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TRAINING AND EMPLOYMENT OF LAND MINE AND BOOBY TRAP DETECTOR DOGS (U)

FINAL TECHNICAL REPORT
VOLUME II

by

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ABSTRACT

The present document is intended as a procedures manual and reference text to be used during the training of initially naive canines for land mine and booby trap detection service. No directly related experience on the part of the handler/trainer personnel is assumed. Each successive phase of training is treated in detail, and all specialized training aids and facilities are described and/or illustrated. Commonly encountered training difficulties are discussed and appropriate solutions indicated. Techniques of service deployment are described in the concluding chapter.

Chapter II presents a discussion of those concepts of operant and classical conditioning which are relevent to land mine and explosive booby trap detection training and has been included to provide handler/trainer personnel with a basic knowledge of the underlying behavioral principles. In this regard it should be recognized that the procedures herein described are specifically oriented to land mine and booby trap trip wire detection problems, and may not be applicable in other canine training contexts.

The techniques and procedures elaborated in the present document were developed for the United States Army Mobility Equipment Research and Development Command, Ft. Belvoir, VA, over a period of approximately three years by Southwest Research Institute, San Antonio,

TX, under Contract No. DAAK02-73-C-0150. Most of the data and
research findings reported herein were generated during the course
of the same experimental program.

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CHAPTER I

INTRODUCTION

Historical Perspective. Throughout the history of warfare, including the recent hostilities in Southeast Asia, specially trained dogs have accompanied man into combat or have been deployed in direct or indirect support of combat operations. Initially, entire formations of attack dogs, sometimes fitted with formidable spiked collars and body armor, were dispatched into battle against enemy forces. With the development of gunpowder and the associated modifications in military tactics, the value of dogs in direct combat diminished significantly. Nevertheless, their usefulness in other military applications increased. During World War I large numbers of canines were utilized as sentries, scouts, messengers, ammunition carriers, and casualty dogs. It has been estimated that Germany employed over 30,000 dogs for such purposes, and approximately 20,000 animals served in similar capacities with the French Army. At that time the American Armed Forces had no organized canine unit but, in view of their demonstrated value, secured a limited number of dogs from the French and Belgians for casualty, guard, and messenger service.

Dogs were employed on an even larger scale during World War II. Over 250,000 canines served with the armies of the Allied and Axis powers; many were awarded high honors for their wartime performance.

The first large-scale use of dogs for mine detection purposes was by the Russians during World War II. One account suggests that as many as 100,000 mines were detected by these animals on roads, in towns and villages, and at bridgeheads; according to the same report, one especially proficient dog located almost 2,000 mines in one three-week period (1). The need for large numbers of military dogs was recognized by the U. S. Army in 1942 resulting in the establishment of the K-9 Corps. This organization operated five War Dog Training Centers throughout the United States and trained approximately 10,000 dogs for service in World War II. The Patrol/Sentry Dog Training Branch, Department of Security Police Training, Lackland AFB, TX, was established in 1958, and presently, patrol and sentry dogs are trained at Lackland for all branches of the U. S. Armed Forces. The Air Force remains the major user of patrol dog teams; sentry dogs are used primarily by the Army, Navy, and Marine Corps (2, 3).

Current Perspective. Although certain electronic instruments and systems have proven reasonably effective in the detection of metallic land mines, currently-available detectors of this type are not always effective against nonmetallic mines and related surprise-firing devices. And despite the expenditure of millions of dollars and a substantial number of man years of research effort, the U. S. Forces must now face their operational missions without a fully satisfactory instrument

for detecting concealed mines and booby traps. A variety of techniques have been developed for detection of ultra trace quantities of specific vapors emanating from primary explosives; for example, nuclear magnetic resonance, nuclear quadripole resonance, plasma chromatography, gas chromatography, spectrochemical emission spectroscopy, IR absorption, Raman spectroscopy, chemiluminescence, bioluminescence, and enzymatic catalysis. However, each has drawbacks which function to limit its deployment under actual operational conditions. The continuing military need for an effective real-time capability for detection of concealed battlefield threats such as ambushes, buried or camoflaged land mines and similar explosive ordnance devices, etc. could be met by the use of specially trained dogs.

Biodetectors, such as dogs specially trained for olfactory detection of explosive substances, have demonstrated tremendous value as mine/ booby trap detectors. Their olfactory sensorium has been shown to be sensitive to small quantities of the explosive target substance; it is highly selective, and the animals have a detection range (off leash) which reduces physical danger to the handler/operator. Furthermore, most breeds of dogs are intelligent, motivated to perform, respond reliably to verbal and non-verbal commands, and can be trained to execute complex tasks. Indeed, scout dogs, land mine/booby trap detecting dogs, and

tunnel detecting dogs, although deployed on a relatively limited scale, were found to be highly effective in operational use in Southeast Asia (4).

For certain types of devices (e.g., non-metallic mines, trip wires) and in certain scenarios (e.g., trails over rough terrain, railroads, buildings), canines which have been specially trained for explosive detection appear to constitute the best all-around detection system currently available. State-of-the-art technology suggest that it will be a number of years before a portable instrument is available which equals the detection sensitivity of a dog trained for explosive detection. However, even if the upper limits of the dog's olfactory acuity is attainable via instrumentation, experience indicates that factors such as equipment size and susceptibility to ambient "noise" may remain problems.

While the tracking, sentry, and patrol capabilities of trained canines have long been exploited in sundry military contexts, the use of dogs for olfactory detection of concealed ordnance devices remains a relatively recent innovation. The latter application of dogs, largely the result of modern, scientifically-oriented training techniques, represents a significant addition to the repertoire of valuable services performed by talented canines, and the now routine use of such animals by police and military agencies throughout the world for the detection of controlled substances and dangerous devices attests to the utility of canines trained for such tasks.

In addition to observations made under conditions of actual wartime deployment, a number of formal research studies have demonstrated that olfactory discrimination training attained in canines by application of established principles of operant reward conditioning appears to constitute an ideal approach to the problem of detection of land mines, booby traps, and related ordnance devices. For example, data collected by Southwest Research Institute (5) have shown that specially trained canines can function effectively as detectors of metallic and nonmetallic land mines and allied surprise-firing devices (at least under non-extreme climatic circumstances). The false alert rate observed during these evaluations also compares very favorably with other detector systems; on the average, less than 2.5 false responses per half-mile traverse.

The detection performance observed during these tests is also regarded as impressive in light of the age of the target plants at the time the tests were conducted. Approximately, one-half of the experimental targets had been implanted 8 months, and the other one-half about 5 months prior to the evaluation. A subsequent evaluation sequence conducted at Yuma Proving Ground, October, 1975, revealed that trained canines are also capable of reliably detecting freshly installed land mines and booby trap trip wires (mean age of implantation of approximately 10 days).

In light of these and related findings, the feasibility of the biodetector concept appears well proven. Indeed, for certain types of devices (e.g., non-metallic mines, trip wires) and in certain scenarios of deployment (e.g., trails over rough terrain, railroads, buildings), canines which have been specially trained for explosive detection would appear to comprise the most effective general-purpose detection system currently available.

Purpose of Present Manual. While the capabilities of mine detector canines have been well documented, the experience of several years of carefully-controlled studies at Southwest Research Institute (5,6) has shown that the successful training of such animals requires the application of a sequence of complex and sophisticated operant conditioning techniques by a knowledgeable, experienced trainer/handler. The purpose of the present manual is to provide a systematic and detailed presentation of the techniques employed in the training and deployment of dogs for detection of concealed land mines and booby trap trip wires. Many of the procedures described herein have general utility in diverse canine training applications; others are specific to ordnance detection tasks.

Obviously, certain unique problems which may be encountered, as well as the precautions and subtle procedural modifications which may be necessary during training of a particular dog cannot be anticipated

in any text no matter how extensive. Nevertheless, a careful study of
this document should adequately familiarize the uninitiated animal han-
dler with the procedures involved in training dogs to detect land mines
and booby trap trip wires. It must be emphasized that the most effi-
cient way for a naive handler to learn these procedures is by observing
and assisting canine specialists who are experienced in these techniques.

Selection of Dogs. Detailed guidelines regarding selection of dogs
suitable for land mine/booby trap detection training have been presented
elsewhere (7). However, an overview of the salient considerations
is given below for the sake of completeness.

Breed: Although early U. S. programs employed a diverse array
of canine breeds for general military service, the German Shepherd and
Labrador Retriever have gained almost universal acceptance in recent
years. The German Shepherd enjoys particular favor for patrol and
sentry duties due to its size, strength, agility, fearless disposition,
and inherent distrust of strangers. However, for mine/booby trap and
related olfactory detection tasks, where sheer physical strength and
aggressiveness are relatively unimportant, there is reason to believe
that breeds other than the German Shepherd might be used to advan-
tage. Indeed, excessive aggressive tendencies could be regarded as
an undesirable trait in a detector animal deployed on short notice in
an area occupied by naive and unsuspecting friendly troops. The use

of the Labrador Retriever, a breed possessing good olfactory acuity and a generally docile nature, may eliminate this unwanted characteristic without sacrificing detection proficiency.

Sex: The animal's sex appears not to be an important variable with respect to the performance of detection tasks. However, female dogs should be spayed prior to initiation of training in order to minimize cyclic variability in performance and to eliminate a potential source of distraction for male trainees.

Age: Training for sentry and patrol duties is generally not undertaken before the dog has achieved 12 months of age since it is difficult to elicit a sufficient degree of aggression in younger animals. For olfactory detection tasks, however, the candidate dogs may be acquired and preliminary training initiated at an earlier age. Eight weeks would not be an unreasonable age to begin preliminary obedience training.

Olfactory, Auditory, and Visual Acuity: Obviously, a successful mine detector canine must possess average, or, preferably, better than average olfactory acuity. Any evidence of a less than normal sense of smell, including abnormal or partially obstructed airways, provides grounds for immediate rejection.

Although the exact mechanism of detection of booby trap trip wires by trained canines remains unclear, one theory holds that subtle auditory cues created by wind-induced vibrations of the wire serve in

part to alert the animal to the presence of this class of surprise firing device. Assuming this hypothesis to be true, good auditory acuity represents a valuable attribute in a potential detector dog.

Although most breeds of dogs are not noted for keen visual acuity, it is possible that sight plays a partial role in the detection of booby trap trip wires and surface-deployed mines. Therefore, evidence of gross visual dysfunction provides cause for rejection.

Temperament: Temperament comprises one of the most important characteristics of a successful detector canine, and potential candidates must be screened very carefully on this complex dimension. General curiosity, alertness, vigor, and physical energy are desirable traits and should be afforded considerable emphasis in the selection of a potential trainee. As a rule, gregariousness and a friendly, if perhaps guarded, acceptance of an approaching stranger are also useful predictors of success in training. However, this does not mean that animals displaying an air of confident aloofness will not develop into excellent performers. In any event, shy and timid dogs which attempt to escape or cower when approached should be rejected.

Furthermore, animals displaying strong aggressive tendencies are not particularly desirable for detector applications, although fear of novelty represents an equally undesirable characteristic. Animals of the latter temperament generally do not learn new tasks quickly and tend to be highly distractable in the field.

Finally, gunshyness cannot be tolerated in a military dog. This trait can be identified by straightforward empirical procedures.

Motivation: Eagerness to please is an especially valuable asset in any working dog. Animals possessing this trait respond to verbal praise and affection with clearly recognizable positive reactions. The relative incentive value of food rewards is also an important consideration in the overall selection process since food reinforcement constitutes a principal feature of the detection training protocol.

Medical Considerations: All candidates should receive a thorough screening by a qualified veterinarian prior to acceptance, including a radiologic examination for coxofemoral pathology (disease or abnormality of the hips) and elbow dysplasia. German Shepherds are especially prone to hip dysplasia.

Stool samples should be inspected for evidence of common parasites such as hookworms, roundworms, whipworms, and tapeworms; heartworms may be detected by examination of blood samples. Special attention should be paid to the possibility of heartworm infection in warm climates and in areas plagued by large mosquito infestations. The presence of parasites does not necessarily eliminate an otherwise acceptable dog since most types respond favorably to treatment.

The veterinary examination should include screening for evidence of injury, disease, and other physical abnormalities. All obligatory

vaccinations should be current (canine distemper, infectious canine hepatitis, leptospirosis, and rabies).

Other useful indicators of good health include an even glossy coat, healthy gums and teeth, clear eyes free of excessive discharge, and lean, trim muscular development.

CHAPTER II

PRINCIPLES OF CONDITIONING

The fundamental strategy underlying the training of land mine/ booby trap detector dogs involves the application of laboratory-proven principles of operant (or instrumental) and classical (Pavlovian) conditioning to modify the animal's behavior such that it actively seeks out and detects the ordnance devices of interest and immediately thereupon executes a clearly recognizable alerting response signifying the detection. As such, detection training can be regarded as a form of applied behavioral modification. Although the principles of operant conditioning clearly apply in the detection training process, the role of the Pavlovian conditioned response is less certain. A strong argument can be made to the effect that the laws of classical conditioning underlie the development of powerful secondary reinforcers which (a) come to serve as important supplemental reinforcers in establishing and maintaining the behaviors of interest, and (b) permit effective handler control over the dog's general behavior. The operant/classical dichotomy remains the subject of considerable controversy among experimental psychologists concerned with learning phenomena, and a satisfactory experiment to differentiate the relative contributions of the two processes to the acquisition of complex tasks remains to be devised. However, the operant and Pavlovian paradigms can be distinguished on operational

grounds, and from a practical point of view the associated theoretical issues are largely academic. Nevertheless, it is important for the prospective canine specialist to possess a fundamental grasp cf the processes involved in order that he may appreciate the rationale and more effectively apply the principles underlying the detection training sequence.

Definition of Learning. An all-encompassing technical definition of so complex a term as learning (conditioning) is difficult if not impossible to formulate. At least two major kinds of useage of the term may be distinguished. In the first useage, most relevant for the present application, learning refers to ongoing behaviors, and especially to systematic changes in those behaviors. In the second useage, it refers to some sort of internal events ("mental" or "psychological" processes) presumed to underlie the observed behavioral changes. The latter useage is best left to learning specialists of theoretical inclination.

Accepting for the present purposes the direct behavioral definition, learning can be most usefully and generally defined as a relatively lasting change in behavior occurring as a function of reinforced practice (8). Although this definition may not satisfy all experts, it nonetheless does indicate the basic meaning normally associated with the concept.

Certain qualifications need to be made before the definition of the term learning can be considered reasonably complete. Learning must be distinguished from other processes which produce behavioral changes but not as a function of prior behavior in any directly relevant manner. Learning is also commonly distinguished from certain super-ficially very similar behavioral changes where different underlying mechanisms are assumed to operate.

With regard to the first kind of distinction, there are several causes of behavior changes which need to be excluded from the def-inition stated earlier. Among these are maturation (or growth), fatigue, drug and dietary effects, disease effects, and adaptation.

Maturation produces behavior changes by means of changes in bodily structure, on a genetic basis and without regard for previous experience; for example, the marked changes in behavior that typically occur at certain critical periods in development. Although these changes are certainly subject to influence from previous experience, and therefore may be said to have been influenced to some extent by learning, nevertheless they are basically a function of a different kind of causative factor (for example, hormone secretion) which is largely independent of previous experience.

The same statement can be made for each of the other exclusions, with the possible exception of adaptation, and for similar reasons.

Fatigue operates to reduce behavioral output by means of lactic acid accumulated in the musculature and not adequately removed by the circulatory system, and thus does not classify as a type of behavioral change produced by learning. Similarly, drugs and dietary factors produce changes in behavior by operating more or less directly on the sensory, neural, or effector mechanisms. Disease processes may also affect any of the organ systems and so influence behavior.

