keeping your dog fit, active and stimulated. The Code of Practice indicates that 'if time alone is excessive, you can expect behavioural problems that are distressing for both you and your dog' [2].

Allow dogs regular access to enriched exercise areas

Providing groups of compatible dogs with regular access to large, enclosed areas allows social contact, exercise and an opportunity to explore an environment different to that of the kennel. Exercise areas can be enriched further by changing features of the environment to make it more challenging or stimulating.

Environmental enrichment can include variations to the [4, 19]:

1. Physical environment - platforms, layout, physical features/structures
2. Degree of social contact - other dogs and humans
3. Sensory stimulation - auditory, visual, tactile, olfactory and taste
4. Food presentation - schedule, frequency, portion size, type of food and container
5. Cognitive engagement - puzzles, tasks, novel activities

To increase the complexity of the outdoor exercise area, and therefore benefit dog welfare, a variety of safe, robust structures (e.g. tunnels, platforms and toys) and substrates (e.g. grass and sand) should be provided (Figure 6). Some UK dog rescue charities use sand as a flooring substrate in outdoor areas. This is both practical for husbandry staff who need to clean the area and also beneficial for the dogs, providing them with an opportunity to dig. To maintain the benefits of providing outdoor exercise areas, the contents of the environment should be changed and moved around regularly to reduce boredom. It is also important that dogs always have access to clean water, shade and shelter while using outdoor exercise areas, and that the climatic conditions are monitored.

Kennel enrichment

In potentially restrictive environments (both physically and socially) such as kennels, enrichment can help to encourage natural behaviour and provide mental stimulation, including allowing dogs to make choices or explore something new [4, 19, 20].

Dogs housed in enriched kennels show less alert and pacing behaviour than dogs housed in non-enriched kennels; they also show increased resting behaviours [4]. Enrichment can be used to promote the ‘Five Needs’ set out in the Animal Welfare Act 2006 [5]. Some examples of effective kennel enriching items include audiobooks (Section 1), chew toys (Section 2) and platforms (Section 3). Dogs should be provided with toys and/or feeding enrichment unless a veterinarian advises otherwise [11].

By having a good understanding of your dog’s natural behaviour, temperament, instincts and physical needs you can tailor the enrichment so that it is appropriate for them. Monitoring responses to enrichment and recognising changes in your dog’s physical and mental state that may require more or less enrichment is also critical (e.g. during socialisation, illness, injury or pregnancy) [4, 12].

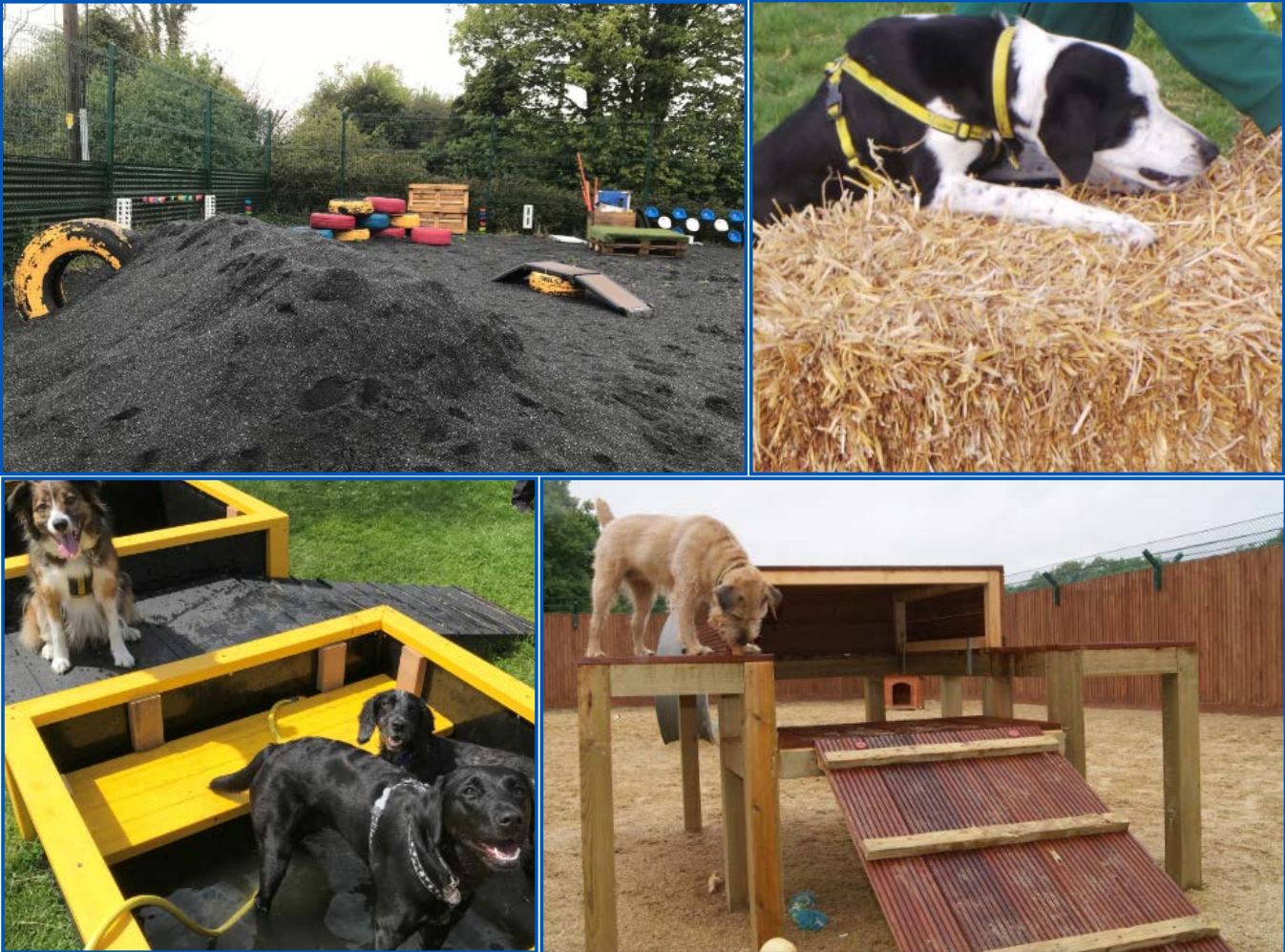


Figure 6: Examples of outdoor exercise area enrichment. Photographs reproduced with permission from the Dogs Trust.

4. Need to be housed with, or apart, from other animals

Quick Wins

Provision of positive human and dog contact

Dogs are social animals and generally find interaction with humans and other compatible dogs very rewarding. Providing positive interactions on a daily basis, both inside the kennel and external to the kennel environment, can therefore benefit dog welfare.

The provision of daily activities involving people and/or other compatible dogs (e.g. group walks and group exercise in free runs involving dogs which are known to interact in a friendly manner) can also help to reduce fear and distress by helping to ensure dogs are socialised and familiar with a range of kennel staff and their neighbouring animals. It is important to assess what type and amount of interaction each individual dog finds rewarding to meet their needs. Dogs which do not enjoy social interaction should not be forced to do so, but should be provided with environmental enrichment as an alternative.

Policy and Design

Pair housing

Dogs may find being left alone distressing. Pair housing carefully-chosen compatible dogs greatly enhances their welfare [21] (Figure 7). Pair housing has been successfully and widely adopted within research, rescue and working dog kennels.



Figure 7: Pair housed dogs

Tips for pairing dogs

1. Provide adequate space and resources appropriate for the number, size and breed of dogs. Space requirements should be increased according to the number of dogs housed together and should allow all dogs to lie outstretched at the same time at any angle within the kennel [11-14].
2. Ensure that the health requirements of all dogs are considered to prevent suffering and minimise the risk of disease spread.
3. Assess individual temperament for pairing suitability; dogs that find social contact with other dogs rewarding may adjust better to paired housing. It should be noted that a dog's motivation for human contact may not indicate their motivation for contact with other dogs. Do not mix dogs that show aggressive traits towards other dogs. As a general starting point, try to match dogs based on temperament, size, sex and neuter status.
4. Staged introductions should take place to assess compatibility and gradually introduce dogs. This could include housing dogs in adjacent kennels, repeated direct contact meetings (supervised and on a leash), increasing durations of time socialising together (e.g. within an outdoor exercise environment) and preferably kennelling in a neutral housing space (not previously inhabited by either dog) [6]. Regular monitoring for undesirable behaviours both inside and outside of the kennel environment following introduction is advised, including (but not limited to) growling, snapping, biting and lunging.
5. Observe interactions between dogs relating to resources to ensure that resource guarding (i.e. dogs aggressively defending food, toys etc.) is not an issue. There should be multiples of all resources equal to or greater than the total number of dogs in the kennel to allow access by all of the individuals. Separation during feeding, and in the presence of toys or chews, may be advisable to avoid aggression or rapid ingestion of food.

5. Need to be protected from pain, suffering, injury and disease

Quick Wins

First aid and emergencies

Employing organisations should have Standard Operating Procedures (SOPs) in place for emergency care. It is important to be familiar with these SOPs, to know how to carry out basic first aid and to have immediate access to the necessary first aid equipment in an emergency. Up to date information regarding access to veterinary services (including out-of-hours provision) should always be available so that no time is lost in the event of emergency requiring veterinary advice or intervention. This is particularly important if working in an unfamiliar area or part of the country and details of local veterinary services should be identified prior to deployment. Plans should also be in place to protect dogs and staff in case of fire or other emergencies.

Know when and where to go if you have health concerns

It is important that dogs are presented to a veterinary surgeon if there are any concerns over their general health. Routine healthcare, as defined by the employing organisation, such as vaccination/worming protocols, must be kept up to date.

Recognise 'normal' in your dog

In order to know when a dog is unwell it is necessary to know what 'normal' is for that individual dog. All dogs will be slightly different, so it is important to be familiar with their individual behaviour and demeanour. Dogs should be checked at regular intervals throughout the day for signs of illness, injury and/or abnormal behaviour. A dog's normal weight, eating/drinking habits, urination/defecation routine (frequency, volume, colour, smell and consistency) and, for entire bitches, season interval and length should be identified and recorded. It is also useful to monitor resting heart and breathing rate, gait patterns and general energy levels. This information should be readily available within the dog's records.

Recognise trends

When spending nearly every day with an animal it may become difficult to recognise subtle changes. For monitoring changes over time, some handlers use a 'Black/Red' recording system. On regular weighing if the weight is the same, or has gained, the entry is made in black ink. If the weight is less than last weight then the entry is made in red ink. Several red entries could signal progressive weight loss which should trigger investigation (for example, if weighing monthly then more than three consecutive red entries should initiate a consultation with a veterinary surgeon for a check-up). Similarly, more than a defined number of black entries could indicate weight gain which should be investigated.

Policy and Design

Kennel design and maintenance

As previously mentioned in Sections 1 to 4, modifications to kennel design can help to prevent or minimise suffering. Materials used for the construction and contents of the kennel should not be detrimental to the dog's health, including if it is chewed, damaged or destroyed by the dog. In addition, a regular schedule of detailed kennel inspections should be in place at a time when the kennel is empty to monitor it for physical features that could lead to pain, suffering, injury or disease. This includes leaks, sharp edges, loose or broken fixtures and fittings (e.g. panels, wiring, hinges etc.) and inadequate security.

Emergency isolation facilities

The Animal Boarding Establishments Act states that all reasonable precautions should be taken to prevent and control the spread of infections/disease. There should be housing available for sick or injured animals to minimise the risk of transmission to other dogs and assist recovery.