The distinction between these various kinds of processes and learning is an important one both practically and theoretically. It is important in practice because the actions which need to be taken to correct undesirable behaviors differ markedly. For example, a dog whose poor olfactory discrimination performance is thought to be due to an insufficient number of training trials may be given certain kinds of remedial treatment (e. g., additional practice sessions). But if the animal's poor performance is actually the result of organic factors (e. g., loss of acuity due to disease or injury) this type of treatment will be of little value. Many similar commonplace examples should be evident to the reader. Distinctions of this type are of considerable practical importance since the canine specialist must be attentive to correct identification of problems encountered during the course of training. Confusions which occur as a result of insufficient knowledge or errors of analysis are of course detrimental to overall training objectives.

One further distinction should be introduced at this point. This

is the distinction between learning and performance. Although learning cannot be measured in the absence of behavior (i.e., performance), nevertheless it is also true that lack of performance does not necessarily indicate lack of learning. Before learning can be demonstrated behaviorally, some degree of motivation must be present. Thus an animal which has learned some particular response (e.g., halting and sitting down upon detection of a booby trap trip wire) will not perform appropriately unless adequately motivated. The topic of motivation in land mine/booby trap detector dogs is discussed in greater detail in Chapter VII.

Operant Conditioning. Of the two major subclasses of learning phenomena, instrumental and classical conditioning, the former appears to play the larger role in the training of dogs for land mine and booby trap detection. Although not precisely synonomous, the term operant conditioning is often used in place of instrumental learning and will be adopted for the present discussion. Formally, operant conditioning may be defined as any learning (a) based on response-contingent reinforcement and (b) not involving choice among experimentally defined alternatives. The requirement that reinforcement be response contingent qualifies the learning as instrumental, and the specification that the behavior be nonchoice means that only a single relevant response class exists and that the performance measure must be framed in terms of response magnitude (e.g., frequency of occurrence, rate, amplitude, latency, speed, etc.).

Operant behavior is controlled by its consequences; that is, occurrence of the reinforcing event is contingent upon prior execution by the organism of some prespecified response. Any response so controllable, that can be made to occur at a convenient rate, and that, when completed, leaves the animal in a state and position where it is free to respond again can be employed as an operant response. In the context of mine detector organisms, the response of interest is sitting down following detection of the target device, and reinforcement consists of timely delivery by the handler of an effective reward (food, verbal praise, etc.). All responses which meet the experimenter's predefined criteria receive reinforcement in simple conditioning paradigms; in others, however, only a selected proportion of such responses are reinforced (e.g., see "Partial Reinforcement," p. 24).

Reinforcement. It will be noted that in the general definition of learning as well as that of the subclass operant conditioning, the notion of reinforcement appears as a key element (i.e., reinforced practice, response-contingent reinforcement). Simply stated, reinforcement corresponds to what the layman would call reward or punishment. Examples of the many events which can serve as reinforcers of learning are food for a hungry animal or human being, certain pleasing tastes, praise (e.g., a "well done" from one's superior), or escape from punishment. Reinforcement is of such obvious importance in learning that it was long

ago dignified as the Law of Effect (9). This law formalizes the fact that any act (response) which has a satisfying effect — for instance, satisfaction of a motive state, escape from punishment, or relief from fear — will be learned, but any act which produces an unpleasant effect — such as frustration of a motive, or fear — will not be learned. Reinforcing events may be categorized as positive or negative; a positive reinforcer tends to increase the probability of occurrence of any response which immediately precedes it, and negative reinforcers act to decrease the probability of a preceding response. Theoretical issues aside, the simple fact that positive reinforcement operates to strengthen learned associations has been called the Empirical Law of Effect (10).

Operant Conditioning Subtypes. Many different experimental procedures have conventionally been included under the rubric of operant conditioning, and of this number, "nondiscriminative operant conditioning" and "discriminative operant conditioning" are most relevant in the present context. Nondiscriminative operant conditioning is the procedure frequently called simple reward training. With animal subjects the reward is usually food or water; with humans (often children) it may be money, a trinket, or a piece of candy. The positive reinforcer may either be "primary" — that is, presumably unlearned (food, water, and so on); or it may be "secondary" or "conditioned" — its rewarding properties being tied to past learning (money, tokens, goal boxes in which food was previously obtained, and so on).

Discriminative operant conditioning is somewhat more complex in that a cue (or discriminative stimulus) signals the availability of reinforcement, and eventually the subject comes to execute the appropriate response vigorously in the presence of the cue, but weakly, if at all, in its absence. The astute reader will recognize that the training of dogs for detection of land mines represents a form of discriminative operant conditioning as illustrated for both general and specific cases in the following diagram. (The dotted line indicates the strengthening effect of reinforcement upon the stimulus-response association).

General Case: Cue → Response → Reinforcement

Mine Detection: Characteristic Odor → Sit → Food (primary reinforcer)
                                               +
                                       Praise (secondary reinforcer)

A potential problem in the operant conditioning of complex tasks is that the probability of spontaneous occurrence of the response of interest may be exceedingly low. In such situations, opportunities for reinforcement are correspondingly few in number and, as a consequence, learning may be painfully slow if not impossible. For example, the probability that an untrained dog will spontaneously sit upon smelling a land mine is extremely slight. How then could one hope to reinforce this stimulus-response sequence? The solution to this dilemma arises

from the fact that in operant conditioning it is possible to "shape" behavior through appropriate use of reinforcement. In fact, a skillful trainer can shape very complex response sequences in a relatively short time. The essential point about shaping is that the learner is led to the final response through the learning of a chain of simpler responses. In other words, the learner comes to approximate the final response through a series of successive steps. The technique of shaping is sometimes called the "method of successive approximations (11)." It will be seen in a later chapter that mine detection training involves an elaborate shaping sequence starting with a simple nondiscriminative responding to pure explosive samples, progressing through the discrimination of explosive odors from a myriad array of associated but irrelevant odors, and culminating in the search and detection of live mines deployed in actual field environments.

Classical Conditioning. As will be recalled, the second major subclass of learning phenomena is called classical or Pavlovian conditioning, thus named after Pavlov, the Russian physiologist, who noted in the course of his investigations of digestive processes that stimuli which regularly preceded the appearance of food to a dog (for example, the sight of the food pan, the smell of food, the sound of footsteps of the approaching experimenter) came to elicit "psychic" salivary and gastric secretions (12).

The essential feature of classical conditioning is a set of experimental operations involving an unconditioned stimulus (UCS) which

reliably produces a measurable unconditioned response (UCR) and a conditioned stimulus (CS) that has been shown by test not to produce the UCR. The CS and UCS are then presented repeatedly to the organism in a specified order and temporal spacing, and a response similar to the UCR develops to the CS that is called the conditioned response (CR). Although various temporal arrangements of the CS and UCS characterize the classical conditioning paradigm, what distinguishes it from operant conditioning is that presentation or omission of the UCS is independent of CR occurrence. By contrast in the operant conditioning paradigm a contingent relationship exists such that occurrence of the response results in the presentation or omission of the reinforcing event (13). The importance of the classical conditioning paradigm with respect to the training of land mine/booby trap detector dogs arises from the fact that by virtue of this process certain originally meaningless phrases such as "Good Dog" acquire powerful secondary reinforcing properties.

Secondary Reinforcement. From the point of view of need reduction, primary reinforcers are those which reduce some innate, vital physiological need of the organism, such as the need for food or water, or to escape pain. Secondary reinforcers, on the other hand, do not meet such innate needs, but come to be effective through a learning process. From the descriptive point of view, a primary reinforcer is simply one

which is effective without any prior training, whereas a secondary

reinforcer, sometimes called a conditioned reinforcer, requires prior

association with a primary reinforcer to be effective. More formally,

a secondary reinforcer may be defined as a stimulus which after it has

been paired with a primary reinforcer, will itself begin to act as a

reinforcer. That is, it will increase the probability of a response (11).

In terms of operations, it is clear that the procedures required to pro-

vide a neutral stimulus with secondary reinforcing powers are those of

Pavlovian conditioning. Hence, an originally neutral (conditioned)

stimulus is repeatedly paired with a primary reinforcer (unconditioned

stimulus), and thereby the former acquires certain reinforcing proper-

ties of the latter (14). Secondary reinforcement may be illustrated by

the following example:

> The sound of a buzzer, in itself, is not
> reinforcing to a rat. If, however, the buzzer
> is paired with a primary reinforcer, it will ac-
> quire the ability to reinforce. The experiment
> begins by sounding a buzzer every time a rat
> is given a sip of sugar water. Then the rat is
> put in a Skinner box and allowed to learn, for
> the first time, to press the lever. Instead of
> reinforcing the rat with sugar water, however,
> the experimenters reinforce it with the buzzer
> that had been paired with sipping sugar water.
> The buzzer now works very well as a second-
> ary reinforcer to increase the rate of lever
> pressing (15).

In addition to serving as a reinforcer in the learning of new

responses, secondary reinforcement can act to maintain behavior when

no primary reinforcement follows the response such as would occur during

experimental extinction. This effect is illustrated by the following

experiment:

> Rats were trained to press a bar in a Skinner
> box with a click accompanying the presentation of
> primary reinforcement. After the animals had learn-
> ed the response, two groups were formed. Neither
> group received primary reinforcement for bar presses,
> but in one group bar presses were followed by the click.
> In the other group, no stimulus followed bar presses.
> The results showed that responding was maintained far
> longer in the "click group" than in the "nonclick group"
> (16).

It has already been indicated that terms such as "Good Dog"

serve as powerful secondary reinforcers in the acquisition and mainten-

ance of desired responses in dog training applications. These phases

acquire their secondary reinforcing capacity through repeated pairing

(i.e., classical conditioning) with primary reinforcers (food) in the

overall reinforcement sequence as will be seen in a later chapter.

Delay of Reward. The normal procedure in operant conditioning is to

reinforce the subject immediately upon making the required response.

If, however, a time delay is introduced between completion of the con-

ditioned response and delivery of reward, learning is interfered with,

the extent of the interference being determined by the duration of the

delay. In other words, asymptotic performance in operant conditioning

is inversely related to the duration of reward delay. Furthermore,

rate of acquisition (learning) will also be retarded. Indeed, there is

experimental evidence to suggest that actual declines in levels of

performance already achieved may occur if the delay is sufficiently long (17). Similar phenomena take place in classical conditioning where delay of reward procedures are generally known as CS-UCS interval manipulations.

The implications of delay of reward with respect to the training of land mine/booby trap detector canines are clear: reinforcement should be administered as quickly as possible following each correct detection. Otherwise, rate of learning may be seriously retarded. (An important exception to this rule occurs in the case of partial reinforcement as described below).

Extinction. In operant as well as classical conditioning it is possible to remove or extinguish a learned response by withholding reinforcement altogether, an operation which might be regarded as infinite delay of reward. If, for example, a rat in a Skinner box (a common term for a laboratory operant conditioning apparatus) no longer receives food pellets when it presses the response lever, its rate of responding progressively declines until it makes no more responses than it did before it was trained. When the number of responses is not greater than it was before conditioning commenced, the behavior is said to be extinguished. Similarly, withholding reinforcement from a well-trained mine detector dog will also result in extinction. If the practice is continued long enough, the animal's search and detection behaviors will cease entirely.

Partial Reinforcement. In the most straightforward conditioning

paradigm, every response meeting the experimenter's prespecified criteria (i. e. , "correct" response) is reinforced, a procedure termed continuous reinforcement (CRF). Other factors equal, CRF reinforcement schedules result in the most rapid learning of the behavior of interest. However, other reinforcement strategies are possible, most notably those in which only a selected subset of all correct responses are rewarded. Such procedures are known as intermittant or partial reinforcement (PR). For example, every 2nd or every 3rd (or every n^{th}) response may be reinforced. Alternatively, a random proportion of correct responses may be scheduled for reinforcement, e. g. , a 50% random PR schedule is one in which, on the average, half of the trials receive reinforcement, the other half do not. Other PR arrangements are possible.

A significant feature of many PR paradigms is that behaviors so conditioned tend to persist longer (show greater resistance to extinction) if reinforcement is totally withheld than do those learned under conditions of CRF. This phenomenon is known technically as the partial reinforcement effect (PRE). A hypothetical illustration of the effects of PR on the acquisition and extinction of operant conditioned behavior appears in Figure 1. Note the increased resistance to extinction in Group II which was trained under PR.

Such enhanced resistance to extinction, if shown to occur in the
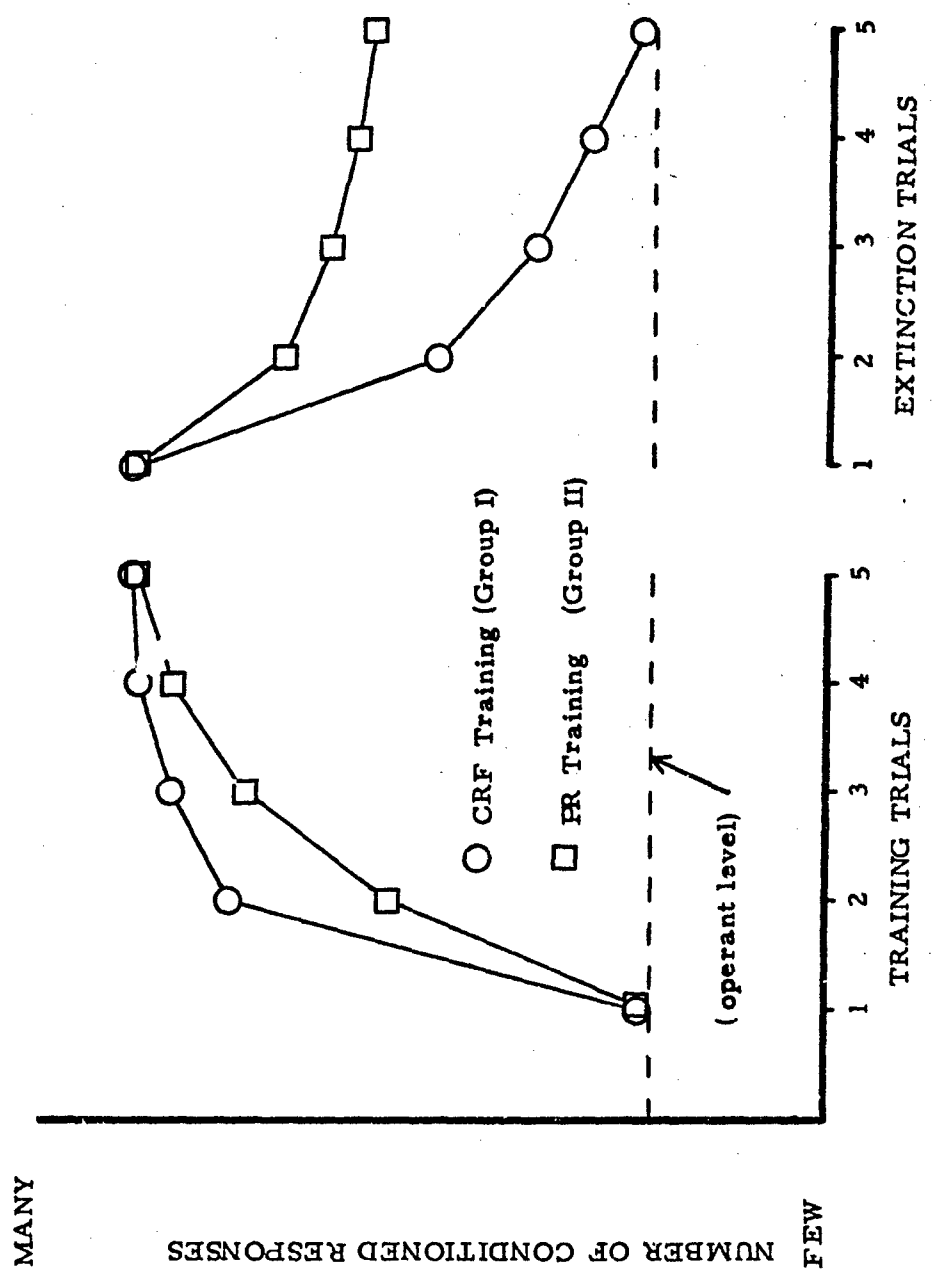
Fig. 1. Hypothetical example of effects of CRF versus PR during training and extinction.

case of mine/booby trap detector dogs, would represent a phenomenon of considerable importance ince during actual deployment the handler generally will not have real-time knowledge as to whether a given alerting response is correct or false. Under these circumstances, it is not possible to administer the customary reinforcement, and the conditioned behavior may therefore progressively extinguish.

Unfortunately, few data are available to indicate whether or not the PRE occurs in the case of mine detector canines deployed in simulated tactical environments. As of this writing, only one formal experiment of this type has been undertaken to assess the potential beneficial effects of PR during training on subsequent resistance to extinction (18). The design of this experiment was straightforward: In an ongoing series of formal canine mine/booby trap detection evaluations, a subgroup of 5 dogs was shifted to a 50% random PR schedule during the latter phases of training. During the second half of each experimental evaluation, all correct responses went unrewarded. Another subgroup of 5 animals trained under CRF also received no reinforcement during the second portion of each evaluation series. The relative detection proficiency of these two groups of dogs was compared to determine whether or not the PR procedure does indeed retard extinction of mine/booby trap detection performance.

The results of this investigation revealed that both groups of animals continued to perform at high levels of proficiency during the

non-reinforced series of extinction trials regardless of type of training (CRF vs. PR), and thus no clear evidence of a PRE per se was observed. However, the length of the extinction test series was relatively short and may have been inadequate to permit emergence of differential rates of extinction in the present study. In any event, there is good reason to believe that PR during training will lead to enhanced resistance to extinction in land mine/booby trap detector dogs since the PRE is obtainable under an extremely wide range of conditions and organisms. There is some question as to whether it occurs in fish, but at the mammalian level it enjoys something of the status of a behavioral law (17).

It must be recognized that even if PR training leads to more persistent responding over non-rewarded trials, total extinction will nonetheless result if reinforcement is withheld over a long period.

CHAPTER III

PERSONNEL, FACILITIES, AND EQUIPMENT

Personnel. The ultimate success of any dog training program and the welfare of the animals enrolled therein rests entirely in the hands of the training center personnel. The responsibilities of these individuals include, but are not necessarily limited to, the meticulous and system- atic application of the prescribed training regimen, physical care of dogs assigned to the training center, maintenance of facilities and equip- ment, and maintenance of appropriate records. In general, efficient operation of a canine land mine/booby trap detection training center entails four duty assignments: supervisor, kennelmaster, training assistants, and trainer/handlers.

   A)   Supervisor: The responsibilities of training center supervisory personnel include:

      1)   Supervision and coordination of overall training center operations.

      2)   Assignment of dog/handler teams.

      3)   Insuring that training personnel understand and apply correct principles of training; assuring that training personnel understand the physical and psychological characteristics of their dogs.

      4)   Supervision of all phases of training.

      5)   Evaluation of each dog's progress in training;

supervision of final proficiency examination.

   6) Orientation and training of inexperienced trainer/ handlers.

   7) Evaluation of special training problems; development of necessary remedial actions.

   8) Maintenance of records.

   9) Insuring that special instructions are carried out.

  B) Kennelmaster: The primary duties of the kennelmaster, whose activities must be carefully coordinated with the trainer/handlers, are:

   1) Physical care and feeding of all dogs assigned to the training center.

   2) Maintenance of kennel facilities and training areas.

   3) Treatment of minor wounds and illnesses; procurement of professional veterinary attention as needed.

   4) Care and maintenance of equipment and special training apparatus.

   5) Procurement of equipment and operating supplies. (including explosives and related training aids).

   6) Proper destruction of old or contaminated training aids (e. g., explosives).

  C) Training Assistants: The responsibilities of training assistants include:

1)   Preparation of training aids, practice trials, etc.

2)   Scoretaking (i.e., acquisition of training data).

3)   Assisting trainer/handlers as necessary.

4)   Assisting kennelmaster in performance of his routine duties.

D)   Trainer/Handlers: The trainer/handlers represent the key elements in the operation of a successful training program; their duties and responsibilities include:

1)   Provide for the well-being of all dogs assigned to their care.

2)   Responsible and systematic application of the detection training sequence.

3)   Understand and integrate each dog's special strengths and weaknesses to attain maximal performance.

4)   Assist other trainer/handlers as needed.

5)   Report all unusual problems or difficulties to supervisory personnel.

Assuming the availability of an adequate number of training assistants, one trainer/handler operating in a full-time training capacity can normally manage the training of 3 to 4 dogs at a time. Although occasional development of special interest in one dog among the several assigned to a trainer's care is probably inevitable, caution must be

exercised to insure that preferential treatment does not interfere with the training of other dogs. Conversely, the trainer must restrain himself from ignoring, or worse, taking out day-to-day frustrations on a less favored animal.

Unfortunately, there is no clear-cut "psychological profile" or otherwise purely objective procedure for selecting qualified trainer/ handlers in advance. However, experience has identified certain personality characteristics possessed by the vast majority of successful dog trainers and handlers. Summarized below, these traits have been discussed in greater detail elsewhere (19):

1)   Friendly attitude toward dogs.

2)   Intelligence.

3)   Patience and perserverance.

4)   Mental and physical coordination.

5)   Physical endurance.

6)   Resourcefulness.

7)   Dependability.

In addition to the characteristics listed above, the handler's attitude toward his assignment acts as a critical variable in the overall performance of the handler/dog team. Most dogs possess an uncanny ability to sense and react to the attitude and general frame of mind of their handler. Thus, the handler who projects an air of enthusiasm and genuine interest

may find his personal buoyancy reflected in terms of noticeable improvements in the performance of his dog. Similarly, a sincere and enthusiastic delivery of verbal praise for correct behavior will almost certainly contribute favorably to the dog's performance.

While certain of these characteristics may be identified in an initial interview conducted by experienced personnel, others can be accurately assessed only by observation of actual performance. For this reason, it is recommended that prospective trainer/handlers be retained on a trial basis. A final decision regarding each candidate's qualifications can generally be made following a two-week progress evaluation.

Although of limited relevance from a practical point of view, handler experience may operate as an important factor contributing to overall variability in the detection proficiency of a given dog. A series of previous canine mine detection performance evaluations provided an opportunity to assess the effects of this variable (6). The degree of experience possessed by the handler personnel assigned to the latter mission could be divided roughly into three categories: extensive, moderate, and minimal. All handlers worked with the same pool of previously-trained animals, thereby permitting the detection data to be analyzed in terms of handler experience. The results of this analysis

revealed that the most experienced handler (20 year's experience with military working dogs) produced the highest detection scores (80.14% correct overall). A second individual with moderate experience (4 + years) turned in the next highest scores (74.0%). At the lower end of the experience dimension were three individuals all of whom had less than 6 months' experience as handlers and none as trainers. These men produced scores of 62.82, 69.74, and 69.60 per cent. The highly experienced handler thus averaged approximately 13% higher detection scores than the most inexperienced individuals. The observed trend, which is revealing, probably real, and consistent with expectation, must nevertheless be interpreted with caution for several reasons; in particular, (a) the data are quite limited and may have been confounded by other variables (e.g., handler motivation), and (b) the technology of land mine/booby trap detection training had not been fully elaborated at the time these tests were conducted.

Facilities. Suitable facilities are required for the housing, care, and training of land mine/booby trap detector canines. In general, these facilities will include outdoor kennels and exercise areas, service and storage buildings, indoor training facilities, and a large outdoor area suitable for advanced field training.

    A)   Kennels: Numerous factors must be taken into account in the construction of permanent kennels to insure the health, comfort, and

safety of animals in training. Outdoor kennels are appropriate, but
each dog must be individually quartered to maintain proper sanitation
and to prevent fighting and other disturbances. It is recommended that
the kennel construction standards promulgated by the Institute of
Laboratory Animal Resources, National Research Council, National
Academy of Sciences (20), be observed in complete detail, specifically:

1) Kennel Site. The kennel facility should be located
(a) in an area free of restrictive zoning laws, (b) at a reasonable dis-
tance from highly populated regions, (c) away from high-noise environ-
ments, and (d) preferably on high ground to promote good drainage
and to eliminate free-standing water. Natural barriers such as trees,
shrubs, or hills are desirable to provide supplemental protection from
the elements and to reduce distractions.

2) Materials. Materials recommended for outdoor-
facility construction are those which are moisture resistant and easily
sanitized. Concrete or concrete-block construction is desirable for
permanent buildings.

3) Run Surfaces. Concrete is desirable for outdoor
runs, and it must be adequately sealed. Since plastic or epoxy sealers
can result in slippery surfaces, a small amount of sand should be
sprinkled on the surface before it hardens. Aluminum oxide also pro-
vides a surface with adequate traction qualities.

4)   Kennel Size and Construction.   Minimum kennel

size for canines may be found by the following computation (20):

$$\frac{(\text{length of dog in cm} + 15.24)^2}{10,000} = \text{kennel surface area (m}^2).$$

However, it has been found that a 1.2 m x 3.6 m run represents a minimal

optimal size for German Shepherd - and Labrador Retriever - sized

dogs.   Individual kennels should be of metal post and chain link fence

construction and fitted with a top of similar fabrication.   The top should

be at least 183 cm high to permit easy access and facilitate cleaning.

Kennel floors should slope toward a central drain to eliminate

standing water and to receive waste matter flushed off during cleaning.

It is also desirable that the kennel drains be connected to a sanitary

sewer or suitable septic system.

Each kennel should be provided with a metal or wooden dog

house mounted on rails 5 - 8 cm above the surface of the run to prevent

the accumulation of waste materials.   It is recommended that the house

be fitted with a remotely-operated door so that the animal may be tem-

porarily confined during cleaning and sanitation operations; dogs forced

to stand on hard, wet surfaces for long periods may develop sores on

the feet.

If feasible, the entire kennel complex should be covered by a

roof to provide shade and protection from rain and snow; the sides of

the structure may be left open to promote ventilation. A barrier for wind protection should be provided during periods of harsh weather and in cold climates. A proper kennel installation is shown in Figure 2.

5) Water Supply. Large quantities of fresh water are required for cleaning and drinking purposes. Water suitable for human consumption must be used.

6) Electrical Supply. The kennel facility should be lighted and fitted with weather-resistant electrical outlets for operation of steam cleaners, pressure sprayers, and related cleaning apparatus.

B) Exercise Runs: The kennel facility should be provided with a number of chain link pens (e.g., 6 m x 15 m each) to permit periods of exercise on days when the animals are not heavily worked. If separate exercise runs are not practical, a suitable area for kennel chaining should be provided. These areas may be used for temporary quartering during kennel sanitation operations.

C) Service Areas: Suitable service buildings are required for the operation of the dog training facility. These include:

1) Food preparation room.

2) Facility for washing, sanitation, and drying of food pans, water buckets, etc.

3) An area for the preparation and storage of training aids and related supplies.

4) Food storage building. This facility must be insect and vermin proof and in warm climates, air-conditioned or otherwise
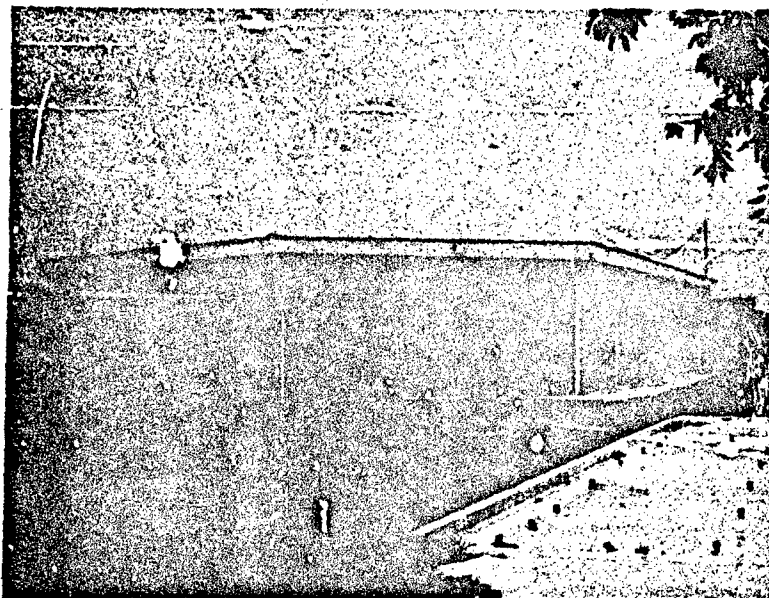
Fig. 2. Canine kennel installation.

ventilated to retard spoilage. Humidity control is also desirable.

      5)   Office space for supervisory personnel and record storage.

      6)   An assembly area and lunch room for training personnel.

      7)   Veterinary treatment room.

      8)   Bunkers of approved construction for storage of explosives and ordnance devices used in training.

      9)   Rest rooms with showers.

D)   Indoor Training Areas. Preliminary olfactory discrimination training is conducted indoors; 4 m x 6 m rooms supplied with lighting and electrical outlets are optimal for this purpose. These areas should be devoid of furnishings and all other fixtures not actually required during training exercises. It is desirable that the floor be of bare concrete construction to facilitate cleaning. The number of such rooms required will, of course, depend on the number of dogs in training at any one time; in general, each indoor training area can be expected to serve approximately 6 to 8 dogs per 8-hour working day depending upon stage of training and assuming efficient scheduling.

E)   Outdoor Training Areas. Construction of trails and simulated minefields used during field training exercises demands a sizeable tract of unimproved, unpopulated land. Literally dozens of trails are required for the training of as few as 10 to 12 dogs and thus

a large area will be necessary; a 2,000 to 3,000 acre site is not unrealistic for this purpose. Since large numbers of live (defuzed) land mines must be deployed for prolonged periods in outdoor training areas, complete fencing and appropriate security measures must be provided.

Equipment. The items below and shown in Figures 3 and 4 represent minimal equipment required for proper training of land mine/booby trap detector dogs. Special equipment and training aids utilized during various phases of training are described in a later chapter.

A)   Leather collar.

B)   Leather harness.

C)   Choke chain.

D)   Leather training leash (183 cm).

E)   Cotton web or nylon braid training leash (9 m).

F)   Kennel chain (2.5 - 3.0 m).

Fig. 3. Clockwise from bottom left: leather collar, muzzle, leather harness, metal choke chain.
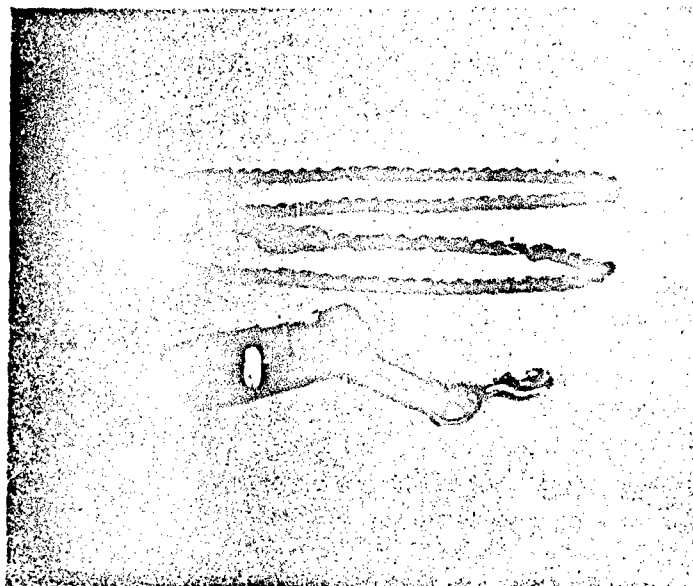
Fig. 4. Kennel chain (top) and leather leash (bottom).