Health examination

Regular health examinations to assess for skin conditions, oral complaints (redness, swelling or ulceration), feet pad/nail condition etc. may help to identify areas to be monitored or treated at an early stage. Reward-based training (e.g. provision of food treats) can be used to reduce stress associated with physical examinations and other handling/husbandry procedures and makes these into positive experiences for dogs [22].

Seek expert welfare advice and support

Welfare issues are often complex to resolve and involve a range of factors. If you have concerns about your dog's welfare or behaviour that are not resolved through changes in their kennel environment or routine (as discussed above), it is important to seek further, expert advice.

Your veterinary surgeon is an important first point of call in order to rule out any health-related issues. Further expert advice on welfare and behavioural issues can be obtained from organisations such as the Association for the Study of Animal Behaviour (ASAB) [23] or the Association of Pet Behaviour Counsellors (APBC) [24]. These bodies certify a network of appropriately qualified and experienced clinical animal behaviour experts, who will work with you to identify problems and suggest structured treatment plans to try to resolve them.

Keeping effective records

In order to keep track of dog welfare and solve any problems rapidly, it is important to keep clear, up-to-date and easily accessible records. These should cover areas including:

- Vaccination history
- Veterinary treatment received/ongoing
- Weight
- Kennelling provisions (e.g. toys, other enrichment, furniture, access to outdoor exercise areas)
- Any behavioural/welfare issues including:
 - Frequency/circumstances of occurrence
 - Any significant incidents (e.g. aggression, bites)
 - Possible causes
 - Previous attempts to resolve
 - A behaviour modification plan to resolve any issues (agreed and reviewed with trainer/veterinary surgeon/clinical animal behaviourist as appropriate)

Associated guides and information

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GUIDANCE

Key points to consider when specifying, procuring and implementing detection dog services



This short guidance document is intended to help those responsible for an organisation or site's security to procure effective detection dog services that meet their security needs. It outlines the steps necessary – from identifying the Operational Requirement, through procurement to successful implementation.

Understanding your Requirement

- *Be clear about your Operational Requirement*
 - What threats and risks are you trying to mitigate that detection dogs might help address?
 - What threat items?
 - Explosive materials and / or devices?
 - Including fireworks, pyrotechnics, flares?
 - Firearms and / or ammunition?
 - Drugs?
 - Electronic items?
 - In what context?
 - Entering your building or site in vehicles? (Cars, vans, lorries, etc?)
 - Entering your building or site in deliveries and / or mail?
 - Brought in by people (staff, contractors, visitors, the general public)?
 - Hidden or otherwise left behind in your building / on your site?
 - Screening people or items leaving a building or site for loss-prevention purposes?
 - How might detection dog capability contribute to the security of your organisation / site, and complement other security measures?
 - In addition to their ability to detect threats, and be deployed flexibly, dog teams can provide visible reassurance to the public while deterring those with hostile intent.

Operational considerations

- *A handler and a dog should be regarded as a team – detection capability results from them working effectively together.*
 - A dog should only have one handler, though a handler may have up to two dogs (for example, allowing one dog to work while the other rests).
 - A skilled handler knows how to get the best out of their dog – and should be proactive at spotting and acting when the dog isn't performing to the best of its ability.
- *Like people, dogs can suffer from fatigue and/or boredom, both of which will affect their performance.*
 - There are no definitive rules as to how long a dog can work effectively for, either without a break or overall within a working day; it will depend on a variety of factors including the nature and intensity of the search task, the age and breed of dog, and the ambient temperature.
 - Where a dog is working continuously, for example searching a constant stream of vehicles arriving at a site entrance, it may well need a break after around 20 – 30 minutes.
 - A good handler will know their dog and recognise when it needs a rest or a break; this is one of the reasons why it is strongly recommended that a dog should always work with the same handler, and why a handler may have two dogs (working one while the other rests).
- *A team (handler and dog) should only be deployed for roles in which they have suitable training and experience as a team, and can demonstrate competence.*
 - Do **not** allow mission-creep. For example, a dog team that has only been trained for, and demonstrated competence at, screening vehicles should **not** be deployed to search a building (until they have undergone the necessary additional training and demonstrated competence). Even though the dog may **appear** to search the building effectively, it may not have the skills and experience to recognise trained (threat) odours in that environment.
 - A dog should only be trained to detect explosives **or** firearms **or** other specific classes of threats. Where this is not the case and a dog is trained across multiple threat classes, there is a risk that an inappropriate emergency response is initiated in response to the dog indicating, for example a response appropriate for detection of explosives is initiated when in fact traces of drugs were actually present.
 - It is important to understand the provenance and history of a dog. The detection dog service provider **should** maintain, and hence be able to provide, a full record of the dog's life, including any medical history, training and operational experience. Consider reviewing this. The dog should be uniquely identifiable by a microchip.
 - Has the dog previously been “retired” for inadequate performance?
 - Has the dog previously been trained, for example, to detect drugs but is now being marketed as an explosives detection dog?

- *Understand your detection dog service provider's commitment to, and investment in, operating to the highest standards and latest good practice. How does this apply to training (both initial and on-going) and animal welfare, and to continuing professional development of their handlers?*
 - Ask to see training records for any new dog teams engaged, and consider reviewing auditing periodically and on contract renewal.
 - Are training records well-structured, detailed, and up to date?
 - Are issues that occur – whether in training or operationally – noted, with training needs identified and their timely completion to a suitable standard evidenced?
 - Do explosives detection dog teams have regular opportunities to train on a wide variety of threat-relevant explosives (spanning commercial, military and home-made materials of different origins, ages and quantities)?
 - *There are significant health and safety, security and administrative burdens associated with storing explosives and using them for training detection dog teams. Regular access to a broad range of samples is key to developing and maintaining a robust detection dog capability.*
 - Are training and assessment sessions operationally relevant / realistic? Are they well matched to the types and sizes of threats, concealments, and types of searches identified in your operational requirement?
 - Are training and assessment sessions led by an independent instructor?
 - Do the handlers keep up to date on, and follow, latest good practice, for example the latest HM Government Detection Dog Guidance Notes (<https://www.npsa.gov.uk/canine-detection-guidance-notes>)? What other continuing professional development do they do?
- *Be clear about what capability your dog teams do (and don't) offer.*
 - No individual security measure is perfect, but a layered approach combining multiple different effectively implemented security measures can be very hard to defeat.
 - Are there other measures you can add (or adapt) that would usefully complement your detection dog capability?
- *Be clear and realistic about how to respond when a dog "indicates".*
 - Dogs are trained to "indicate" (e.g. freezing or sitting, looking in the direction of the source of the odour) when they smell a scent that they have been trained to detect.
 - This does **not** necessarily mean that a material of concern is present in a quantity that poses a threat. For example, an explosives detection dog may detect some contamination on someone who legitimately works with explosives. Or, the dog may simply smell something benign that it thinks smells similar to a trained material.
 - Dogs may also show "interest" where they encounter an odour that is similar, but not identical to, a trained one. Such "interest" may be quite obvious or very subtle. As there are a very wide variety of potential threat materials (e.g. commercial, military and home-made explosives) and their odour may also vary with factors such as age and differing storage conditions, spotting and acting on "interest" is essential. Again, a handler who knows their dog well should easily spot signs of "interest".

- It is essential that all “indications” and signs of “interest” are investigated appropriately as part of a defined escalation process; unless there are other robust indicators or intelligence that a threat is present, it will not normally be appropriate to immediately initiate a full emergency response.
- *Ensure your site’s security operating procedures – including escalation and emergency response protocols – cover your detection dog capability.*

Legislation and Standards

- *The National Canine Training and Accreditation Scheme – Private Security Industry sets standards for the explosives detection dog team accreditation in the private security sector.*
 - NPSA recommends that all explosive detection dog teams meet this standard.
 - It is good practice for detection dog service providers to demonstrate compliance with **BS8517-2 Security Dogs Part 2 – Code of Practice for the use of Detection Dogs**. This provides a valuable foundation for, but does not in itself guarantee, effective capability.
- *A dog handler should have the appropriate SIA licence where their role is deemed a licensable activity.*
- *It is essential that you consider the health and safety, and animal welfare, implications of deploying detection dog teams on your premises.*
- *You have no right to search or screen people or their possessions, but may make compliance with security measures a condition of entry to your site.*
 - Some people may object to being screened by a detection dog for cultural, religious or other reasons; it is essential that you have alternative search procedures in place to accommodate to such requests.

Effective procurement – getting the detail right

- *As with any other procurement activity, take appropriate steps to ensure your chosen detection dog service provider(s) meets your needs (as identified through your operational requirements), and that they fully understand your requirements.*
- *Ensure key details are formalised in your procurement arrangements with your detection dog service provider(s); many of the points raised in this guidance note may be relevant. In addition:*
 - Consider whether you always want the same teams (handlers and dogs) – you may wish to issue them with access control passes – or whether you will accept any teams your provider offers on a given day. Will you tolerate sub-contracting? And if so, how will that be managed and quality assured?
 - Where you always require the same teams, how will absences (leave, sickness, etc.) be accommodated?
 - Where you always require the same teams, but not full-time, do you have any concerns about where else the teams may be deployed?
 - Under what circumstances might you wish to uplift or otherwise alter your detection dog service requirements? And how would your chosen supplier propose to meet such requests?
- *Does your supplier have any requirements of your organisation / site – e.g. shaded space to park dog vans, or areas to train, rest and/or exercise dogs?*

Summary

In summary, training and maintaining an effective detection dog capability is a resource-intensive activity. An effective capability is unlikely to be cheap, but can be deployed flexibly where it will offer most significant security, reassurance and deterrence benefit. As with all security measures, it is essential to understand your operational requirement and take all appropriate steps to ensure any contracted detection dog service meets your site or organisation's particular needs.

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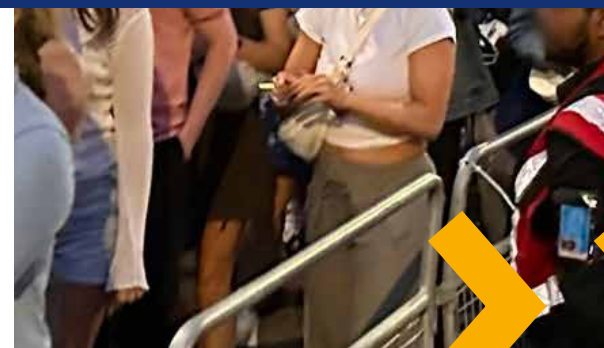
Mitigation of Terrorist Threats at Venues during **Ingress** and **Egress**



Introduction

This guidance aims to highlight the primary security concerns arising during the ingress and egress phases of venue operations. It will subsequently outline various strategies for mitigating the related risks. Recognising vulnerabilities in these situations and striving to reduce them is a fundamental part of protective security planning and an essential task for those with responsibility for ensuring the safety and security of staff and visitors.

The terms ingress and egress are used in this document as they are phases or periods of time. To some extent these words are interchangeable with 'entry and exit', however, the intention is to look at the vulnerabilities that arise, particularly as a consequence of crowds forming, during the build-up, arrival, departure and dispersion stages of a venue's operation. Ingress and egress may not always be linear and can occur concurrently for example during multiple event days or at large shows operating over extended periods. This does not detract from the purpose of this guidance which is to help identify vulnerabilities during ingress and egress and propose potential control measures.