CHAPTER IV

OBEDIENCE TRAINING AND PHYSICAL CONDITIONING

As indicated in Chapter II, the method by which dogs learn and become competent in the performance of complex tasks is by repetitive reinforced practice of the correct behavior. Many hundreds, even thousands of repetitions and a considerable amount of operant shaping may be required before full proficiency is attained in the case of unusually subtle or complicated discriminations. Immediate reinforcement for correct responding is the key to success. In the early stages of training, it is often necessary for the handler to literally show the animal what to do including outright physical positioning. This point cannot be overstressed. No amount of reinforcement will result in the acquisition of a desired response unless the dog knows what is demanded of him to begin with. In other words, effective reinforcement is impossible unless immediately preceded by the correct behavior. Worse, indiscriminate reinforcement of task-irrelevant responses will inevitably lead to the acquisition of so-called "superstitious" behaviors, learning of competing responses, confusion, and in all probability, a considerable degree of consternation and frustration on the part of the trainer. In a very real sense, dog training is a highly mechanical procedure; through a process of association dogs learn to make conditioned responses to verbal commands, but, anecdotal reports notwithstanding,

there is no convincing experimental evidence to suggest that they possess the capacity to manipulate symbols or comprehend complex language. Therefore, nothing will be gained by irrational pleading, cajoling, verbal abuse, or similar emotional outbursts. If such foolish behaviors on the part of the handler have any effect at all it is probably negative and may engender an atmosphere of uncertainty, distrust, and lack of confidence.

It should be apparent that the most important requirement in a dog trainer/handler is patience. Training for detection of land mines and booby traps is a repetitive and time consuming venture, and to make a dog repeatedly perform the same exercise until it is thoroughly mastered demands dedication and self-discipline. Patience and firmness result in a well-trained dog.

Several methods may be used to reinforce a dog including verbal praise, petting, food, retrieving a ball, and an opportunity to play. Of these, food and verbal praise (accompanied by petting) have been found to be effective in the training of land mine/booby trap detector dogs, the former because of its primary reinforcing quality, the latter by virtue of its acquired secondary reinforcing power. Obedience training is accomplished exclusively through the use of verbal praise and petting, while all three reinforcers are used during detection training exercises. However, some dogs respond more effectively to verbal praise than to food, while the behavior of others may be more powerfully controlled

by the opposite combination. The handler should therefore determine early in training which factor acts as the most potent reward for each animal and emphasize this technique during subsequent exercises.

Although the entire philosophy of dog training is based on the notion of positive reinforcement of correct behavior, the need for correction will arise from time to time. If a dog makes an error or commits an improprietous act, he must be corrected in order to learn right from wrong. Withholding food and praise and the admonition "NO", spoken sternly, or a sharp jerk on the leash is normally sufficient. Correction must be administered immediately since the animal cannot associate a reprimand with an error committed some time previously. In more technical terms, delay of reinforcement is equally ineffective be it reward or punishment.

A dog should not be corrected for clumsiness, slowness in learning, or inability to understand what is expected of him. In these cases, correction may retard the dog's training instead of accelerating it.

Harsh punishment is neither desirable nor necessary in the training of detector dogs. Physical reprimands are reserved for acts of defiance, biting, or deliberate disobedience of previously-learned commands, and even then should be inflicted only as a last resort.

Obedience Training. Every prospective land mine/booby trap detector

dog must successfully complete a basic obedience course prior to the initiation of detection training. Obedience training produces a reliable, well-disciplined animal, and establishes communication and rapport between handler and dog — attributes necessary for effective detection training. In this regard, the importance of the handler/dog "team" concept, characterized by mutual trust and confidence, cannot be overemphasized. Obedience training also provides an opportunity for the dog to learn the significance of the corrective admonition "NO"; in all future training this command will mean either "you made an erroneous response" and/or "stop whatever you are doing immediately!"

Both on-leash and off-leash obedience exercises are conducted utilizing verbal and hand-signal commands, and all dogs are required to master "sit," "stay," "down," "heel," and "recall" as a minimum response repertoire. Effective obedience training may be initiated in dogs as young as 12 weeks of age although actual detection training exercises should not be undertaken until the animal has achieved the age of at least 6 months. Like human children, young dogs possess a short attention span and, in such cases, the length of obedience training sessions must be limited. Several 10-minute work periods several times per day will be far more effective than one 30-minute session. Forcing a young dog to work beyond its attention span will be a wasted effort for both dog and trainer.

Any dog of sufficient intelligence, motivation, and trainability to be considered for land mine/booby trap detection training should be able to master the basic obedience course in about 4 weeks of daily practice. Dogs started as pups may require slightly more time.

Both verbal commands and hand gestures are used to convey commands to the dog. The trainer/handler must be thoroughly familiar with all commands, know how to execute them, and know what responses to expect from the animal before obedience training can proceed. Verbal and hand signal commands, issued properly, are easily understood by the dog, but it is imperative that they be given correctly, reliably, and consistently if training is to progress effectively. All verbal commands are single syllable words (e.g., SIT, HEEL, STAY, etc.) since such terms are least likely to be confused with other similar-sounding words. (For the same reason, single syllable words are preferred for dog names).

If the dog is to respond favorably to verbal and hand signal commands, the trainer must first have the animal's undivided attention. Therefore, before each training session begins, it is desirable to exercise the dog for several minutes and to allow it to urinate or defecate.

As previously indicated, the actual words used in verbal commands probably have no meaning to the dog; by a process of reinforced practice, the animal comes to associate the sound of each command with the appropriate response. Therefore, the trainer must strive to always give each

command in the same tone of voice. A strong, firm, and forceful
tone of voice will lead to best results. By the same token, verbal
praise should be delivered in a genuine, enthusiastic manner; it is not
possible to deceive a dog by means of false or hypocritical expression.
Eyes and facial expression are also important channels of communi-
cation, and dogs frequently look to the trainer's eyes for telltale evi-
dence of approval or disapproval. The trainer must react accordingly
by being sincere, consistent, and realistic in the administration of
praise or reprimands. The handler should never attempt to reprimand
his dog by glaring or staring into the animal's eyes; this practice tends
to make the dog nervous and can result in uncertainty and confusion
regarding what is being demanded of it. Be straightforward and con-
sistent.

From the beginning, the dog must never be permitted to ignore
either a verbal or hand signal command. The animal must learn to
associate each command with its immediate and complete execution.
it should never be allowed to suspect that there is any alternative ex-
cept to obey, and laxity or halfhearted enforcement on the part of the
handler may lead to an attitude of disobedience that will result in dif-
ficulty and delay in the training program.

The word "NO", spoken sharply, is used to indicate that the
dog has made an error or is engaging in undesirable activities, and is

the only word ever used as a negative command. The dog must never be slapped with the hand or leash. The hand is an instrument of praise, and the animal must not be allowed to fear it. In the same way, striking with the leash may cause the dog to become leash-shy and thereby lessen the effect of its proper use.

A sharp tug on the leash given simultaneously with the command "NO" is almost always a sufficient reprimand; the dog's name should not be used in conjunction with "NO." If this form of reproof is not successful, the dog should be taken out of the training situation and chained or kenneled. In the jargon of operant conditioning, this practice is known as a "time out" for erroneous behavior and constitutes a mild, but frequently effective, form of punishment. Clearly, the dog must not be praised, petted, or permitted to play during time out intervals. Otherwise the animal may quickly learn to deliberately commit an error or refuse to perform in order to escape the training situation.

Finally, the trainer must avoid excessive use of the term "NO" since by a process of association the dog may learn to respond to the verbal reprimand itself rather than to the desired command.

During early obedience training, hand signal commands are given simultaneously with the relevant verbal expression. After a sufficient degree of proficiency has been attained, either type of command used alone will result in execution of the desired response.

A)   Heel.   The initial command taught in basic obedience

training is HEEL.   There are two basic positions for HEEL: one when

the dog and handler are moving and the other after the team has halted.

In the first case the dog is trained to walk at the handler's left side, and

in the second, to stop and sit at the left side after the team has halted.

In proper heel position the dog's right shoulder is in line with the handler's

left knee.   The animal's body should be parallel to that of the handler,

and during marching exercises, the dog must neither surge ahead nor

lag behind.   Correct execution of the HEEL command is shown in

Figures 5 and 6.

Basic obedience commands are first taught with the dog on

leash at the handler's side.   The accepted hand signal corresponding

to the command HEEL is a sharp slap to the handler's left thigh given with

the open hand.   The verbal command and hand signal are given simultan-

eously as the handler commences forward movement and are also used

before any change in direction and one pace before coming to a halt.

In the latter instance the dog must learn to stop and sit in proper posi-

tion at the handler's left side.   The verbal command and hand gesture

should be repeated frequently during early training sessions.

When starting from a resting position, the dog's name is spoken

followed by the command HEEL (in conjunction with the hand signal).

Marching exercises are always begun with a step forward with the
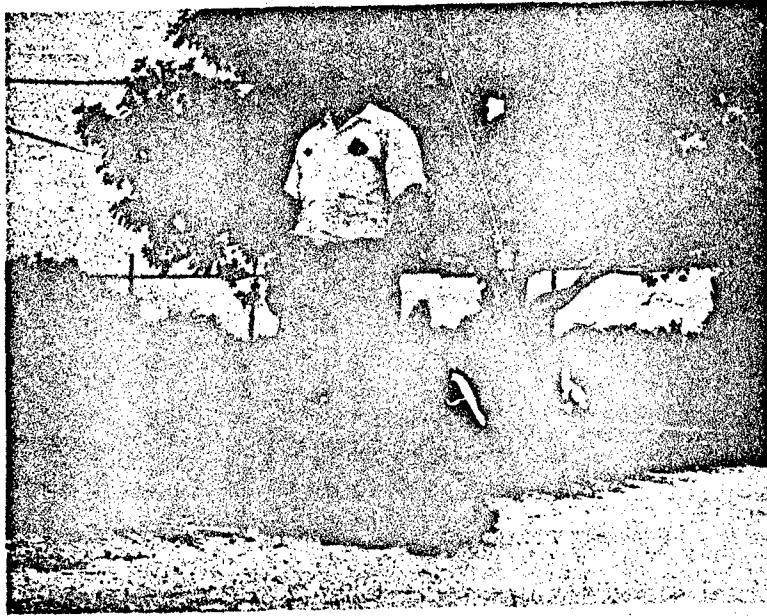
Fig. 5. Heel/Sit position.

Fig. 6. Heel during march.

left foot since body motion serves as an extremely important cue to the

dog. Motion of the left leg and foot, being next to the dog, thus acts

to telegraph the handler's intentions. During early training sessions,

a slight forward jerk of the leash may be needed to indicate to the dog

that he must move forward and maintain pace with the handler. Re-

peated use of the verbal and hand commands accompanied by brief tugs

on the leash are used whenever the dog lags behind or moves out of

position. The handler should avoid looking back or stopping if the

animal drops behind; all commands should be issued as if the dog were

in front. Verbal praise ("Good Dog") and encouragement are administered

as the dog moves into correct position. Note that the leash is always

held in the right hand in a loose "J" position. It should not be held

tightly — little more than resistance and resentment will be accomplished

by constantly pulling or dragging the animal. A dog walking behind the

handler cannot be pulled into proper position; quick tugs and releases are

a far more effective means of showing the animal what it must do. Calling

the dog's name, slapping the left leg, and verbal encouragement may

also be used to coax a lagging dog into position. If the animal surges

ahead or moves out too far from the handler's side, the handler gives

the reprimand "NO," tugs and releases the leash, and repeats the com-

mand "HEEL." Forging can also be discouraged by changing or reversing

direction; the lead should be snapped and the command "HEEL" given

simultaneously. In any case, the dog is rewarded verbally and physically as soon as it returns to the proper heel position.

The dog must be taught to remain at the handler's side during all changes in direction. On movements to the left, the command "HEEL" (plus hand gesture) should be given _after_ the handler's right foot strikes the ground and the pivot to the left is begun. This procedure prevents the dog from blocking the handler's path. The handler should avoid "giving ground" to the dog on left turns; although this practice may cause the animal to be brushed or turned by the left leg during early training sessions, the dog will soon learn to turn as soon as the verbal command is issued.

On movements to the right (which includes the reversal or about face), the command "HEEL" is given _as_ the handler pivots to provide sufficient time for the dog to assume the heel position before the maneuver is completed. A quick tug on the leash will assist the dog during learning of right turns. Finally, when coming to a halt, the command "HEEL" is issued one pace before stopping to give the dog enough time to assume the correct position.

It may be necessary to employ repeated tugs on the leash during early training sessions. However, this procedure should be discontinued as soon as the dog achieves reasonable competence lest the animal come to rely excessively on these cues.

Initial training sessions should be restricted to short traverses (e.g., 4-6 paces between halts) and simple straightline movements with no turns. More lengthy sequences involving multiple turns are introduced as the dog gains proficiency and confidence.

B)   Sit. The sit response should be taught in conjunction with heel since, upon a halt from a marching heel, the animal must stop and sit at the handler's left side. In a proper sit position the dog's body is parallel to that of the trainer with the right shoulder in line with the handler's left knee. The "SIT" command is taught by saying the dog's name followed by the command "SIT" delivered in a firm tone of voice; as the command is given, the handler grasps the leash several inches above the choke chain and tugs sharply upward. At the same time the handler pushes down firmly on the dog's hindquarters. To properly accomplish the latter maneuver, the palm of the hand must be placed over the dog's hips with the fingers positioned at the base of the tail. The proper technique is shown in Figure 7. As an alternative to the upward tug on the leash, the right hand may be placed under the dog's chin and a gentle upward pressure exerted. Lavish verbal praise and petting are administered as soon as the sit maneuver is completed. As training progresses and the animal learns what it is expected to do when commanded to "SIT," physical assistance may be deleted.

If the dog does not sit facing directly forward, the handler must

Fig. 7. Assisting the dog into the SIT position.

swing its body into correct alignment by firmly but gently pushing or

pulling the hindquarters into proper position. Excessive force or

roughness must be avoided, and physical correction of position should

be followed by praise. Physical correction is used to show the dog the

correct posture; it is not intended as a form of punishment for sitting

incorrectly. If the dog sits behind the handler, it should be coaxed

and gently pulled forward using the left hand for guidance.

Once the dog has learned to sit reliably upon verbal command

at the handler's side, it must be taught to generalize this response to

other situations, for example, standing or lying at some distance away

from the handler. In such cases the dog must learn to sit promptly

upon command but is not expected to return to the handler's side. To

properly execute this maneuver the handler must be facing the dog and

have its full attention. The latter is normally achieved by speaking the

dog's name just before giving the "SIT" command.

The remote sit is most easily taught with the dog on leash in

the down position. The handler stands facing the animal at a distance of

1.0-1.5 m with the leash held at the side in the right hand. The com-

mand "SIT" is given accompanied by a sweeping upward movement of

the right arm which ends with the handler's hand and arm extended

above the head. Properly executed, this movement will cause a quick

upward tug to be transmitted to the choke collar. As soon as the dog

sits up, the handler steps in to administer praise. The same upward
sweeping movement of the right arm comprises the correct hand signal
command for sit. Subsequently used without the leash, this gesture is
performed by first extending the right arm downward at the side with
the palm of the hand slightly cupped and turned forward toward the
dog. As the command "SIT" is issued, the arm, held rigid, is moved
forward and up over the handler's head. Upon completion, the handler's
arm is raised fully upward with the palm facing to the back. As the dog
gains proficiency, the use of the leash may be discontinued and the dis-
tance separating dog and trainer increased in gradual increments.

     C)   Down. When the trainer gives the command "DOWN,"
the dog, whether starting from a standing or sitting position, must promptly
lie down on its stomach with head up and front limbs parallel and extended
forward. It is best to introduce the "DOWN" command with the dog in the
heel/sit position; the handler bends down and grasps the leash just above
the snap with his left hand. Next, he gives the verbal command "DOWN"
while forcing the dog into position by pushing downward on the leash with
his left hand. After the dog is in the down position, the handler gives
verbal praise prior to returning to a standing position.