¹ [ProtectUK | Home](#)

² [Guide to Safety at Sports Grounds 'Green Guide' - Sports Grounds Safety Authority \(sgsa.org.uk\)](#)

³ [Introduction \(thepurpleguide.co.uk\)](#)

⁴ [Safer Crowds Safer Venues](#)

Scope

Who is this guidance for

This guidance can be applied to any venue where crowds are likely to form during ingress and egress. The sort of venues envisaged include stadia, concert venues, exhibition centres, theatres, nightclubs, shopping malls, theme parks and temporary sites that are set up for short periods or single events such as festivals.

It will be most useful for people with responsibility for the design or operational security at venues or events including: venue owners and operators, event management and security companies, agencies and their planning teams, security co-ordinators, safety officers, security advisors (in the public and private sectors), risk assessors, security managers and duty or operational managers.

Some of the measures mentioned in this document are for advanced security regimes at higher risk venues that have the capacity and budget to put them in place. Many other measures mentioned are more elementary and emphasise design, communication, operational or procedural measures that can cost very little but still enhance a venue's security posture regardless of its size or budget.

What this guidance covers

This guidance outlines potential vulnerabilities during ingress and egress and then provides a scalable approach to security regimes, from a basic design to more complex solutions. It covers:

- **Crowding during ingress and egress.**
- **Key components of reducing risk.**
- **Understanding potential threats.**
- **Identifying vulnerabilities during ingress and egress.**
- **Control measures to be considered when looking to reduce risk.**
- **The importance of recording security processes, testing, reviewing and revising.**
- **Through an example, shows how control measures may be applied at a venue.**

What this guidance does not cover

During ingress and egress there are potential safety issues, through overcrowding, which could lead to crushing, trampling or other potentially life-threatening consequences. These concerns are hugely important to the management of events and should be considered as part of the overall planning and risk assessment process. This issue is not covered in this guidance, but further information can be found on the ProtectUK website¹ and within the Sports Grounds Safety Authority (SGSA) Green Guide² and Supplementary Guidance 03 'Event Safety Management'. Also, the Purple Guide³ is a comprehensive document outlining safe standards for the running of outdoor events. Lastly, for small to medium size venues, there is a good practice guide called 'safer crowds safer venues'⁴, that focuses on crowd management in UK performance and licensed spaces.

Crowding during ingress and egress

What is a crowd?

A crowd is a group of people who are gathered together in a specific location or area. The term 'crowd' typically implies a large number of individuals but can vary in size dependant on the environment or setting.

Crowds can have a diverse composition of individuals with different backgrounds, beliefs and motivations. When attending a particular venue, they may be united by a common interest, goal or purpose.

In a crowd, people often interact with one another, and the resulting dynamics can range from peaceful and cooperative, to energetic and enthusiastic, or even disorderly and unpredictable, depending on the circumstances and the behaviour of the individuals involved.

A crowd can sometimes exhibit certain characteristics that differ from individual behaviour. Factors such as anonymity, lack of individual responsibility and group influence can change the actions and decision-making of individuals within a crowd.

Crowds often act in a socially coherent manner and their actions can act as an early warning. For example, there may be a mass movement when a crowd responds to a perceived threat.

Why are crowds potential targets?

Crowds are potential terrorist targets for reasons including:

Exposure

Crowded areas, such as those that form during ingress and egress, are often accessible areas where there is little protection, which makes them vulnerable to an attack.

Soft targets

Crowds going to venues often consist of people who are excited, relaxed, chatting or otherwise distracted and may not have security awareness.

Demographic

Certain events may attract sector(s) of the population that makes them an attractive target for certain threat actors.

High profile and impact

Terrorist groups aim to generate maximum impact by targeting locations where a large number of people are gathered. Attacks on crowds can result in high numbers of casualties, widespread fear, and disruption of everyday activities.

Psychological impact

Terrorist attacks on crowds can create fear, anxiety and a sense of insecurity among the general population. By targeting crowded places, terrorists aim to create a climate of fear and disrupt social harmony, potentially influencing public opinion and causing socio-political ramifications. Media attention amplifies the impact of their actions.



The threat during ingress and egress

The start and finish times of events are usually predictable, as are the areas where there will be increased crowd density during ingress and egress. This increases vulnerability at these times and locations and must be taken into consideration as part of the security planning process.

During ingress, venues can create potential target areas as crowds form. This could be during the approach to the venue, at gates or restrictions on the outer perimeter, at a ticket check area, search area or point of entry. Clearly, safety is an important consideration in all of these areas, and safety and security should be considered together.

The threat during egress differs, in that crowds may form whilst leaving a controlled environment and entering an uncontrolled area where they can become a potential target. A site can become particularly vulnerable at this stage as exits are opened and people flow out into public areas. The people leaving may be exposed to risk, as well as those still in the venue where control measures may have been lifted to facilitate egress, thereby affording opportunity to a threat actor to enter the site or proximity of the site unhindered.

In both cases the problem centres around the congregation of people who are vulnerable to attack where there are limited security measures in place. This is particularly relevant in areas that may be outside the curtilage or direct control of the venue.

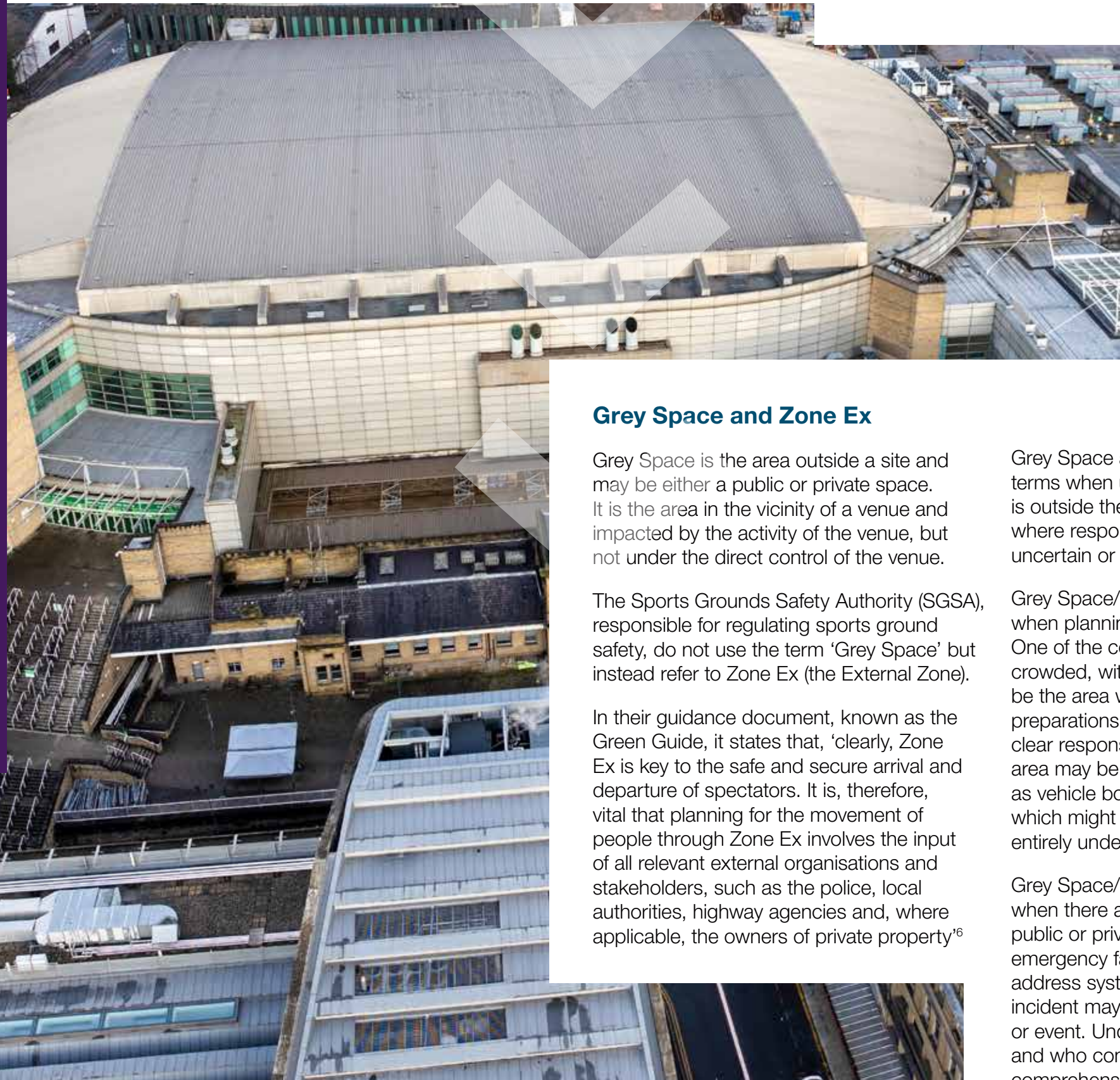


Example

Manchester Arena

Manchester: 22nd May 2017, a lone attacker waited in a large foyer area adjacent to the Manchester Arena. When the pop concert finished, people were making their way out of the event while others had come from outside the venue into the foyer area to meet up with or collect friends or family members (children). When the foyer was full of people, the attacker detonated his suicide explosive device. Twenty-three people died, including the attacker, and hundreds of others suffered physical injury.

There are many lessons to be learned from this incident including the vulnerability of crowds during egress and the need to make sure that risk is identified, understood, and effectively managed by the parties concerned. This will require effective communication and collaborative working. Full details of the Manchester arena inquiry are available online.⁵



Grey Space and Zone Ex

Grey Space is the area outside a site and may be either a public or private space. It is the area in the vicinity of a venue and impacted by the activity of the venue, but not under the direct control of the venue.

The Sports Grounds Safety Authority (SGSA), responsible for regulating sports ground safety, do not use the term 'Grey Space' but instead refer to Zone Ex (the External Zone).

In their guidance document, known as the Green Guide, it states that, 'clearly, Zone Ex is key to the safe and secure arrival and departure of spectators. It is, therefore, vital that planning for the movement of people through Zone Ex involves the input of all relevant external organisations and stakeholders, such as the police, local authorities, highway agencies and, where applicable, the owners of private property'⁶

Grey Space and Zone Ex are interchangeable terms when used to describe the area that is outside the immediate control of a venue, where responsibility for security is shared, uncertain or even disputed.

Grey Space/Zone Ex should be considered when planning security and safety for events. One of the concerns is that such areas may be crowded, with high vulnerability. It could also be the area where terrorists make their final preparations for an attack. If there is a lack of clear responsibility and/or accountability, the area may be undefended by measures such as vehicle bollards, CCTV, or security patrols, which might otherwise be considered if it was entirely under the control of the venue.

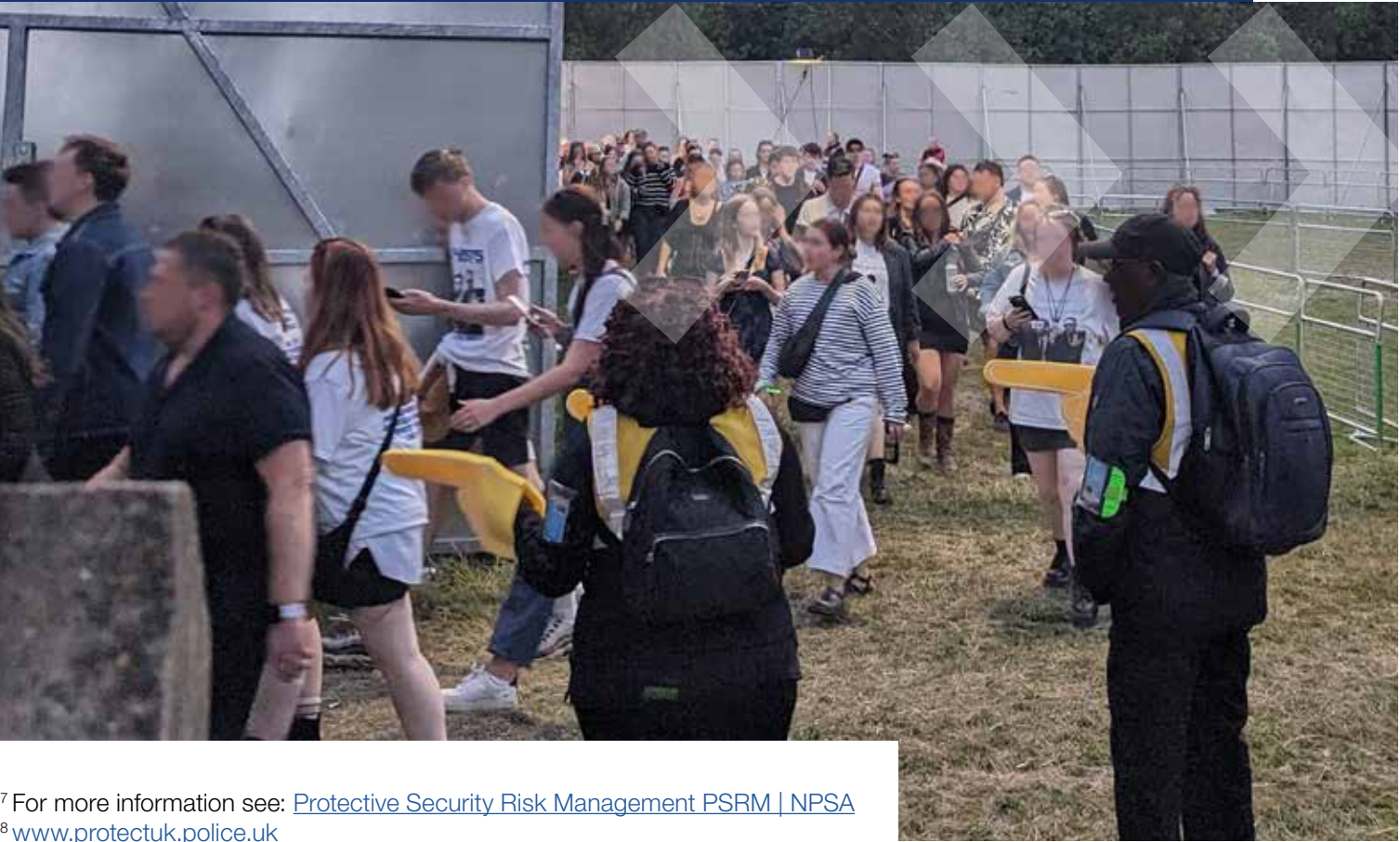
Grey Space/Zone Ex may also be significant when there are connected or adjacent public or private buildings that have separate emergency facilities such as alarms or public address systems that if triggered during an incident may affect the response to a venue or event. Understanding these facilities and who controls them should be part of comprehensive operational planning.

⁵ Manchester Arena Inquiry reports - GOV.UK (www.gov.uk)

⁶ Zone Ex - Sports Grounds Safety Authority (sgsa.org.uk)

Key components of reducing risk

This guidance does not prescribe a risk assessment process (guidance can be found on the NPSA⁷ and ProtectUK⁸ websites). However, identifying and reducing vulnerabilities is a key component of any risk assessment process. When looking at ingress and egress the following steps makes it possible to identify the areas of concern and help prioritise any necessary mitigation measures.



⁷ For more information see: [Protective Security Risk Management PSRM | NPSA](#)
⁸ www.protectuk.police.uk

Understanding the potential threats

The key terrorist threat types relevant to crowded areas are shown in the table below. They are the most common attacks that have occurred in the UK in recent times.

Threat	Description
 Marauding Terror Attack (MTA)	The use of blades or other weapons, including guns, to attack people. Attacks can be fast moving and violent, as assailants move through a location aiming to find and kill or injure as many people as possible. There have been numerous incidents of this type in the UK with multiple fatalities.
 Vehicle as a Weapon (VAW)	Deliberately driving a vehicle at an individual or into a crowd to cause harm. Terrorists have used this attack type to cause multiple casualties in the UK and Europe. It is low complexity, low cost, requires little planning or skill and is less likely to be detected in the planning phase. There have been instances where a VAW attack has been followed by an MTA.
 Improvised Explosive Device (IED)	Devices can be carried, placed, posted or delivered by vehicle. Some expertise is required to make a home-made explosive device. Explosive devices of all types and delivered in various ways have been used in the UK.
 Fire as a Weapon (FAW)	Petrol or other flammable material used to start a fire, with the intent to cause harm to people. FAW is defined as being part of an MTA and can be used as a distraction tactic, as a means to augment another attack methodology, or as a disruption or deterrence to the emergency services' response. In several MTA attacks in the UK, FAW was an intended element of the attack.
 Hazardous Substances	Attacks can involve the use of corrosive or flammable chemicals, toxic or radioactive materials. The damage and injury caused by an attack depends on the material and the manner in which it is used. These attacks are rare but can have significant impact.

It is important to understand how these threats could apply to an identified venue whilst recognising that the threat has shifted from being target specific to consequence focussed (i.e. threat actors may target random crowded places if they can achieve their aims). This supports the need for additional security considerations around vulnerable crowded areas. Venue operators who consider they may be a low risk target should not ignore the fact that a hostile actor may identify the venue as a 'soft target', if security is poorly developed. An incident at any venue is likely to have a high impact.

Threats change over time, for example, drone technology and their use is rapidly evolving. To date drones have not been used as terrorist weapons in Europe or the UK. Currently, the advice is to understand how your venue might be vulnerable to a drone attack and, if necessary, explore how proportionate counter drone mitigations can be incorporated into your security plan to help mitigate the risk. Venues should refer to the NPSA and ProtectUK websites for counter drone guidance and keep their security stance under continuous review.



Identifying vulnerabilities during ingress and egress

In order to identify vulnerabilities during ingress and egress it is necessary to understand the way a venue operates - why, where and when crowds form and for how long.

Below are two illustrative examples showing crowded areas during ingress and egress. The vulnerabilities are then identified.

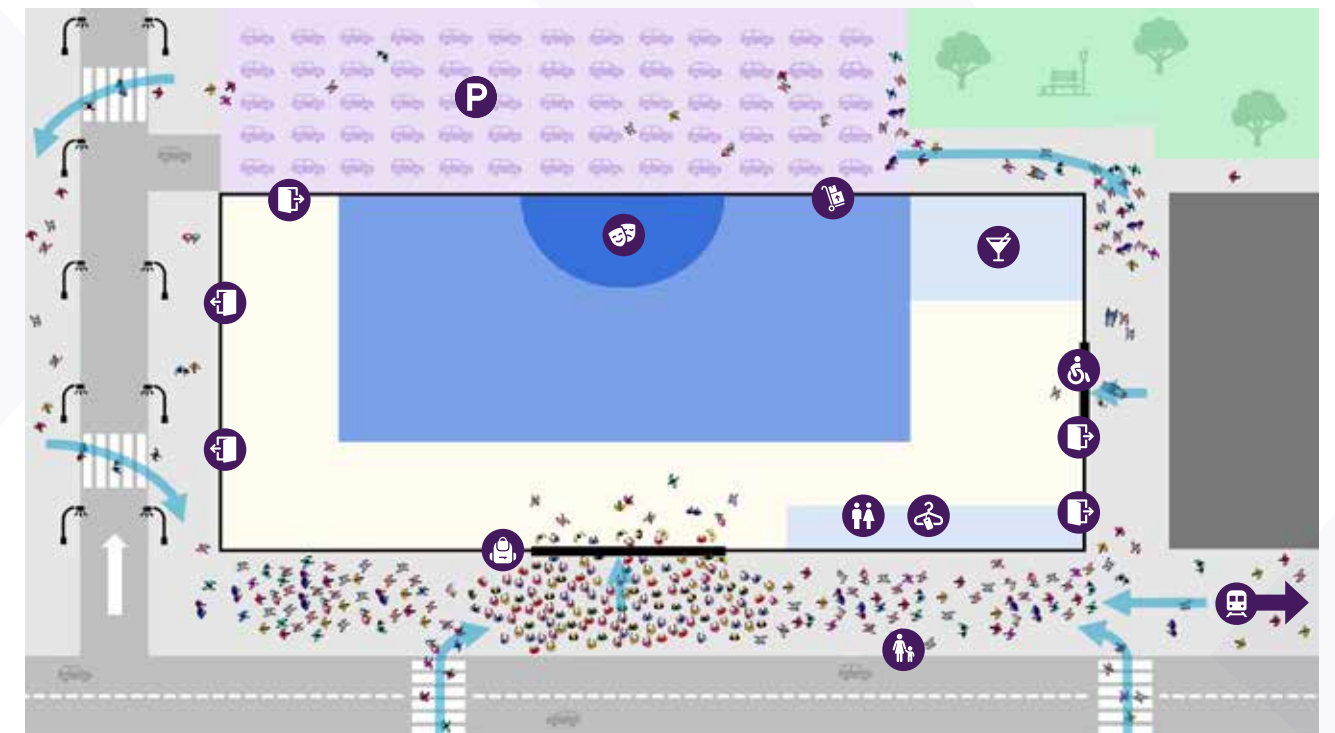
Example 1

**Medium sized theatre (950 seat)
located in town centre**

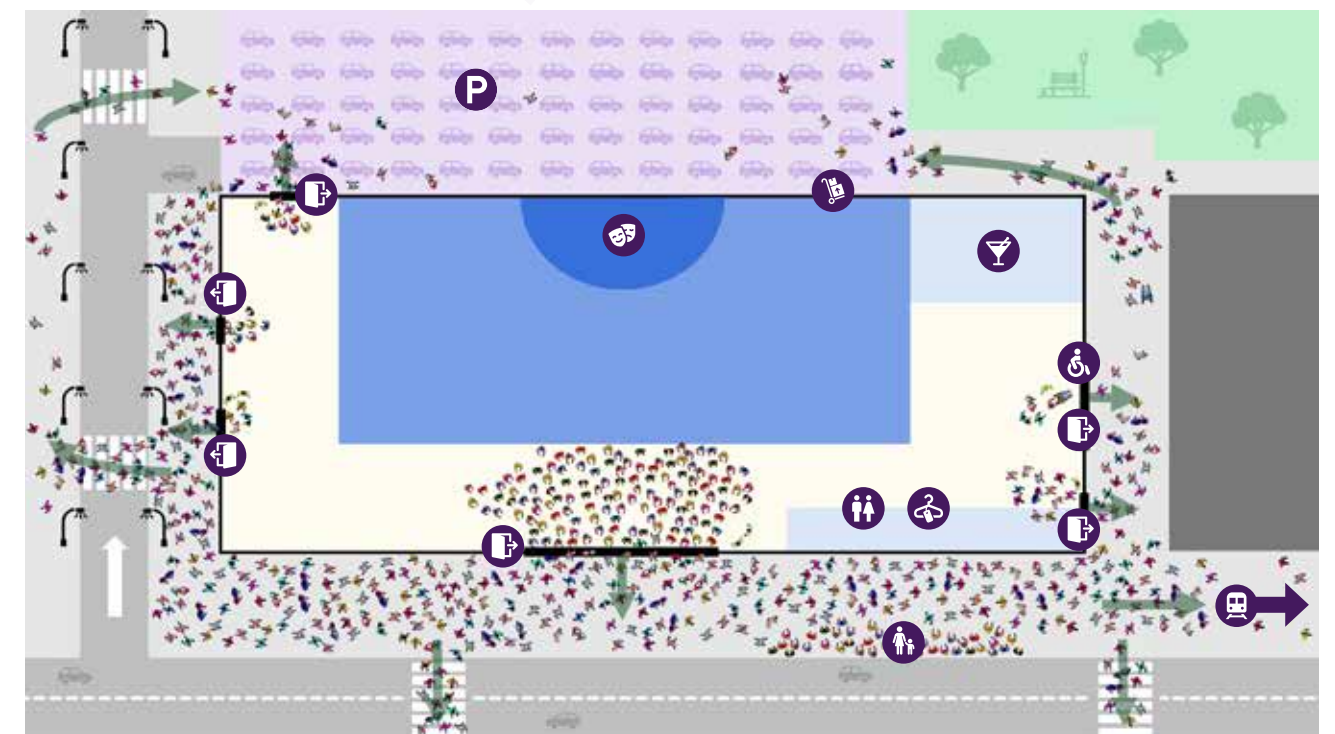
In these illustrations the following vulnerabilities are highlighted:

- Because of its confined urban setting, the theatre will have crowded places on the pavement outside the theatre and in the entrance lobby as visitors queue to go through the search regime. These crowds are exposed and vulnerable.
- When the show is sold out or near full capacity, these crowded areas are predictable and will last for a measurable amount of time whilst loading takes place. This pattern can be observed and considered by any threat actor undertaking hostile reconnaissance as part of their attack planning.
- Anything that causes a delay to the smooth ingress of visitors adds to vulnerability; this may include people bringing larger bags that need to be deposited before entry.
- When the show closes, the main entrance will again be very busy as many people will automatically leave by the same point at which they entered. Additional exit points may be opened to speed up egress but because everyone is leaving at the same time, crowded areas form throughout most of the perimeter and on the pavement towards the railway station.
- At certain events, particularly where young people attend, parents or guardians may congregate at the egress areas to collect them. This creates a slight inflow toward the event at the time when most people are exiting. Apart from adding to the general congestion, it also gives ideal cover to a threat actor heading towards an event when everyone is leaving.
- In this example, during both ingress and egress, the crowded areas adjacent to the road are vulnerable to hostile vehicles.

> Ingress phase



< Egress phase



Key

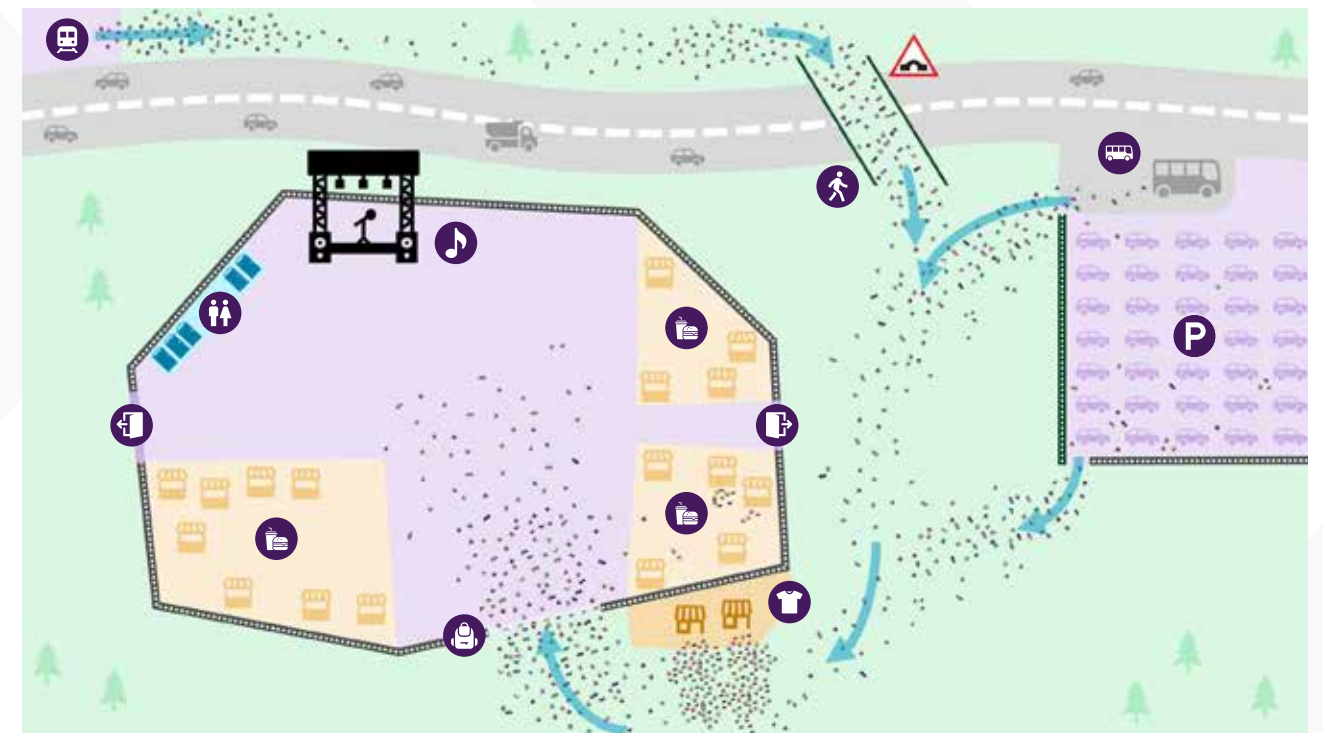
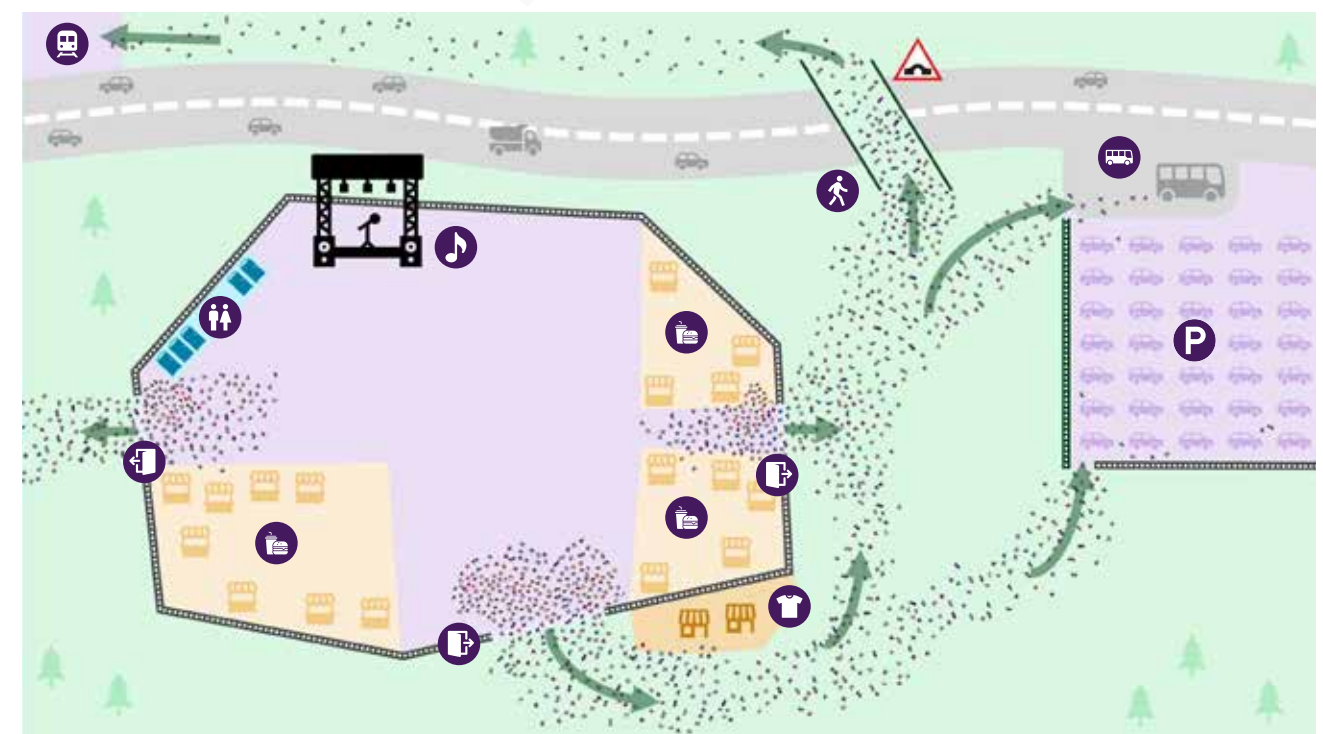
- | | | | |
|---------------------|--------------|---------------------------|---------------|
| Train Station | Exit | Bar | Cloakroom |
| Car Park | Stages | Toilets | Back of House |
| Accessible Entrance | Pickup Point | Bag Search / Ticket Check | |

Example 2**Music festival, multiple day event (10,000 ticket capacity per day) near rural village**

In Example 2 the following points are highlighted:

- The event is temporary and accordingly security vulnerabilities have to be anticipated and planned for in advance by those running it. Venue design will play an important part in minimising crowded areas at ingress and egress, as will the way the operation is conducted.
- Health and safety requirements, including site safety, crowd management, emergency preparedness and stakeholder co-ordination, will form a big part of the considerations. The Purple Guide⁹ published by the Events Industry Forum gives comprehensive guidance on relevant legislation, regulations, and industry standards.
- In this example, the principal areas of risk in terms of vulnerable crowds are the bridge and the main entrance before the search is conducted. These are pinch points and are assessed as likely to be crowded areas for both ingress and egress.
- In this scenario there could be a question over responsibility for the bridge, for both security and health and safety. Ownership and responsibility should be clearly defined and agreed as part of the licensing process. Regardless, it should be flagged in any risk assessment and control measures will undoubtedly be required.
- The conflict between vehicles and pedestrians needs to be understood. Clearly, it is undesirable to have cars near crowds because of safety and security concerns. The road, drop off point and car park need to be viewed in this context and suitable physical and/or operational measures put in place.
- During ingress the main entrance would be busy, but because this point is some distance from the transport link areas, it is unlikely to be congested, particularly if the search regime is well planned and resourced.
- Careful thought should be given to the location of facilities that may cause congestion before the 'secure area' of a site. In some venues this may include a baggage drop; in this example, the sighting of a merchandise store selling T-shirts and memorabilia outside of the site perimeter could cause a crowded area. Consideration should be made to the placement of the store and the possibility of moving it within the secure perimeter.
- Venue design would need to take into consideration the danger from the road. It is likely that some form of barrier and marshalling would be needed to stop crowds attempting to cross the road rather than using the bridge. This could enhance perimeter protection.
- In the scenario described the event is held over several days, giving a threat actor an opportunity to observe the site and identify areas of weakness. Hostile reconnaissance could start well in advance of the event by researching online information. Mitigation for these vulnerabilities is explored below.

⁹ [The Purple Guide](#)

> Ingress phase**< Egress phase****Key**

- | | | | |
|----------------|------------|---------------------------|-------------------|
| Train Station | Exit | Merchandise | Food and Beverage |
| Car Park | Main Stage | Toilets | |
| Coach Drop-off | Footbridge | Bag Search / Ticket Check | |

Control or mitigate risks

An effective risk assessment will identify vulnerable areas. The most significant risk reduction occurs when well-structured security measures are put in place to mitigate these vulnerabilities. However, as outlined in the St Denis convention¹⁰, security must not be considered in isolation. It should form part of a co-ordinated plan that includes safety, security and service.