     It should be noted that many dogs resist being forced into the
down position since it is somewhat unnatural and makes them unusually
vulnerable to the handler or other dogs. Therefore the handler must

exercise special caution to avoid being bitten during initial DOWN exercises. However, as the dog's confidence increases while in the down position, his resistance to executing the command will decrease. Once this occurs, physical placement is only used when required.

An alternate technique for placing a resisting dog in the down position has been developed by U. S. Air Force dog training personnel (3). In this procedure the handler kneels down beside the dog and grasps the leash in the left hand just above the snap; with the right hand he draws the dog's front feet from under him and lowers him to the ground while simultaneously giving the command "DOWN." The handler lowers the dog by placing his right arm behind the dog's right front leg and grasping the left front leg about 15 cm above the pad; pushing the legs forward until the dog is in the down position. In both methods of placing a dog in the down position, the handler may give verbal encouragement while pushing downward on the leash or while lowering the dog to the ground. A dog should not be corrected during introductory training if he assumes an improper position such as rolling over on his side. However, after the dog has learned the command and does not lie parallel, the handler gives the command SIT, and then repeats the verbal command DOWN. The verbal reprimand "NO" and repeat of the command DOWN are given when the dog moves or indicates that he may break from the down position.

The hand signal for DOWN, which is used to put the dog into the down position when separated from the handler, is introduced after the dog has become competent at going down at the handler's side. The gesture is given by first facing the dog with the right arm raised above the head with fingers extended and palm forward. While voicing the command "DOWN" the arm is swept downward in an arc which ends with the extended hand slightly below waist level. To facilitate initial training, the leash may be held firmly in the left hand at about chest level with all slack taken up. As the right arm moves downward in the DOWN gesture, the right hand is diverted just enough to deliver a sudden slap to the taut leash thus jerking down the animal's head. A sharp "DOWN" command is given just as the right hand strikes the leash. As in the case of the SIT command, the use of the leash in DOWN exercises should be discontinued after the dog has begun to attain proficiency; thereafter it is used only for correction or remedial exercises.

D)   Stay. The verbal and hand signal command to STAY may be given with the dog in any position. Upon being instructed to stay, the animal must remain in position until given another command. Initial training in the command STAY is conducted with the dog in the Heel/Sit position. As the dog progresses in basic obedience, the command STAY may be given while the dog is in the Down, Sit, or Standing positions. After the dog assumes the Heel/Sit position, the handler gives the verbal

and hand gesture command STAY. The hand signal is given with the left arm. The left arm, locked at the elbow, is held parallel to the left leg; the fingers are extended with the palm of the hand facing the dog. The gesture commences by bringing the arm forward approximately 45° followed by a movement of the hand directly toward the dog stopping just short of its face as shown in Figure 8. Care must be exercised to insure that the animal is not actually struck in the face during this maneuver. After giving the command, the hand is returned to a resting position at the handler's left leg. If a dog breaks from either the Heel/ Sit or Down position, the handler gives the reprimand "NO," repeats the command and gives the verbal and hand gesture command STAY.

The command STAY is also used when the handler is giving commands away from his dog. This phase of training is initiated with the dog in the Heel/Sit position at the handler's left side. As the verbal and hand commands "STAY" are given, the handler steps forward one pace placing the right foot directly in front of the dog. On the second step the handler brings his left foot alongside the right pivoting 180° to come to rest facing the dog at a distance of one full pace. During the first several exercises the animal may fail to differentiate this procedure from the earlier Heel command, which, as will be recalled, is always initiated on the left foot. Until this discrimination becomes established, the dog may break position and attempt to move forward with the handler.
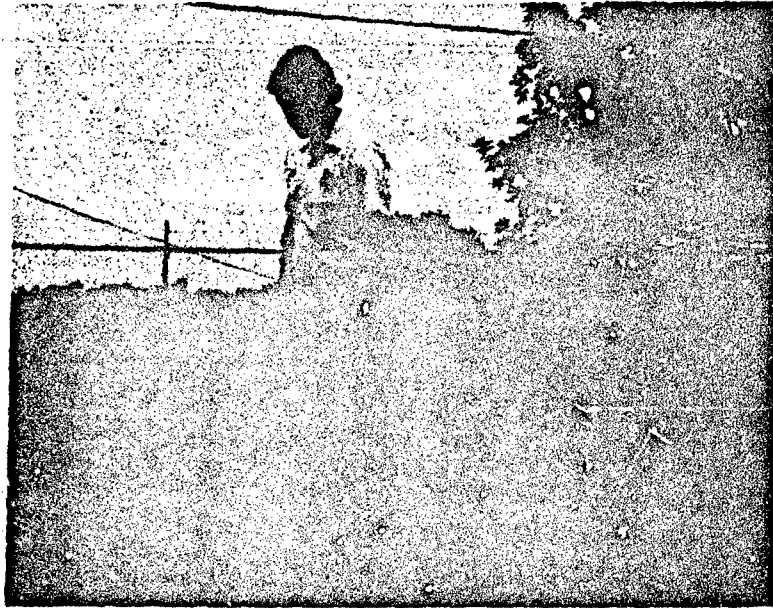
Fig. 8. Hand signal for STAY.

However, stepping in front of the dog permits the handler to observe and halt the animal's attempt to break position.

As the dog's performance improves, the distance between handler and dog may be increased by taking several paces before pivoting to face the dog. As the end of the leash is approached it must be transferred to the left hand and held directly over the belt buckle. This procedure allows the handler to give the STAY command with the _right_ hand when facing the dog. In other words, the gesture for Stay is delivered with the left hand when the handler is standing at the dog's side, but with the right when standing in front of and facing the animal. The latter gesture is made by raising the right arm from a position of rest at the handler's side followed by a downward pushing motion directed toward the dog's face with the fingers extended and palm facing forward. Subsequently, the right hand is returned to its original position along the right leg.

Should the dog break or begin to move while at the end of the leash, he must be corrected at once by giving the reprimand "NO" followed by a repetition of the command to stay. If the animal nevertheless fails to hold position, the handler repeats the reprimand, gives the command "SIT" (placing the dog into position if necessary), repeats the command "STAY," and then returns to the end of the leash.

To return to the Heel position, the handler issues the verbal and

hand commands to STAY and then steps toward the dog with the right foot. At the same time, the leash is given a circular flip to the left so that it comes to rest on the right side of the dog's neck thus preventing it from winding around the animal's head. The handler then continues to circle to his right and behind the dog, changing the leash from the left to the right hand and taking up the slack in the leash as he returns to the Heel position.

As the dog's proficiency in the STAY command increases, additional complexities may be introduced with the dog still on leash. For example, after giving the command "STAY," the handler may circle around the animal, step over or even straddle the dog, and gradually increase the time the dog must remain in position. When the dog stays in correct position for the prescribed time, it is praised; if it breaks position, it must be corrected and repositioned followed by a repetition of the exercise. These procedures tend to reinforce the command STAY and increase the handler's confidence in the dog.

E)   Recall. The recall represents an elaboration of the previously learned Heel exercise; the same verbal and hand signal commands are employed. Upon receiving this command the dog must move from its current position and location and return to the Heel/Sit position at the handler's left side. Training for recall is best initiated with the dog in the Sit/Stay position facing the handler at the end of the leash.

The handler calls the dog's name and gives the verbal and hand signal commands "HEEL." If the dog appears relucant to come on command, it may be necessary to repeat the command and tug directly forward on the leash. (Upward or downward tugs should be avoided lest the dog confuse this gesture with Sit or Down, respectively). When approaching from the front or right quarter the dog should be encouraged to circle to the left passing along the handler's right side, crossing behind his back, and coming to rest in the Sit/Heel position at his left side. Sidestepping and judicious guidance with the leash may be used to assist the dog during early training.

Once the dog has become fully proficient in the execution of basic obedience commands on the 183 cm leash, more advanced training can be undertaken. The basic commands and training procedures remain as before, the only difference being in the use of the 9-meter leash. Accordingly, the distance separating handler and dog can be increased while still retaining on-leash control.

Off-leash exercises represent a straightforward extension of on-leash performance. Initial off-leash training should be limited to maneuvers executed at the handler's side. This procedure allows the handler to carefully evaluate the dog's proficiency and to immediately revert to on-leash training if remedial training appears necessary. Smooth transition from on-leash to off-leash training can often be

expedited by an intermediate stage in which the leash remains attached

to the choke collar but is not actually held in the handler's hand. Rather,

the leash is draped loosely around the handler's neck passing across

the front of the left shoulder and behind the neck with the end hanging

down along the right side of the chest. In this way the leash is instantly

available if the dog attempts to break away or needs supplemental cor-

rection. After a few practice sessions in this transitional stage, the

leash can be removed entirely. Often this can be accomplished very

effectively and with minimal interruption by simply bending down and

unclipping the leash in the middle of a marching Heel exercise; for the

remainder of the session the leash is left dangling around the handler's

neck completely detached from the dog. Ultimately, the use of the leash

for obedience training can be discontinued altogether. An air of con-

trolled confidence on the part of the handler seems to be quite helpful

in making the switch from on-leash to off-leash deployment; a dog that

performs well on leash will normally perform just as well without it.

During all stages of obedience training the handler should strive

to continuously mix the sequence of commands since excessive repeti-

tion of the same exercise may result in boredom on the part of the dog.

As the dog's performance improves, practice sessions may be extended

in length and the distance separating dog and handler increased pro-

gressively. A dog which will reliably execute all basic commands

off-leash at a distance of 15 m has achieved a satisfactory degree of

proficiency for all normal requirements. It should be understood that most dogs can be trained to perform obedience maneuvers far more complex than those described above. However, experience has shown that a more elaborate obedience repertoire is unnecessary in dogs assigned to land mine/booby trap detection service. In any event, frequent obedience refresher sessions must be scheduled during the course of detection training and subsequent maintenance intervals. These exercises serve to maintain proficiency and act to reinforce the handler/dog team relationship.

Physical Conditioning. Dogs, like humans, require periodic exercise to remain in top physical condition, an absolute must in working dogs whose normal deployment may demand strenuous exertion for prolonged periods. Accordingly, the training center should be provided with an appropriate exercise area equipped with a formal obstacle course (sometimes also called a confidence course). Frequent use of such an installation provides exercise, builds the animal's confidence, trains him to negotiate obstacles and rough terrain, and increases the handler's control over the dog.

An exercise course suitable for use with land mine/booby trap detector canines consists of an abbreviated version of the confidence course described in AFM 125-5 (3). Specifically, a series of hurdles and related obstacles are arranged in order of increasing difficulty in

a closed track of generally oval or rectangular shape. The various
obstacles should be positioned approximately 8-10 m apart in order to
allow sufficient running space and to permit the dog to regain composure
between problems. An acceptable sequence of obstacles consists of two
60-cm high wooden hurdles, small oil drum pyramid, two 90-cm high
hurdles, large oil drum pyramid, 90-cm wooden hurdle, elevated cat-
walk, 90-cm wooden hurdle, and tunnel. Some of these units are illus-
trated in Figure 9. Construction of these devices is not critical; but
splinters and sharp edges must be removed to prevent injury to the
animals. Some general design considerations include:

A)   Hurdles: Basic construction of 2" x 4" (5.08 x 10.16 cm) and
1" (2.54 cm) lumber; painting is not necessary but will aid in protection from
the elements. Removable boards should be incorporated as a means of ad-
justing height from 30 to 90 cm.

B)   Oil Drum Pyramids: Pyramidal stacking of 3 (low) or 6 (high)
empty 50-gallon (189.27 l) metal oil drums; drums should be fastened
together securely to prevent possible collapse during scaling exercises.

C)   Elevated Catwalk: This type of obstacle increases the
dog's surefootedness and teaches him to walk on narrow surfaces of
varying heights. Suitable catwalk dimensions are 5 m (L) X 0.6 m (W)
X 0.75 m (H). Acceptable types of construction include single large log
(braced and with bark removed), parallel telephone poles, or simple
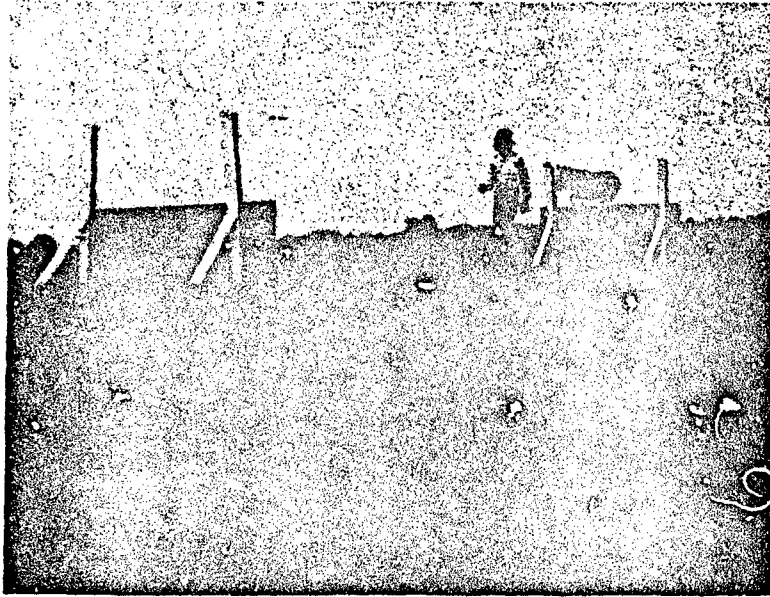
Fig. 9. German Shepherd being exercised on confidence course.

elevated wooden platform.

(D)　　Tunnel: A 5 m length of 60-cm (D) galvanized metal drain pipe laid on the surface of the ground provides a suitable fixture for tunnel negotiation exercises; adjustments in diameter may be required depending upon the size of the dogs being trained. The center portion of the tunnel may be covered with dirt if desired; if not, the pipe should be braced to prevent rolling.

The terms "jump" and "scale" are used to describe a dog's actions when negotiating elevated obstacles. When the dog jumps over an obstacle, he clears or hurdles it; when the animal jumps as high as possible and climbs or scrambles the remaining distance, he is said to scale the obstacle.

Training to negotiate an obstacle course begins with the dog on leash, a procedure which allows the handler to guide and assist the animal over each obstacle. Off-leash exercises are introduced as the dog's confidence and proficiency increase. In negotiating a confidence course, the dog jumps or scales an obstacle only upon hearing the verbal command "HUP." Many dogs appear reluctant to jump wooden hurdles until a certain degree of confidence has developed, and for this reason it is desirable to lower the barriers to a height which can be stepped over during early exercises. As the handler/dog team approaches the hurdle at a slow jogging pace, the handler steps over it with his left foot

simultaneously giving the command "HUP." If the dog hesitates or balks, the handler stops on the opposite side of the hurdle and helps his dog over by coaxing, tugging on the leash, and repeating the command "HUP." After the dog crosses the hurdle, the handler praises his dog, and gives the command "HEEL." As the dog progresses, additional boards are inserted until a desired height, not to exceed 90 cm, is attained. Thereafter, when the handler is approximately two paces from the hurdle, he commands HUP and instead of stepping over the hurdle, passes to the right and goes around it. As the dog's front feet strike the ground the handler commands HEEL. After the dog assumes this position, he is praised. Similar procedures are used to train the dog to scale oil drum pyramids except that the handler himself need not climb these obstacles. However, it may be necessary to stop, encourage, and physically assist the dog during early training.

Catwalk training is begun by approaching the obstacle with the leash held in the right hand and the dog in Heel position. The command "HUP" is given approximately 1 m from the catwalk; liberal praise and petting are administered after the dog jumps or climbs onto the platform. Many dogs possess an instinctive fear of high, unconfined areas; therefore, physical assistance and verbal encouragement may be necessary if the dog appears anxious or refuses to mount the catwalk. Once the dog is on the catwalk, the handler gently continues to pull the leash forward.