The following sections detail security measures that are relevant to decreasing risk during the ingress and egress phases of a venue's operation. It should be recognised that some of these measures will not be suitable for all venues. It is important to ensure that those security measures that are considered relevant and necessary are highlighted and recorded in relevant documentation (i.e. risk assessment/security plan).

Security measures



Safe and secure environment

Throughout a venue's operation, there needs to be a level of management that makes it as safe as practicable from terrorist threats. Measures that help create a safe and secure environment include:

- Considering security within the vicinity of the venue (Grey Space/Zone Ex). What measures are required and who has responsibility and/or accountability for putting them in place?

Communication with relevant agencies and stakeholders, including the emergency services, local authority, businesses, neighbours, local transport providers etc. is essential to agree appropriate and proportional measures. **If there is denial or obstruction by those who have a role to play the facts must be recorded and other solutions explored.**

- Creating a clear, effective, security cordon within which there is a good level of control and situational awareness.
- The deployment of barriers and fencing should be carefully considered and integrated with other safety and security measures. **It is fundamental that type and placement of barriers and fencing do not present greater risks than those they are intended to control.**
- Operational practice and procedures to create and maintain a safe environment, such as appropriate defensive searching of vulnerable areas and maintaining sterility through security tagging of sealable areas, CCTV and or regular checks and patrols.
- Site design that minimises pinch points and has considered measures, such as:
 - landscaping that restricts vehicle movement and allows efficient unobstructed pedestrian flow.
 - long 'walk up' areas to spread crowd out (this may not be appropriate for all sites).
 - expansion or release areas for contingency operations, for example to accommodate more arrivals than expected or to redirect crowds where necessary.
 - consider having 'soft ticket' and/or 'soft security' checks (e.g. asking people to show their tickets and redirecting people with bags) at advanced locations away from the entry points of the venue.
- if practical, have more than one entry point.
- entry and exit areas being uncluttered and free from fragmenting materials.
- minimising areas for concealment of prohibited articles such as weapons or explosive devices.
- removing any unnecessary clutter so that anything out of place can be readily seen, (this includes bags, coats etc. belonging to stewards and security staff).
- good line of sight and lighting for visual and optical surveillance.
- eliminating CCTV and radio signal blind spots.
- egress layout with multiple exits allowing rapid dispersal.
- consideration of the impact on those with accessibility issues and provide suitable workarounds where necessary.
- Advance messaging on your website and tickets and by using social media to warn attendees about the security regime and in particular items that are prohibited (e.g. large bags, knives, bottles, fireworks, etc). See NPSA guidance on Security Minded Communications¹¹ (SMC).
- Dealing quickly and decisively with any prohibited behaviour such as unauthorised vendors or ticketless visitors.

¹⁰ [St Denis convention](#)

¹¹ [Security-Minded Communications guidance | NPSA](#)



Keep the big threats away

The big threats include hostile vehicles and large bags or objects (e.g. equipment boxes etc.) that may contain explosives or weapons. These items have potential to cause the most damage or have the biggest impact, and as far as possible should be kept away from crowded places at or in the vicinity of the site. Some measures to consider are:

- Ideally create a zone around the venue where traffic is isolated and prevented from gaining access to any crowded place or critical structure.
- Hostile Vehicle Mitigation (HVM) measures such as vehicle security barriers, bollards or landscape design are optimum. However, there are many options and innovative solutions available; see public realm design guidance for further information¹².
- Always consider the entire ingress and egress route to ensure crowds associated with your venue are protected as far as is practicable. Keep pedestrian and vehicle interaction to an absolute minimum. For example, move drop-off and pick-up points away from crowded pedestrian areas, reorganise entry queues to form in an adjacent side street instead of at the front entrance, and close nearby car parks during the peak egress period to allow pedestrians to get away from the area.
- The provision of separate bag search lanes is good practice, especially at venues where there is a high visitor return rate (e.g. football) as it is an effective way of changing behaviour because people do not like the delay and inconvenience, resulting in fewer bags being brought to the venue.

- Restrictions forbidding large bags being taken into venues is a widely used measure because they are an obstruction or encumbrance and they could be used to conceal weapons or explosives.
- If it is anticipated that large bags or suitcases are likely to be brought to a venue, they should be deposited at a dedicated offsite location and away from vulnerable crowded areas. They should be searched before they are stored.



Understand crowds

It is important to understand how the venue operates in terms of crowd formation and audience profile.

- Understanding where crowds form at the site and why. This may be achieved by data collection (observation or manual/automatic counts) or by calculation (static analysis or crowd modelling).
- Clear data can help with operational decisions e.g. the number/type of search lanes required, etc. It could also capture variations applicable dependant on type of event, demographics and even weather conditions.
- Consider the audience profile and likely behaviours. Identify what is 'normal' behaviour for your site, so that you are able to recognise those that are behaving differently.
- Where possible, research and collate information from other venues that may have hosted the same artist or held a similar event. Open source material can also be useful.

Ensure a safe ingress

There are many things that will help reduce vulnerability and ensure a safe ingress. These may include:

- Coordinating and understanding the roles and responsibilities of all agencies and stakeholders involved. This is particularly the case for large events where there maybe a number of agencies and stakeholders involved with independent systems and protocols.
- Changing the arrival profile of visitors by timed entries or messaging regarding pre-event entertainment to encourage people to arrive early.
- Considering how the risk to gathering spectators can be minimised. Suggestions include search and screening of people looking to enter queue space, queuing within HVM barriers, or increased presence of staff.
- Maximising the number of entry points so that there is less congestion. Having an efficient entry process where ticket checks and search and screen procedures are well resourced, managed and co-ordinated. Consider 'high footfall screening' to speed up throughput (see glossary for details).
- Where possible and appropriate having a long run up to the entry gates with early ticket checks to create a steady flow and deter ticketless people trying to put pressure on the system to gain entry.
- Ensuring crowd flow is maintained by having good visual awareness of the site, e.g. through raised viewing platforms for security/stewards, good use of CCTV and efficient marshalling.
- Concentrate monitoring effort on areas that are particularly vulnerable and locations that a threat actor is more likely to select in order to carry out hostile reconnaissance.
- Deploying specialist resources such as explosive detection dogs and Behavioural Detection Officers (BDOs) to identify prohibited items being brought into the area and to spot suspicious behaviour of those planning or seeking to undertake malicious acts (it is important these resources are appropriately trained, see National Canine Training and Accreditation Scheme¹³ and NPSA Behavioural Detection Guidance¹⁴).
- Using an element of randomness when selecting people and bags to undergo a more thorough search.
- Having the ability to communicate with the whole crowd, both audio and visual (signage), particularly in emergency situations.
- Ensuring plans consider exceptional circumstances, for example identifying where crowds and queues might extend if there are issues on the surrounding train/tube lines.

¹² [Public Realm Design for Hostile Vehicle Mitigation | NPSA](#)

¹³ [National Canine Training and Accreditation Scheme \(NCTAS\) – Private Security Industry \(NCTAS-P\) | ProtectUK](#)

¹⁴ [Behavioural Detection | NPSA](#)

Ensure a safe egress

It should be recognised that egress is a time of vulnerability for a crowded event. The following will help reduce risk:

- Before people start leaving, check all egress routes for any obstructions, suspicious people or articles.
- Reduce the volume of people leaving at the same time by having after show events or activities.
- Have good signage and use staff to direct attendees to the correct exit points.
- Use the optimum number of exit points to encourage continual safe crowd flow and rapid dispersion.
- If there are likely to be people meeting/collecting attendees, identify areas where this can happen that are not obstructive to egress crowd flow and where they will not become crowded areas. If possible, the meeting points should be located within areas covered by protective measures (e.g. within an area protected by HVM). Information about such meeting points could be restricted to ticket holders (i.e. just available on issue of tickets) so that it is not generally known.
- Do not open the exits too early unless there are stewards on hand to prevent unauthorised entry by unsearched people into the event space.
- As the end of the event approaches monitor the outside area using CCTV and consider using trained Behavioural Detection Officers (BDOs) or stewards to look for any suspicious activity or people loitering or coming toward the crowded area or event space.



Security awareness

Minimise the opportunity for threat actors to complete reconnaissance and prepare for an attack. Create and promote proactive security awareness by introducing measures that may include:

- Use Security Minded Communications (SMC)¹⁵. This can help limit the amount of useful information available to a threat actor, show that you take security seriously and have a deterrent effect on them early in their planning.
- Staff being properly briefed about the terrorist threat.

- Training and awareness to help staff understand what hostile reconnaissance is, what it looks like and how and when to report suspicious activity. (ACT training and SCan training¹⁶ – for information see ProtectUK¹⁷)
- SCan training can help staff use 'The Power of Hello' to challenge suspicious activity and to increase customer service.
- Identify any areas that may be useful to threat actors if they were preparing to attack the site (final preparation points FPPs – see glossary). This may include toilets or areas that give good cover. Take steps to minimise this possibility through design or operational measures such as regular but unpredictable patrols.
- As illustrated by this guidance, ingress and egress are key times of vulnerability. Staff should be particularly alert at these times. Where feasible, CCTV cameras focusing on key areas should be monitored by trained staff.
- Information obtained about any suspicious activity or hostile reconnaissance must, where appropriate, be forwarded to police and should also be passed between teams and at the end of shifts in case it reoccurs.
- Suitable and appropriate staff handovers both during and at the conclusion of shifts creates continuity and heightens security awareness.

¹⁵ [Security-Minded Communications guidance | NPSA](#)

¹⁶ [ACT Awareness and ACT Security e-Learning are now available in one place on ProtectUK | ProtectUK](#)

¹⁷ [See, Check and Notify \(SCaN\) | ProtectUK](#)



Response planning

A planned and co-ordinated response will mitigate the impact of an attack should an incident occur. Preparations and procedures for responding to incidents are part of the planning process and should focus on how to get people away from danger. The following are response planning considerations:

- The ability to communicate effectively and to co-ordinate an effective response to an incident is essential. This may involve a dedicated Security Control Room (SCR) or Control Point (see glossary). Ideally, for larger venues, an incident management room should also be identified.
- Develop a communications plan detailing how your site communicates, what is communicated, when and by whom. This should include steady state comms as well as what should happen in an emergency.
- Staff that are equipped with radios must be appropriately trained in their use. For further information on communications see NPSA guidance on command and control¹⁸.
- Rapid and effective reporting is critical. Staff must be able to report suspicious incidents, this could be by radio, telephone or reporting directly to a supervisor who is close by and has a radio.
- The public should also be encouraged to report suspicious incidents to any member of staff who must then know how to respond. A venue should have practical response plans in place and staff must be aware of their roles within these plans (for example, what to do if they or a member of the public find a suspect package).
- When an incident occurs, at or nearby a venue where there are high numbers of people, mobile telephone communications often become overloaded. Accordingly, venues should not be exclusively reliant on this means of communication.
- Evacuation plans are required for all venues to meet fire safety standards. Evacuation in the case of a terrorist attack may differ from fire evacuation; for example, if certain routes cause people to move toward danger. The escape plan may need to be adapted for different threat types and could include a full evacuation, a partial (phased) evacuation or an invacuation. The development of an exceptional egress plan is outlined in the Green Guide¹⁹. It highlights that in some circumstances evacuation will involve the use of unfamiliar alternative routes, necessitating a very controlled approach.
- Considering the impact on crowd safety and security if a decision to evacuate is made. Test, exercise and rehearse your response to the attacks considered to be the highest risk. There needs to be clear leadership to initiate and ensure safe crowd movement away from danger in emergencies. For further information see NPSA guidance on command and control²⁰.
- Lockdown may not be suitable for all sites or all forms of attack. However, it can be a lifesaving response and, where appropriate, should be developed, tested, rehearsed and refined. The type of lockdown used should be adapted to respond to the unique circumstance of the site and the unfolding scenario.