He walks beside his dog with his left hand on the dog's left side helping his dog maintain balance. Verbal encouragement is given along with physical assistance while proceeding slowly to the end of the obstacle. The dog is then praised and given the command "HEEL." After assuming the heel position, the dog is rewarded with verbal and physical praise. Progressively less assistance will be required as the dog gains confidence.

The handler usually will find it necessary to assist his dog through tunnels during initial training exercises. This is accomplished by first allowing the dog to inspect the entrance. Subsequently, the handler attaches the 9-meter leash to the choke chain and throws the opposite end through the tunnel. After placing the dog in the Down/Stay position, he walks to the far end of the tunnel, looks at the dog, and encourages him to crawl through. A certain amount of coaxing and tugging on the leash are normal at first. Lavish praise is administered when the dog exits the tunnel.

Off-leash training can proceed after the dog has demonstrated competence on all obstacles in the confidence course. The procedures are the same save that no leash is used. As training progresses, the practice of halting in the Heel position after each obstacle can be deleted and the speed of traverse increased to a fast jog. The handler, who must run around the course keeping pace with his dog and call out the command "HUP" as each hurdle or oil drum pyramid is approached, should shout out verbal praise and encouragement for successful execution

of each confidence-training problem.

Most dogs appear to enjoy confidence training, but the handler should exercise caution lest the dog become overheated or excessively fatigued. These problems are amplified, of course, during periods of hot, humid weather.

CHAPTER V

DETECTION TRAINING AIDS

A variety of specialized materials, supplies, and training aids must be procured and/or constructed for use during routine training of dogs for detection of land mines and booby traps. Some of the required items are available through standard military procurement channels, others may be acquired from commercial sources, and the remainder can be fabricated or installed by the regular training staff as needed. The present chapter provides a complete listing and description of the materials and training aids normally required for land mine/booby trap detection training; it is assumed that the standard complement of dog handling and maintenance equipment is already on hand. Suggested quantities are approximate and may vary depending on the number of dogs in training at any given time. The proper use of various training aids is discussed in detail where appropriate in the following chapter dealing with detection training procedures.

ITEM 1: Glass Bottles.

    (1) Source: commercial supplier.

    (2) Description: 60-90 ml wide-mouth, fitted with screw-on metal lids.

    (3) Quantity: 15-18 per dog.

    (4) Use: containment of raw explosive samples during preliminary olfactory discrimination training.

(5) Comments: Plastic or acrylic bottles or lids cannot be substituted due to potential impregnation by minute quantities of explosive substances. Should this occur, discrimination training may be impeded as a result of training sample contamination.

ITEM 2: Plastic Laboratory Beakers.

(1) Source: commercial supplier.

(2) Description: wide-mouth with top flange; size sufficiently large to completely accommodate glass sample bottles described in Item 1 above (e.g., 150 ml). Beakers should be of a depth such that the top of the sample bottles is flush with, or preferably, 2-3 cm below, top opening.

(3) Quantity: 10-15 per dog.

(4) Use: housing of discrimination training sample bottles.

(5) Comment: The use of plastic beakers permits handling of training samples without actual contact by the training staff, thereby reducing the possibility of inadvertent cross-contamination of positive and negative training aids.

ITEM 3: Raw Explosives.

(1) Source: military procurement channels.

(2) Description: military grade TNT, C-4, Composition B, and tetryl (all types required).

(3) Quantity: approximately 1.5 kg of each type per dog (except 0.5 kg tetryl).

(4) Use: training samples (stimuli) for use during preliminary olfactory discrimination training.

(5) Comments: the use of high-intensity explosive compounds is unavoidable for proper training of land mine/booby trap detector dogs, and all training personnel must recognize and appreciate the potential hazards associated with the handling of such materials. It is recommended that all individuals who may come in contact with these substances be required to complete a safety-oriented explosives handling course conducted by a recognized ordnance expert prior to the initiation of detection training activities. Bulk explosives must be stored in a bunker of approved construction at all times. Small quantities (e.g., training samples) can be kept temporarily in glass laboratory dessicators supplied with a dry dessicant; each type of explosive should be stored in a separate container.

The dessicators may be stored in locked wooden cabinets or chests housed in a remote storage building. The latter must be kept cool, dry, and well-ventilated; appropriate security measures are mandatory.

ITEM 4: Land Mines (Live, Defuzed).

(1) Source: military procurement channels.

(2) Description: 5 types required (three antipersonnel and two antitank).

   a) M14.

      i) Type: antipersonnel, nonmetallic, blast type.
      ii) Charge: 1 oz. tetryl (28.35 gm).
      iii) Description: cylindrical plastic with six external vertical ribs (approx. 39.7 mm H x 55.6 mm dia.).

   b) M15.

      i) Type: antitank, heavy, metallic.
      ii) Charge: 22 lbs. Comp. B (9.98 kgm).
      iii) Description: cylindrical steel with flat bottom and slightly domed top fitted with pressure plate and fuze well (approx. 123.8 mm H x 333.4 mm dia.).

   c) M16A1.

      i) Type: antipersonnel, metallic, bounding fragmentation type.

    ii) Charge: 1 lb. (0.45 kgm) TNT bursting charge (also contains delay, booster (tetryl), and expelling (black powder) charges).

    iii) Description: cylindrical steel with flat bottom and flat top, the latter fitted with a small, threaded fuze well (approx. 139.7 mm H x 103.2 mm dia.).

d) M18A1.

    i) Type: antipersonnel, nonmetallic case with fragmentation face containing steel spheres.

    ii) Charge: 1.5 lb. C-4 (0.68 kgm).

    iii) Description: curved, rectangular plastic case containing steel fragmentation face and explosive charge; bottom fitted with two pairs of scissor-type folding legs; top equipped with peep-type aiming sight; (approx. 215.9 mm L x 34.9 mm W x 82.5 mm H).

e) M19.

    i) Type: antitank, heavy, non-metallic.

    ii) Charge: 21 lb. Comp. B (9.53 kgm).

    iii) Description: flat, box-shaped plastic with rounded corners; top fitted with circular pressure plate (approx. 332.5 mm W x 332.5 mm L x 74.9 mm H).

(3) Quantity: approximately 6 of each type per dog.

(4) Use: intermediate and advanced detection training exercises.

(5) Comments: as in the case of raw explosive compounds, anti-personnel and antitank mines represent extremely

hazardous devices and the same storage and safety precautions must be observed. Although unfuzed land mines can be handled with relative safety, the potential for accidental detonation of the main charge is always present, and training personnel must not be lulled into a false sense of security by virtue of daily exposure to these devices. Familiarity breeds contempt. All personnel should be fully briefed regarding safe handling and deployment procedures before commencing detection training activities.

Detonators and boosters are NEVER used in conjunction with detection training exercises. They should be stored in a separate location, or, preferably, destroyed by properly trained personnel.

Live mines are normally secured from authorized EOD personnel. All mines must be checked upon receipt by a trained ordnance expert to insure that all detonators and boosters have been removed; a second independent check by a different expert represents a desirable safety practice. Although

dog training personnel will not normally be

exposed to land mine detonators and boosters,

it is recommended that they be familiarized

with the appearance of these devices so that they

will be able to recognize a fuzed mine in the un-

likely event one is encountered during training

exercises.

Should a mine be damaged in the course of

training activities, it should be left in place and

avoided by training personnel. A conspicuous warning

sign indicating the location of the damaged device

should be erected pending removal or in-place

destruction by trained EOD personnel.

ITEM 5: Practice Mines (Inert).

(1) Source: military procurement channels.

(2) Description: optimal training efficiency will be achieved if

practice (inert) mines corresponding to each type

of live (defuzed) mine can be obtained. Unfortu-

nately, certain U. S. mines have no practice

counterpart; others are in short supply and may

be difficult to secure. The following types repre-

sent an acceptable compromise.

a) M20.

    i) Type: antitank, heavy, metallic (practice counterpart of M15 service mine).

    ii) Charge: inert filler (9.07 kgm sand).

    iii) Description: similar to M15 service mine.

b) M16A1 (Inert).

    i) Type: antipersonnel, metallic, bounding fragmentation type (practice counterpart of M16A1 service mine).

    ii) Charge: inert filler.

    iii) Description: similar to M16A1 service mine.

c) M19 (Inert).

    i) Type: antitank, heavy, non-metallic (practice counter-part of M19 service mine.

    ii) Charge: inert filler.

    iii) Description: similar to M19 service mine.

(3) Quantity: about 6 of each type per dog.

(4) Use: experimental controls during advanced discrimination training.

(5) Comments: most inert mines can be quickly distinguished from their loaded counterparts by appearance since, with few exceptions, U. S. service mines are olive drab in color whereas the majority of practice devices are painted gray, black, or blue.

Color is not always a reliable distinguishing feature,
however; some M19 service mines are constructed
of gray plastic, and M16A1 inert mines are painted
O. D. green. Certain identification can be achieved
by inspection of printed information stenciled or
embossed on the surface of the mine all inert
units carry the label "Inert" and/or "Practice";
the loading date appears on live devices.

ITEM 6: Trip Wire.

   (1) Source: military procurement channels.

   (2) Description: U. S. military booby trap trip wire (both olive
drab and sand colors required).

   (3) Quantity: approximately 50 m per dog.

   (4) Use: trip wire detection training aid.

ITEM 7: Discrimination Training Board.

   (1) Source: constructed by training personnel from materials
obtained from military or commercial sources.

   (2) Description: 3 m length of 1" x 4" (2.54 x 10.16 cm) unpainted
lumber raised on 2" x 4" (5.08 x 10.16 cm)
wooden blocks. Five equally-spaced holes are
cut through the 1" x 4" (2.54 x 10.16 cm) to receive
plastic beakers described in Item 2 above. The holes
must be large enough to accommodate the maximum

diameter of the plastic beakers which, however, are prevented from falling through by their top flange. A suitable discrimination training board is shown in Figure 10.

(3) Quantity: one per each 5 dogs.

(4) Use: presentation of explosive samples during initial olfactory discrimination training.

ITEM 8: Galvanized Metal Tubs.

(1) Source: commercial supplier.

(2) Description: 10 gallon (37. 85 1) galvanized metal washtubs of sufficient diameter to receive M15 and M19 land mines.

(3) Quantity: 3 per each 5 dogs.

(4) Use: containment of live and practice mines during preliminary mine discrimination training.

(5) Comment: to provide ease of mobility, each tub must be positioned on a 3/4" (1. 9 cm) plywood base fitted with 4 swiveling casters. An appropriate configuration is shown in Figure 11.

ITEM 9: Food Reinforcer.

(1) Source: commercial suppliers.

(2) Description: semi-dry dog food in small pressed or cut cube form (e. g. , Gaines "Prime").
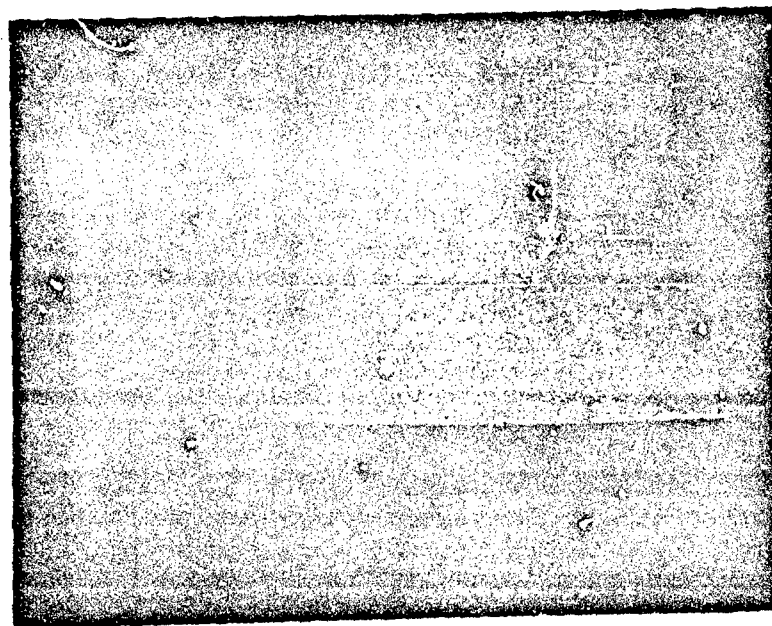
Fig. 10. Discrimination training board.
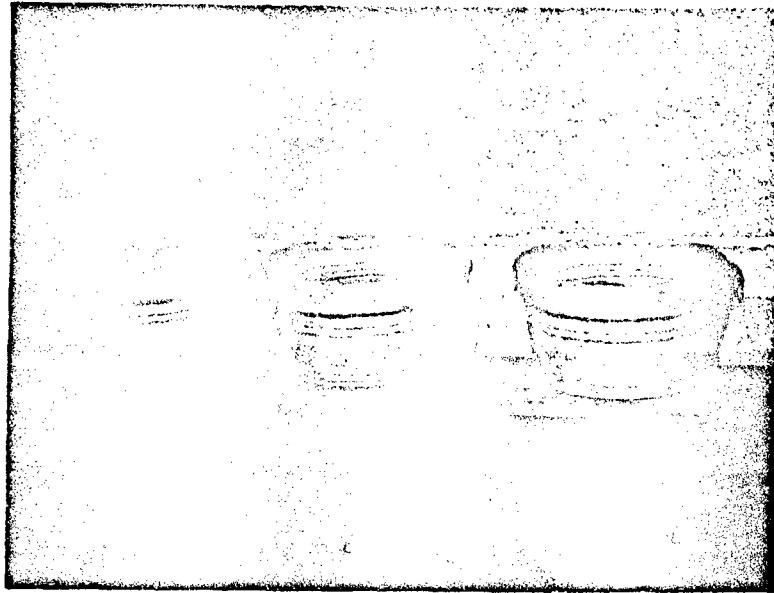
Fig. 11. Galvanized metal tubs positioned on plywood bases fitted with swiveling casters.

(3) Quantity: two 6-oz. (170 gm) packets per training session for German Shepherd or Labrador Retriever sized dogs; smaller quantities will suffice for smaller dogs.

(4) Use: reinforcement of correct responding during detection training exercises.

(5) Comment: semi-dry dog food represents a highly preferred food item for the majority of dogs and thus serves as an effective reinforcing agent. The small size of the individual cubes contributes to convenience in handling and easy apportionment of trial-by-trial rewards.

ITEM 10: Food Pouch.

(1) Source: military procurement channels.

(2) Description: canvas case for field trenching tool with handle opening sewn shut.

(3) Quantity: one each per handler/trainer.

(4) Use: handler-portable storage of food reward cubes during field training exercises.

(5) Comment: the food pouch can be attached to a cotton-web pistol belt for quick access and ease of portability.

ITEM 11: Electric Shock Source.

    (1) Source: commercial supplier.

    (2) Description: conventional pulsed-output electric livestock fence charger.

    (3) Quantity: one per 5 dogs.

    (4) Use: booby trap trip wire avoidance conditioning.

ITEM 12: Data Recording Supplies.

    (1) Source: military or commercial sources.

    (2) Description: clip boards, pens, training data sheets.

    (3) Quantity: one data sheet per dog per day of training.

    (4) Use: collection of daily detection performance data.

    (5) Comments: data sheets appropriate to each stage of training are described in Chapter VI.

ITEM 13: Hand Tools.

    (1) Source: military or commercial sources.

    (2) Description: chisel-point shovel, pick, breaker bar, 3.0 kgm sledge hammer.

    (3) Quantity: one set per training team.

    (4) Use: installation of mine fields and trails.

ITEM 14: Wooden stakes.

    (1) Source: military or commercial sources.

    (2) Description: 2" X 2" X 30" (5.08 x 5.08 x 76.2 cm) wooden stakes pointed at one end.

(3) Quantity: approximately 30 per quarter-mile training lane.

(4) Use: mine location reference markers; demarcation of training lane boundaries.

ITEM 15: Marker Flags.

(1) Source: fabricated by training personnel from materials obtained from commercial suppliers.

(2) Description: suitable marker flags can be made by tying a 50 cm length of 2.54 cm wide plastic surveyor's tape to the top of a 20.32 cm (8 inch) gutter spike.

(3) Quantity: 24 per handler/trainer.

(4) Use: marking of response locations during field training exercises.

ITEM 16: Measuring Tape.

(1) Source: military or commercial sources.

(2) Description: 100' steel measuring tape, 1" intervals, reel type (a 50-meter tape with 1.0 cm intervals may be substituted.

(3) Quantity: one per training team.

(4) Use: measurement of response location coordinates during advanced field training and evaluation exercises; implantation of live and practice mines.

ITEM 17: Cleaning Implements and Supplies.

  (1) Source: commercial suppliers.

  (2) Description: household detergents, Alconox, bottle brushes

                      (for Item 1 above), bottle drying rack.

  (3) Quantity: supply replaced as needed.

  (4) Use: cleaning of laboratory training aids.

ITEM 18: Drying Oven.

  (1) Source: commercial suppliers.

  (2) Description: any thermostatically-regulated electric oven

                      capable of sustaining a temperature of 250° C.

  (3) Quantity: one per 15 dogs.

  (4) Use: final drying and decontamination of training

                      sample bottles (Item 1 above) following between-

                      session washings.

ITEM 19: Stopwatch.

  (1) Source: commercial or military sources.

  (2) Description: pocket stopwatch, 1/5-sec. scale.

  (3) Quantity: one per each training team.

  (4) Use: data taking.

MISCELLANEOUS: The items described above comprise the major

requirements of the land mine/booby trap detection training protocol

described in the present manual. Sundry miscellaneous materials and

supplies not listed may be needed from time to time and should be procured as needed. Maintenance of a modest supply of masking tape, cotton string, wire, and felt marking pens is recommended.

CHAPTER VI

DETECTION TRAINING

Detection of land mines and booby traps in field scenarios is an exceedingly complex task, and training must therefore proceed in a logically-related series of steps or phases of progressively increasing difficulty. It will be recalled from the discussions of Chapter II that this process is called the method of successive approximation or, more technically, "operant shaping." The initial stages of training have only slight bearing on the ultimate detection task, but are nevertheless necessary precursors to the final behavioral objective. In terms of operations, the overall detection training protocol can be subdivided into six distinct sequential phases:

I) Introduction to Explosive Odors

II) Preliminary Odor Discrimination Training

III) Introduction to Land Mine Detection

IV) Initial Field Training

V) Intermediate Trail Exercises

VI) Advanced Field Training

The indicated ordering of these stages of training cannot be modified, nor can any phase be omitted or given cursory attention. Although each successive phase is characterized by a marked increment in difficulty, the transitions between stages have been carefully designed to reduce

confusion on the part of the animal regarding respective task demands, and to minimize disruptions of progress through the overall training sequence. Inherent differences in aptitude will cause some dogs to progress more rapidly than others, and each dog must be treated as an individual; the pace of training must be tailored accordingly. The handler must not succumb to an urge to meet artificial training deadlines (i.e., deadlines not related to the animal's actual progress), nor should he engage in a competitively-inspired race to complete the sequence before other dog/handler teams. No dog may be advanced to a more difficult stage of training until he or she has demonstrated objectively full proficiency in the prior phase.

Although mine detection and booby trap trip wire detection represent operationally distinct tasks, the latter cannot be taught in isolation from the former. Trip wire detection is undertaken during Training Phase IV as described subsequently.

Finally, it is imperative that each dog attain complete proficiency in all basic obedience exercises before detection training is initiated.

Phase I: Introduction to Explosive Odors. Although the means by which trained dogs detect buried land mines has not been unequivocally proven experimentally, the majority of the available data indicate that the process is primarily one of olfaction. Thus, the initial goal of Phase I training is to establish an association between explosive odors and

reinforcement, essentially a process of classical conditioning in which the conditioned stimulus (CS) consists of the relevant odor and the unconditioned stimulus (UCS) is positive reinforcement in the form of a combination of food, verbal, and physical praise.

It is recommended that Phase I training be conducted in a relatively open, quiet area such as the indoor training rooms described earlier (p. 39) in order to maximize the animal's attention span and to minimize the number of distracting events.

The target odorants or stimuli (i.e., training aids) used during Phase I training are intended to approximate as closely as possible the odors commonly found in conjunction with the devices to be detected during operational deployment. In the case of land mines, small samples of the constituent explosive substances (viz., TNT, Comp. B, C-4, tetryl) are employed as training stimuli. These materials are placed into a small glass jar as described in Chapter V (Item 1).

Proper preparation of the sample jars is quite important and the procedures outlined below must be rigorously observed to control contamination. A freshly prepared sample jar must be used for each training session, and the same training aid should not be employed for more than one dog. The jar should be thoroughly washed with a bottle brush and good detergent, repeatedly rinsed (soaking in acetone followed by a final rinse in distilled water is recommended), dried in a high temperature oven (250° C) for 20-30

minutes, and allowed to cool to room temperature before adding the explosive sample. The high temperature drying process assists in driving off residual odor elements which were not removed during washing. NOTE: Once a given jar has been used as a positive training aid (i.e., used to contain explosives), it must not ever be used for any other purpose —particularly as a control sample during subsequent discrimination training. The reasons for this precaution are described later.

The metal jar lids must be scrubbed and dried similarly prior to use. First, however, the cardboard or plastic gasket installed inside the lid should be removed and 6-10 small holes (e.g., 1 mm dia. each) punched through the surface in order to allow volatile explosive odor elements to escape. The holes should be punched such that any sharp edges are to the inside to prevent possible injury to the animal's nose. An inventive reader will realize that a common metal-capped glass saltcellar could be employed very effectively as a sample holder; this substitution is acceptable assuming a sufficient quantity of saltcellars can be obtained.

After the jars and lids have been prepared, a small quantity of explosive is placed into the jar and the lid screwed on firmly. One to two grams of Comp. B, TNT, and C-4 are adequate. Since the odor of tetryl is substantially stronger than that of Comp. B, TNT, and C-4, approximately half that quantity of the former will suffice. For the

same reason, introduction to explosive odors should commence with
tetryl because it is more easily perceived by the dog. A sample bottle
and appropriate quantity of explosive are shown in Figure 12.

Phase I training can be most efficiently carried out by two persons,
the dog handler/trainer and a training assistant (p. 31). The dog is brought
into the indoor (i.e., laboratory) training area on leash (attached to either
the leather collar or harness) and permitted to explore the area thor-
oughly; the dog should also be allowed to become acquainted with the
training assistant.

To begin training, the handler stands at one end of the training room
with the dog in the Heel/Sit position. The training assistant then takes
the freshly prepared sample bottle (hereafter called the "positive bottle"
or "positive sample"), places it on the floor approximately 3-4 m in
front of the dog, and steps back a few paces. The handler next moves
forward and encourages the dog to approach and investigate the bottle by
smelling. Verbal praise ("Good Dog", or "Good Boy" or "Good Girl" as
appropriate), petting, and a small food reward (described in Chapter V) are
given immediately after the animal sniffs the bottle. It is of no consequence
if the dog knocks over the bottle with his nose, but he should be discouraged
from pawing at it or taking it into his mouth. Thereafter the handler and
dog return to the starting point where they wait in the Heel/Sit position. This
sequence is called a "training trial" (or simply "trial") and is illustrated
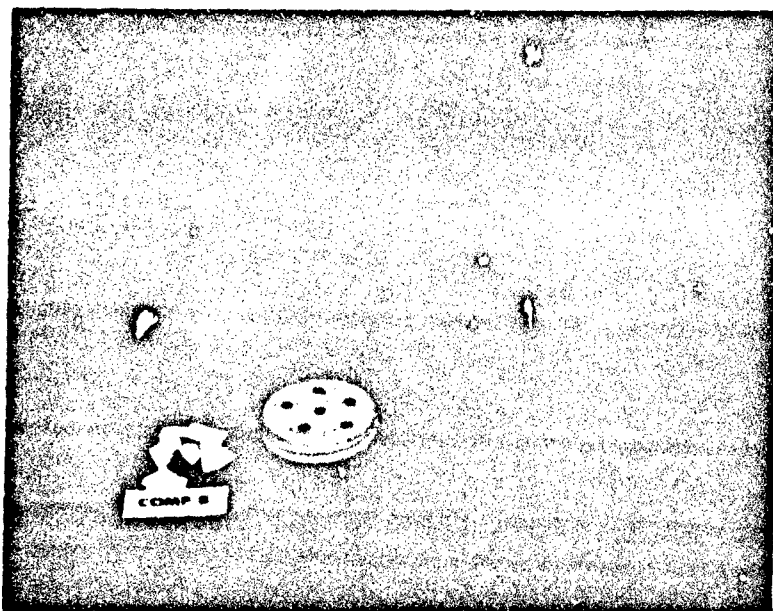
Fig. 12. Sample bottle, perforated lid, Composition B, and appropriately-sized plastic beaker.

in Figure 13. The proper food reinforcement technique is shown in Figure 14.

Normally, little difficulty will be encountered at this stage of training since natural curiosity will cause most dogs to investigate such objects. However, should the animal's attention wander or be interrupted by extraneous factors, tapping or rattling of the bottle by the assistant may prove helpful. Rolling the positive sample a short distance across the floor may also help to capture the animal's attention since practically all dogs are attracted by animate objects.

Following a successful approach-sniff-reward trial, the bottle should be moved several feet by the assistant, and the sequence is repeated.

The timing of the response-reinforcement sequence is critically important: SNIFF, followed immediately by PRAISE (verbal praise and petting), followed immediately by a small FOOD reward. The deleterious effects of delay of reinforcement on the acquisition of both classical and operant conditioned responses were indicated in Chapter II. The trainer must strive to inject inflections of genuine pleasure and enthusiasm into his voice when praising the dog. Profuse praise may seem superfluous or even silly to the novice handler, but it will have a very positive effect on the dog's motivation and performance. Most dogs will try very hard to do what is expected of them in return for praise
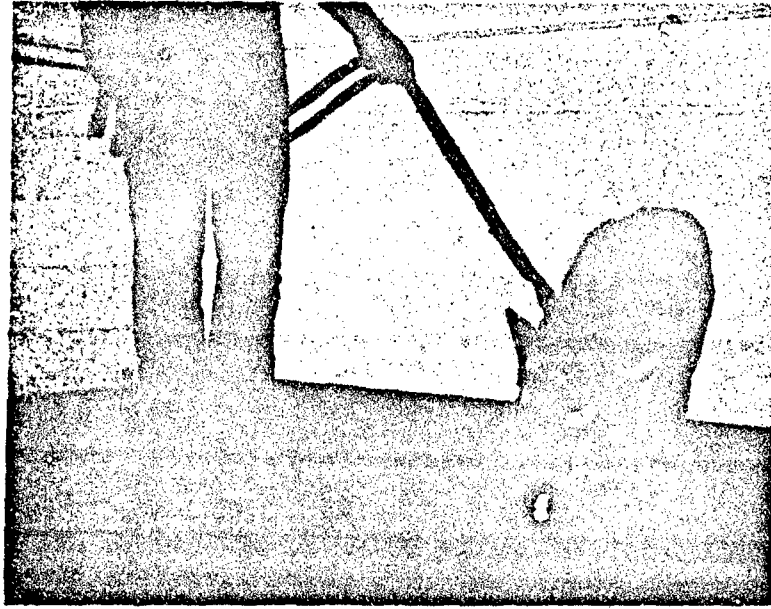
Fig. 13. German Shepherd investigating sample bottle during Phase I training.
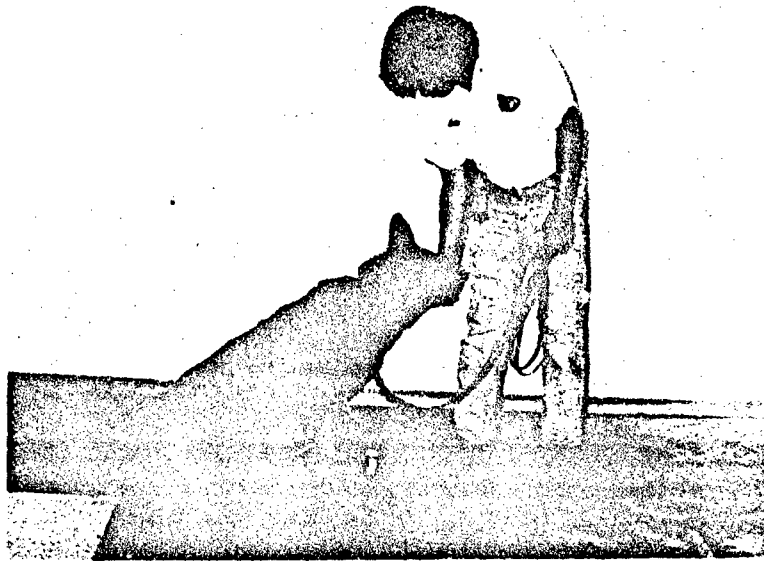
Fig. 14.   Delivery of food reinforcement.

from their handler. This point cannot be overstressed. Indeed, Phase I training should be conducted as a sort of pleasurable "game" for both dog and handler.

To insure proper progress, the handler must strive for absolute consistency of reinforcement from trial to trial since departures from the sniff-praise-food sequence may result in confusion and disrupted learning and, in some cases, can provide undesirable cues regarding positive target locations during more advanced phases of training.

It will be recalled from Chapter II that the acquisition of operant behaviors is based on the principle of multiple repetition of response-contingent reinforcement; that is, immediate reinforcement following execution of the desired response. In a similar way, establishment of the secondary reinforcer "Good Dog" involves a temporally-contingent sequence of events: PRAISE followed immediately by FOOD. The opposite sequence, known technically as "backward conditioning," is far less effective and should not be allowed to occur. In fact, there is little conclusive experimental evidence to suggest that backward conditioned responses can be established at all (13).

Since food reward constitutes a major component of reinforcement in the present training strategy, it is necessary for the dog to be somewhat hungry at the onset of each training session. This requirement may be achieved by means of careful regulation of the animal's daily food

intake. Obviously, such regulation cannot be carried to the point of improper nourishment. However, it may mean that the dog receives a significant portion of its total daily ration as rewards during training sessions. In any event, the particular type of food used as rewards (e.g., Gaines "Prime") should be regarded as a special treat — this particular item should not be included as a part of the animal's regular evening meal. The routine daily feeding must not be provided immediately prior to a training session for obvious reasons. If the dog demonstrates signs of poor motivation (e.g., lack of interest in food rewards, inattentiveness to the task, etc.), it is best to terminate the training rather than attempt to force the animal to work. At this point it may be wise to consider an adjustment in rations. Additional procedural details and some revealing experimental data regarding the effects of dietary manipulations on detection performance are presented in the following chapter.

The amount of food to be given as a reinforcement on each training trial must be controlled with reasonable care. In general, performance in operant conditioning situations is directly related to amount of reinforcement per trial (i.e., directly proportional to magnitude of reward) — the larger the reward, the faster the acquisition and the more vigorous the response. Most laboratory studies have found that performance is a negatively accelerated, increasing function of amount of reward (21).

Applied to the detection training context, this generalization implies that fastest learning would be attained by giving the dog very large quantities of food on each trial. However, if this practice were followed the dog would quickly become satiated, lose motivation, and cease performing altogether within any one session before a meaningful number of trials could be completed. A compromise must therefore be adopted: magnitude of reward must be sufficiently large to generate an adequate incentive, but small enough to permit a useful number of trials to be administered during each training session. Experience has shown that 2 to 3 cubes of Prime per trial (coupled with verbal praise) will serve as an effective reward for German Shepherds or Labrador Retrievers. Proportionately smaller quantities are used with smaller dogs, and a certain degree of trial-and-error experimentation may be required to ascertain an optimal magnitude of reward for each animal.