- It is important that those in command and control of venues consider the impact of their lockdown/evacuation decisions. Communicating those decisions using the most suitable means (public address systems, social media, trained staff) should then direct public movement. An event log should be used to record and provide context for any operational decisions made. (See NPSA command and control guidance in footnote 20 below).
- There must be sufficient medical equipment and medically trained personnel on site. Guidance on the requirement is available through HSE²¹ (search - planning for incidents and emergencies).
- Public Access Trauma (PacT) first aid kits will significantly enhance a venue's first aid preparedness and if a serious incident occurred could be used to improve the survivability of a person with life threatening injuries (see ProtectUK for CT First Aid awareness²²).

There are a number of agencies, professional bodies and stakeholders, including where appropriate: the police (Counter Terrorism Security Advisors – CTSAs), Local Resilience Forums, and local businesses, that can assist with the development and maintenance of security and response plans. The emphasis being on joint working to maximise safety and security.



¹⁸ [Incident Response and Command and Control | NPSA](#)

¹⁹ [Guide to Safety at Sports Grounds 'Green Guide' - Sports Grounds Safety Authority Sports Grounds Safety Authority \(sgsa.org.uk\)](#)

²⁰ [Incident Response and Command and Control | NPSA](#)

²¹ [HSE: Information about health and safety at work](#)

²² [Counter terrorism first aid awareness | ProtectUK](#)

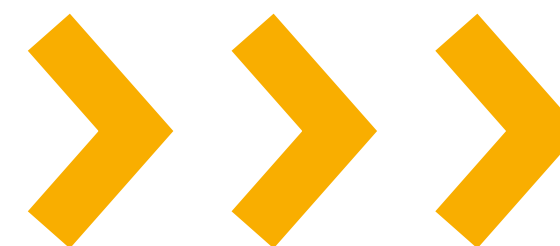




Use the right people

When planning or operating a site it is important that the right people with the appropriate skills are identified or deployed to the relevant jobs. Event organisers have responsibility for making sure those providing security have the time and opportunity to properly prepare for the event. The following apply:

- All staff, particularly security staff, should be properly briefed. The briefing should include the threat and response levels and reminders about roles and responsibilities in both prevention and response if an incident takes place (see ProtectUK for further information about briefing content²³).
- Organisers and managers must make sure there are enough staff available to do the tasks required.
- Use personnel who have plenty of first-hand knowledge, skills and experience in planning for and managing crowd events. Senior safety and security managers should have experience and knowledge of the venue.
- Ensure personnel in all event locations, including those from agencies, are suitably qualified, screened, trained and briefed for their deployment in both normal and emergency situations. This includes ensuring the medical training staff receive is suitable for the type of event and the potential risks (e.g. first aid and trauma response).
- Employ appropriate personnel for appropriate roles e.g. Community Safety Accreditation Scheme²⁴ (CSAS) for traffic management, stewards with relevant spectator safety qualifications or Security Industry Authority (SIA) Door Supervisors, for searching (see glossary).
- Training courses and certification is not sufficient of itself, staff need specific venue instruction for crowd management, safety and security before carrying out their roles.
- Good supervision is essential to make sure staff are doing what they are meant to. Supervisors should ensure that staff are appropriately trained for the job they are doing and competent at doing it. Staff rotation is important to keep people alert and effective throughout the course of the event.
- All staff, whether or not their primary role is safety or security, have a responsibility to keep each other and visitors safe by reporting suspicious items and behaviour. Most people have a sense about things that do not look or feel right, and they should have the confidence to report it to their supervisors and be taken seriously. SCan for All Staff can be used to increase awareness about this subject.



²³ [Tactic IB1: Ensure that staff are briefed on Threat and Response Levels | ProtectUK](#)

²⁴ [Community safety accreditation scheme powers - GOV.UK \(www.gov.uk\)](#)

Record, test, review and revise

A venue or event should have a written security plan that outlines how all aspects of security are conducted at the site. Where applicable this should include the Counter Terrorism measures described in this guidance. The security plan may be part of a wider operational document but should nevertheless contain the policies and procedures relating to all aspects of the security of the venue, including those concerned with ingress and egress.

Operationally, things may not always go as anticipated and the plans should be reviewed, revised and updated as shortcomings are identified and as the venue develops or changes. Certain emergency procedures, for example, lockdown or evacuation, should be tested and exercised to ensure that they work operationally. This should feed into a continuous improvement cycle and changes made as necessary.

When response testing is completed, especially if it is done during a live event, use your communication channels to amplify your effective security plans. For example, using social media to thank customers and staff when the emergency evacuation procedures are tested, explaining it is a vital part of ensuring that the site is ready to respond in the event of an emergency. This will indicate your venues preparedness to any hostile actors.

It is important to keep written records of all matters concerning security including plans, policies, procedures, risk assessments, tests and exercises. Written evidence of the security arrangements will be an essential part of post incident procedures or inquiry.



Conclusion

This guidance is about planning and preparation to ensure the safe and secure operation of venues, with emphasis on situations of heightened vulnerability, notably during ingress and egress.

To address these security concerns, organisations and event planners need to implement a combination of operational and physical security measures, personnel training and security protocols. They also need to have measures in place to ensure a suitable response to an incident should it occur.

The proposed measures in this document are intentionally comprehensive. Not all of them apply to all sites, but where appropriate they should be considered as part of a thorough, coordinated security plan.

During research for this guidance a number of venues were visited. At one of them a security briefing was observed. At the end of the briefing the person conducting said, 'let's hear it' and the security staff actively responded by chanting 'not here, not today'. This venue had excellent security infrastructure and its staff were positively engaged in the key areas of protective security.

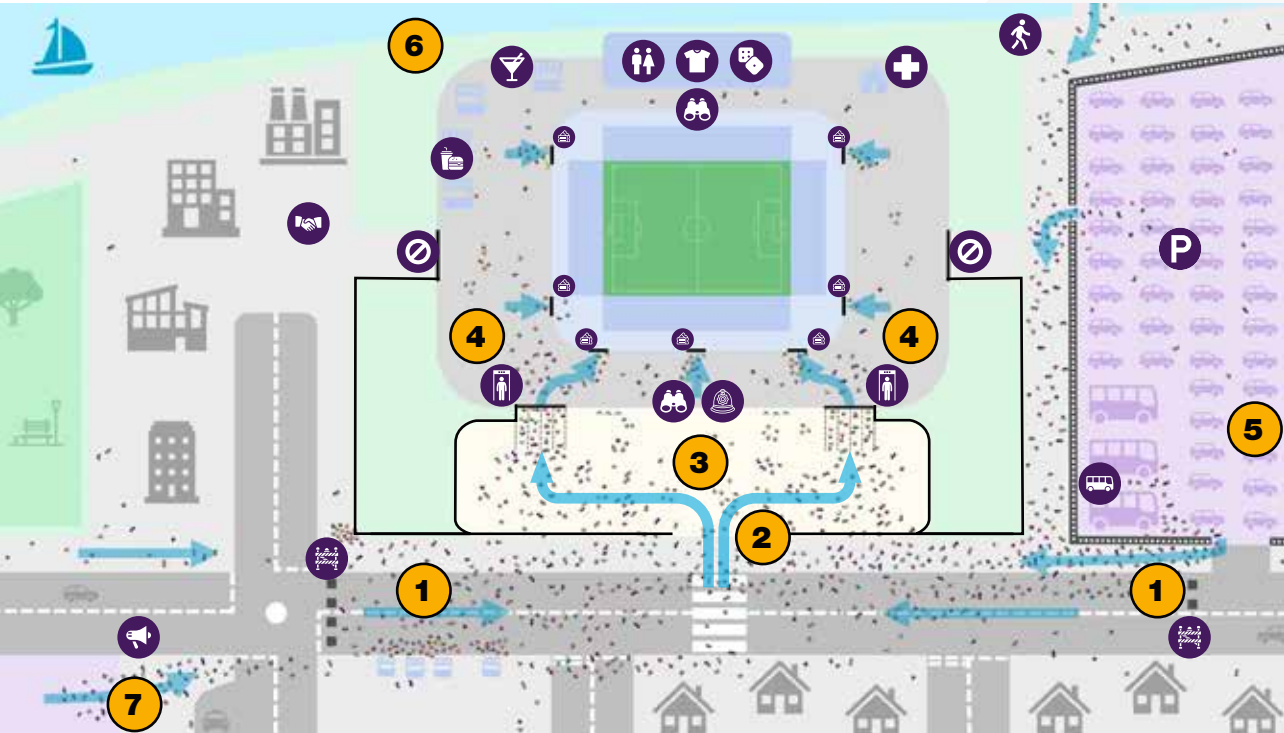
Appendix A

Good practice example

Below is an illustration that helps identify the issues that are relevant during ingress and egress at a fictional venue. The accompanying table details some of the key control measures that could be used to reduce risk in these areas.

A major sporting stadium with a capacity of 30,000 people situated in a town centre.

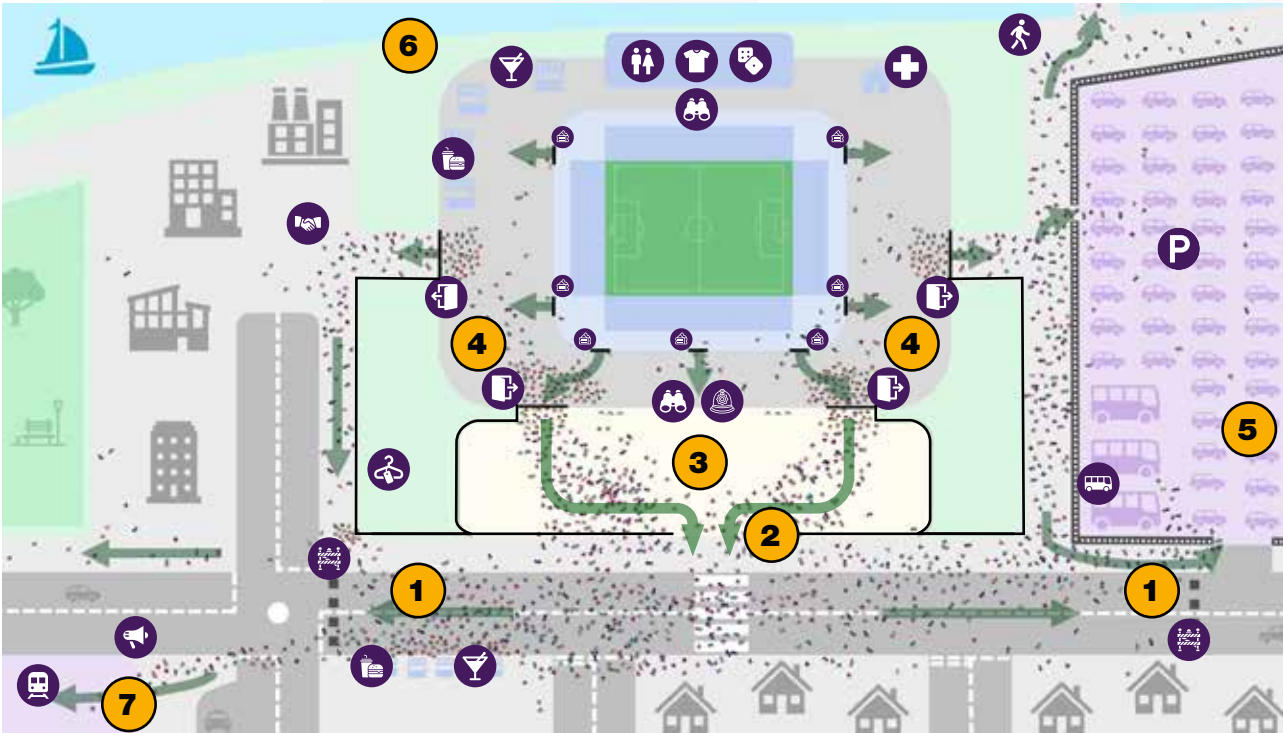
> Ingress phase



Areas

- | | |
|--------------------------------|------------------------------|
| 1 Grey Space/Zone Ex | 5 Stadium car park |
| 2 The initial site entry point | 6 Riverside |
| 3 The outer concourse | 7 Around the Railway Station |
| 4 The inner concourse | |

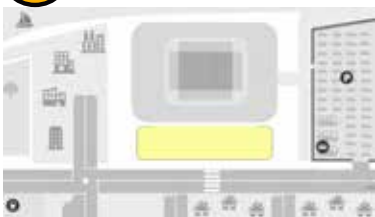
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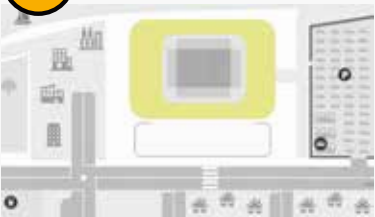
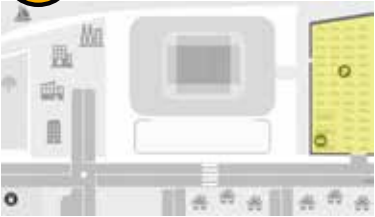


Key

- | | | | |
|----------------|---------------|---------------|------------------------|
| Train Station | Exit | Merchandise | Food and Beverage |
| Car Park | Bar | Toilets | No Access |
| Bus Stop | Footbridge | Ticket Check | Cloakroom |
| Police | Betting Booth | Loud Hailer | HVM |
| First Aid Area | Lookouts | Search Arches | Stakeholder Engagement |

Control Measures for example overleaf

Area	Risk	Control measures
1 Grey Space/Zone Ex  This is a crowded place outside the curtilage of the venue. It is the main access road. Both before and after the event this area is likely to have a medium to high density crowd.	People who are not attending the event can mingle with the event crowd. Without control measures, moving vehicles and parked vehicles could be in this space. Vulnerable to all main threats: VBIED VAW PBIED IED MTA (see glossary for acronym definition).	This space is not within the direct control of the venue. Working with partners (e.g. Local Authority and Police) will be necessary. Without any control measures this area is vulnerable to the threats identified. Ideally the road should be closed to traffic during peak ingress/egress period and suitable HVM measures put in place. In addition to physical measures, active measures should be considered such as security patrols to identify and deal with anything suspicious. BDOs would be useful in this space. Increase situational awareness of what is happening. This can be achieved through the use of CCTV or using stewards or security officers to observe the movement of people and identify suspicious behaviour.
2 The initial site entry point  The first pinch point for the crowd.	This is an area that is likely to have a medium density crowd during entry, and a high-density crowd as people leave following the event. Assuming vehicles are prohibited at this point the key threat is from an IED or MTA.	Vulnerability can be reduced as the venue can control access at this point. Vehicles can be prevented from accessing the site by bollards or other restrictions. The free flow of pedestrians is important to prevent crowd build up. Marshall's should be deployed to encourage this. Their deployment in these areas will also act as a 'high viz' deterrence and help to identify suspicious behaviour. High footfall screening could be desirable if manageable. CCTV coverage of this main access point will afford good situational awareness.
3 The outer concourse  Often a meeting point or point where people gather before entering the stadium. A reasonably high crowd density for an extended period before the event and a high density for a shorter period post event.	A concourse such as this is typically an area where unrestricted, unsearched crowds form before the event. Post event most people will be hurriedly leaving, but others may arrive to meet family or friends. There is opportunity for a threat actor to identify crowded areas for potential attack both pre and post event.	Areas such as this, where crowds can form - particularly towards the event start time and upon egress - have increased vulnerability. They should be checked for any suspicious articles both before the start of the event and before egress. Operational efficiency, i.e. having enough gates staffed and open to ensure rapid inflow is a primary control measure. Also, event staff preparing people for the search processes by advising people of where to go and what they need to do. As above, CCTV at all entry points is useful to monitor crowd movement.

4 The inner concourse  This can be the area used to search and screen spectators. Clearly, this causes congestion and could be a risk area, especially if it is the first occasion a person is likely to encounter some form of security challenge.	Wherever the search regime is located there is an element of additional risk because it is at this point the threat actor could be exposed if he/she has a weapon or explosive device with them. It could be the primary attack location because it is a crowded place or it could become a secondary target if the device is discovered at this point.	Generally, search regimes delay pedestrian flow and cause crowded areas. Maximising the efficiency and effectiveness of search is the aim. This is achieved by having clear policies and procedures regarding what is being sought and why and how this is to be achieved. If just bags are being searched, separate lanes to enable this helps speed up the process. Sufficient trained and competent search staff, using suitable equipment, are also essential elements. New technology is helpful (e.g. high footfall screening). Effective and targeted communications to prepare people for the search regime.
5 Stadium car park  Without control measures, unsearched vehicles will be close to the stadium, particularly the east side of the main concourse.	In this illustration the car park creates opportunities for vehicles to get close to crowded areas on the concourse.	Barriers that prevent cars getting direct access onto the concourse should be a prerequisite for event days. Management of the car park could limit opportunity for any threat vehicles to get close to the vulnerable areas of the concourse (for example only allowing known members' or players' cars in these areas). A vehicle search regime could be put in place, but they are an expensive resource if they are to be effective. CCTV is a useful addition to monitor this area.
6 Riverside  The river runs along the North side of the stadium. A vessel could get within close proximity of crowds on the inner concourse and in the North stand. The most concentrated crowd using these areas is likely to occur during egress.	When completing a risk assessment all threats should be considered. In this illustration the threats from the riverside are very limited. A boat or other vessel could be used to house an explosive device, however, it is an unlikely scenario as the crowded area is likely to be less dense than other zones and the effectiveness of the device is likely to be substantially less.	The river is a good barrier protecting from most threats. If there is concern about the proximity of boats (although this may be assessed as a limited risk), one option is to prohibit mooring along the stadium flank. This could be enforced by using a physical floating barrier creating stand-off from the bank (as deployed at Palace of Westminster). Consideration should be given when developing incident response plans (invacuation/evacuation) as the riverside restricts capacity and throughput of people. As the river is not owned or administered by the stadium any control measures are likely to need co-operation from other stakeholders, in this case it may be the relevant waterway authority.

Control Measures for example overleaf

Area	Risk	Control measures
7 Around the Railway Station  In this illustration the station is near to the stadium. There will be a constant stream of spectators from the station for an extended period before the event and a more concentrated crowd for a shorter period after the event.	This area is vulnerable as it is easily identifiable as a crowded place before and after all events that have high attendance numbers. Stations are separate sites and should have plans in place to limit vulnerability. The area outside the station to the stadium is a Grey Space that is exposed to all the main threats in the same context as Area 1 above.	The control measures for Area 7, outside the railway station and up to the stadium gates, need to tie in with the measures for Area 1. Again, there are other stakeholders involved and in this case the addition of the rail service provider and the British Transport Police. The whole question of Grey Space, where an area is impacted by an event and yet is outside the event's direct control, is one that causes difficulty. Communication, comprehension of the issues and workable solutions are required.

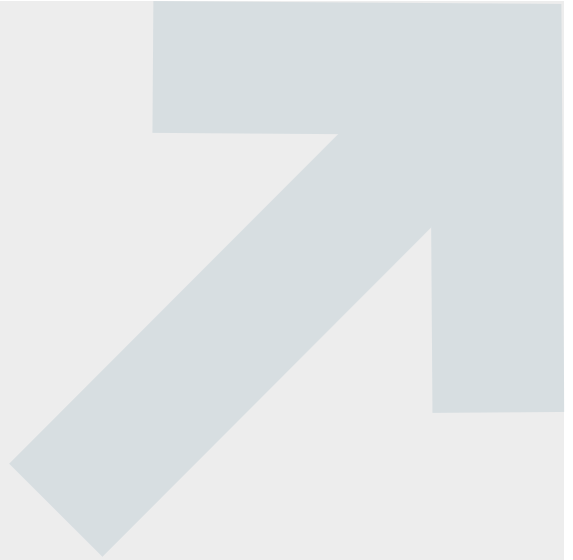


Glossary of terms

Term used	Definition
ACT e-Learning	Action Counters Terrorism (ACT). ACT e-Learning provides counter terrorist training packages for all staff. There is also ACT Security e-Learning for SIA personnel and those wanting specific 'security role' information. The training is available free from the ProtectUK website.
BDOs	Behavioural Detection Officers (BDOs) are security personnel who are trained to identify and assess suspicious or unusual behaviour exhibited by individuals in settings such as crowded public areas. The primary role of BDOs is to detect potential threats to security by observing and analysing the behaviour and body language of individuals.
Control Point	A designated room or area within the venue from which the safety management structure is controlled and operated. Also known as an event control or control room.
CT	Counter Terrorism.
CSAS	Community Safety Accreditation Scheme (CSAS) is where some uniform roles, such as wardens and security guards, can contribute to maintaining and improving community safety by performing roles such as traffic management/pedestrian crossings for events.
Final preparation points (FPPs)	These are areas that may be used by a terrorist(s) to get ready just before they commit to an attack. For example, they could use a poorly lit, out of sight, refuse area to unpack weapons they have in a rucksack.
High Footfall Screening	Techniques for detecting mass casualty threat items, such as improvised explosive devices and firearms, in crowds entering a site without the delay caused by intrusive security processes.
HVM	Hostile Vehicle Mitigation. Measures that are designed to protect against hostile acts where vehicles could be used. Includes design, road layout and vehicle barriers.
IED	Improvised Explosive Device. A bomb.
MTA	Marauding Terrorist Attack. Could be with a knife or any other weapon(s).
NaCTSO	National Counter Terrorism Security Office.
NPSA	National Protective Security Authority (formerly the Centre for Protection of National Infrastructure CPNI).
ProtectUK	A website and App by NaCTSO where information can be found about all aspects of protective security.
SCaN	See Check and Notify (SCaN) is a free training programme that aims to help venues maximise safety and security using their existing resources. It is found on the ProtectUK website.
SIA	Security Industry Authority.
SMC	Security Minded Communications. Guidance developed by NPSA that encourages organisations to use communications to help protect themselves, their staff and visitors from hostile acts.
VAW	Vehicle As a Weapon. Any type of vehicle deliberately used to cause injury.
VBIED	Vehicle Bourne Improvised Explosive Device. A bomb in a vehicle, could be a suicide attack where the driver detonates the IED whilst on board or a vehicle left unattended to be detonated by timer, remotely or by other means.



National Protective Security Authority



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