As indicated previously, the primary objective of Phase I training is to teach the animal the association between odor and reward; training should continue until the dog will quickly approach and sniff the positive tetryl sample on every trial, a task which may require ten or more successive daily sessions of 40-50 trials each. However, it is advisable to limit the first few sessions to 20-30 trials. No particular alerting response is required of the dog at this point in training. To repeat, the

importance of immediate and consistent reinforcement of correct behavior cannot be overemphasized — this point represents the key to success in all animal training programs. Experienced animal trainers are keenly aware that consistent rewards for correct responses prove far more efficient in obtaining desired behaviors than do punishments meted out for erroneous or inappropriate responses. Accordingly, reprimands or other indications of disapproval must not be communicated to the dog at this stage of training. Venting of handler impatience and frustrations on a naive dog is totally unfair and may lead to confusion since the animal probably fails to fully understand what behaviors are required cf it during initial training sessions. Proper techniques for correcting more experienced dogs are discussed in subsequent sections.

The task demands of Phase I training preclude the collection of elaborate performance data. Nevertheless, a complete log of each training session must be maintained and, in addition to date, time of day, and routine dog and handler identification, should include number of trials conducted, length of session, subjective observations regarding the animal's progress, and notations concerning potential problems, etc. These records are used, in part, to evaluate the dog's progress, and often provide helpful insights regarding future training difficulties. As soon as the animal begins to demonstrate a degree of proficiency (i.e., moves quickly and directly to the positive sample on each trial), the data

log should be expanded to include trial-by-trial response latency. The latter is a measure of the time elapsed between the start of each trial and the time when the dog puts his nose to the sample bottle. Response latencies are measured with a stopwatch by the training assistant who is also responsible for entering observed times in the data log. More accurate measurement of response latencies will be achieved if the assistant tells the handler to "START," simultaneously starting the stopwatch, at the beginning of e ch trial.

Response latencies provide a useful quantitative index of the dog's progress: short latencies reflect proper performance, while long latencies are indicative of inadequate learning, lack of motivation, or inattentiveness. A competent animal will have no difficulty in excuting the advance-to-bottle-sniff sequence within five seconds on every trial. Accordingly, a response latency criterion is used to decide when to advance the dog to the next level of task complexity; specifically, 3 successive days of training in which 95% or more of the training trials are successfully completed within the 5-sec. time limit. Attainment of criterion may be determined from the daily performance records by simple computation:

$$\frac{(\text{number response latencies} \le 5 \text{ sec.})}{(\text{total number of trials})} = \text{Percent criterion trials.}$$

Thus far in trai.ing, only tetryl has been used as a sample
stimulus. Once the dog has achieved the performance criterion outlined
above, it must be introduced to the other relevant explosive compounds,
Comp. B, C-4, and TNT, in the order indicated. The procedures used
to introduce the animal to the odor of each substance are identical to
those employed with tetryl; the proficiency criteria are likewise the
same in each case. The handler must be sensitive to evidence of con-
fusion or uncertainty each time a new explosive is presented since the
dog will not have previously experienced the specific odor associated
with that material. Extra praise on the first few trials may be helpful
in smoothing the transition. Most dogs will have no problem generalizing
the stimulus-reward association from one sample substance to another
in view of the fact that, operationally, the desired behavior requires no
sensory discrimination or differential responding to one versus another
explosive.

As soon as the animal has successfully achieved criterion on each
of the four explosive compounds, a series of training exercises are con-
ducted in which all four materials are presented within the same session
in random order over trials. The explosive samples must not be mixed
together, however; a separate sample bottle is used in each case. Once
again, training is continued until the previously specified criterion is
attained (three successive sessions in which at least 95% of the total

responses have latencies of 5 sec. or less).

At this point in training two complexities are introduced. First, in the final mode of search deployment the dog is required to proceed several paces in advance of the handler; this behavior must be learned. Secondly, the animal must be trained to respond to the command "SEARCH." (NOTE: Some handlers may prefer the term "SEEK" which is an acceptable alternative to SEARCH. However, a choice of commands must be made at the outset; the same term must be used thereafter with absolute con- sistency for each dog. Capricious exchange of the two commands re- presents an unnecessary complication which can give rise to confusion).

Training the dog to advance in front of the handler and introduction of the command "SEARCH" are accomplished simultaneously. Both can be achieved most effectively off leash. The handler stands at the usual starting point with the dog in the Heel/Sit position. Upon receiving the START trial indication from the assistant, the handler calls out the dog's name, gives the command "SEARCH" in a firm tone of voice, and at the same time steps forward toward the sample bottle with the left foot. As the bottle is neared, the handler deliberately lags a pace or two behind the dog. As soon as the dog sniffs the sample, the handler moves in to deliver the customary reinforcement. Some dogs may be reluctant to depart from the Heel position at the handler's side because of earlier obedience conditioning; on the other hand, the persistence of this behavior

is frequently overcome by the animal's eagerness to approach the bottle and be reinforced. If the dog refuses to advance ahead of the handler it may be necessary to make judicious use of the leash to gently tug the animal forward each time the command "SEARCH" is given. As a last resort, the 9-meter leash may be attached and pulled on, then released by the training assistant when the handler commands "SEARCH." The handler should encourage and praise the dog for moving forward. At no time, however, may the training assistant give commands, verbal encouragement, or praise to the dog. The animal must learn to listen only to the commands of his handler when deployed in the training or working modes.

As the dog gains proficiency in moving forward on the SEARCH command, the distance between dog and handler is gradually increased. This may be accomplished simply by having the handler lag slightly further behind on each new training session. However, the handler must not fail to move up quickly and reward the dog as soon as it puts its nose to the sample bottle. The slight delay of reward introduced by this practice is not serious and can be offset to some extent by beginning verbal praise as the handler moves toward the dog's position, a procedure which will require a certain degree of coordination and practice. Assuming normal progress, the handler will need to take only the one initial left step forward with the dog advancing the remaining distance to the sample

bottle on his own. (The distance from the starting point to the sample

bottle must be held to a maximum of 4 m during these exercises).

Practice sessions with the handler taking only one step forward should

continue until the previously-specified 95% performance criterion is

achieved on three successive training days. When this criterion has

been met, and assuming no other difficulties have been encountered,

learning of the appropriate indicating or "alerting" response can com-

mence.

It is not adequate that a dog be trained simply to detect mines

and booby traps; he must also be able to alert his handler to the presenc

of these devices. Verbal communication is of course impossible; barking

or howling is undesirable in most cases (especially if hostile forces

inhabit the vicinity of search); and digging or pawing may detonate the

mine. SITTING DOWN and remaining in place possesses none of these

disadvantages and provides an effective alert signal easily observed by

the handler. Accordingly, the SIT RESPONSE has been adopted as the

most appropriate alerting response signifying detection of a land mine

or booby trap trip wire. (Hereafter, the term "response" will be used

to mean SITTING DOWN following a detection unless otherwise specified).

Unfortunately, smelling of an explosive substance or device

is not likely to elicit a sit response in a naive dog

(i.e., the "baseline operant level" is very low in the terminology of the

learning specialist), and the animal must be trained by operant conditioning to emit this response whenever the target odor is detected. This objective can normally be achieved with minimal difficulty by making reinforcement contingent not only upon sniffing the positive sample, but also upon execution of the sit response.

Sit response conditioning trials begin just like any other odor introduction trials attempted to date with the dog in the Sit/Heel position at the handler's side. However, as soon as the dog sniffs the positive sample, the handler gives the command "SIT" in a firm tone of voice. This response should occur almost automatically in dogs adequately versed in obedience exercises. If the required sit response occurs, the dog is heavily praised and given a food reward (the use of larger than normal food rewards on the first several sit response trials may accelerate the learning process). If the animal appears confused and fails to sit, it may be necessary for the handler to provide physical assistance, but the dog should not be reprimanded for not responding correctly on early trials.

With sufficient reinforced repetitions the dog will begin to sit voluntarily upon smelling the training sample. In other words, the response will come to antedate the verbal command "SIT" on each trial. The handler can test for the emergence of this phenomenon by occasionally hesitating on the command: if the response nevertheless occurs, the command is withheld entirely and the dog is heavily reinforced; if the dog

fails to sit within a few seconds, the command is given followed by normal reinforcement. Do <u>not</u> reprimand the dog if he fails to respond in the prescribed waiting interval; he is probably confused regarding task demands.

As the dog gains proficiency, the "SIT" command is gradually deleted, ultimately being used only as necessary for remedial purposes. At this point, the definition of a "correct" trial is expanded to encompass:

        1)   move forward on command SEARCH,

    AND 2)   sniff sample bottle,

    AND 3)   SIT.

Only trials which meet all three criteria are reinforced. Data taking must be adjusted to include the sit response requirement. The session-wise performance criterion now to be achieved is expanded in a corresponding way, viz., 95% of total session trials on which the dog a) moves forward on command, b) sniffs the sample, c) sits down, and d) total sequence completed in 5 sec. or less. Training should continue until criterion is attained on 5 successive days of training. At this time the dog is ready to be advanced to Phase II training.

The trainer should recognize that the practice of stubbornly forcing an animal to work for prolonged periods against its will is of questionable value, and may actually produce negative results. Systematic manipulations of the animal's incentive or motivation to work

generally prove far more effective and include regulation of daily rations, modifications in amount and quality of praise, isolation for persistent task-irrelevant behaviors (i.e., "time outs"), etc. Although the handler should remain alert for evidence of boredom on the part of the dog, especially during the easier phases of training, patient repetition is a vitally indispensible aspect of the learning process. Rest periods during which the dog is removed from the training area may be helpful in the case of short attention span or apparent lack of interest.

Phase II: Preliminary Odor Discrimination Training. Although the scent of the constituent explosive substances appears to be the primary cue associated with the detection by dogs of buried land mines, it is probable that other olfactory elements are involved; for example, human scent and the odor of disturbed earth, crushed vegetation, etc. may be presented in freshly-laid minefields. The dog must be taught to disregard these and other factors not perfectly correlated with land mines and booby traps in order to hold false response rates to an acceptably low level. The olfactory discrimination training prerequisite to this behavioral objective is initiated in Phase II and is conducted in the indoor training room. The techniques are those of "discriminative operant reward conditioning" as discussed in Chapter II.

Phase II training procedures are basically similar to those of Phase I, including the use of the positive sample bottle prepared as before. However, the animal's task is complicated by the addition of one or more

negative or "control" sample bottles identical to the positive bottle save that no explosive materials are placed therein. Hereafter the positive and control bottles will be called the "S+" and "S-" samples, respectively.

It is imperative that the training assistant ready all S- bottles prior to preparing the S+ sample lest traces of explosive clinging to his hands be inadvertently transferred to the negative training aids. So keen is the dog's olfactory acuity that even minute quantities of explosive can be detected, with consequent interference with the discrimination training process. Both S+ and S- samples should be wrapped with masking tape (making sure the holes in the lid remain unobstructed) to prevent the animal from learning a discrimination based on visual inspection of contents.

Once prepared, the S- sample(s) are inserted into plastic beakers (see Chapter V). The S+ sample is then made ready and similarly placed into a plastic beaker. The plastic beakers allow the training assistant to handle and transport the S+ and S- samples without having to touch the bottles per se, thereby minimizing the possibility of cross contamination. As an added precaution, the training assistant should scrub his hands thoroughly after handling the explosive substances and before beginning the training session.

One S+ and one S- sample are employed during the first several

days of Phase II training. Both are slipped into random holes in the discrimination training board (Chapter V) which is positioned on the floor of the training room oriented in a perpendicular manner with respect to dog and handler as shown in Figure 15. A distance of about 4 m between the discrimination board and the trial starting point is appropriate.

A discrimination trial commences with the dog on leash in the Heel/Sit position at the handler's side. Upon hearing the indication "START" from the assistant, the handler calls out the dog's name, gives the command "SEARCH," and steps forward with the left foot. The team advances to the discrimination board where the dog is permitted to smell each sample in succession. If the animal has been properly trained in Phase I, he should stop and sit immediately upon detecting the S+ sample. If he does so he is reinforced with praise and food in the usual manner. The handler and dog then return to the starting position. This sequence completes one trial. If the dog appears confused by the new procedure and fails to sit at the S+, the handler commands him to do so, subsequently delivering reinforcement. The dog must NEVER be reprimanded for slowness or failure to sit on S+ samples; this practice will invariably result in confusion since, in effect, it is like telling the animal that the positive sample is "wrong."
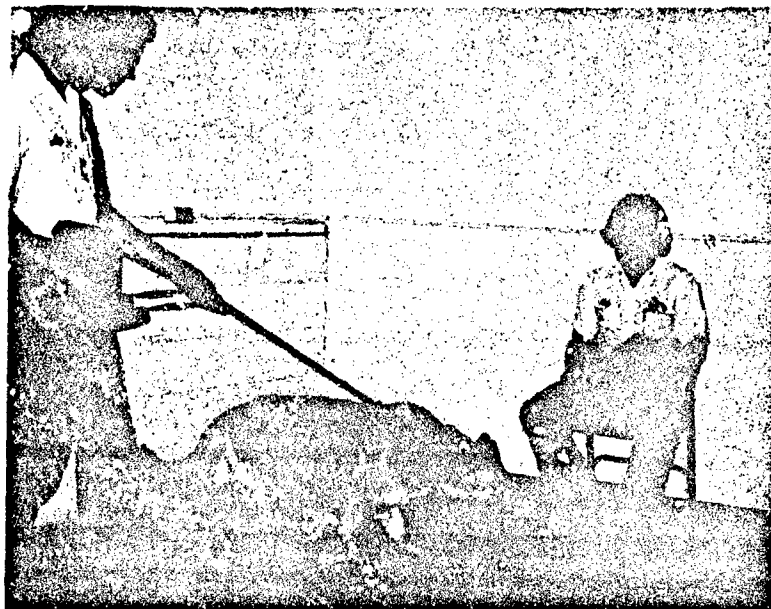
Fig. 15. Proper positioning and use of the discrimination training
board during Phase II training. The training assistant
should be stationed behind the board as shown.

Frequent sits to the S- sample will occur during the early stages of discrimination training before the dog has learned to differentiate the samples. These "false" responses should simply be ignored. That is, the dog must not be encouraged or reinforced in any way for seeking or responding to control samp'~3; nor, however, should it be actively punished for such behavior at this early point in training. The odor discrimination is learned via the key principle of positive reinforcement for correct behavior. The appropriate procedure in such instances is for the handler to speak the dog's name, reissue the command "SEARCH," and encourage the dog to move to the next sample position with gentle tugs of the leash. This process is continued until the S+ is encountered. If the dog then sits without assistance, he is reinforced normally; if not, he is commanded to "SIT" followed by reinforcement. Considerable confusion and uncertainty is normal during early discrimination training. However, most dogs quickly learn simple olfactory discrimination problems given consistent reinforcement for correct responding and patience on the part of the handler.

Upon completion of each training trial and while the dog and handler are moving back to the starting point, the training assistant randomly exchanges the positions of the S+ and S- samples taking care to handle only the plastic beakers and not the sample bottles themselves. Once this has been accomplished a new trial can be initiated. However, in

order to insure correct and timely reinforcement, the handler must be
informed in advance regarding the position of the S+ sample on the dis-
crimination training board. To this end the handler and training assistant
must develop an unambiguous, yet relatively covert signalling system.
For example, a felt marker may be used to number the 5 holes on the
discrimination board, and the position of the S+ sample on each trial
indicated to the handler by a quick display of the corresponding number
of fingers. Verbal communication (e.g., "Position One", "Position
Two", etc.) should not be used since dogs of unusual intelligence may
actually learn to associate the sound of the words with the corresponding
physical position. For similar reasons, the dog should not be permitted
to observe the training assistant while he is exchanging sample positions
between trials. It should be emphasized that all aspects of detection
training are designed to force the dog to detect by means of olfaction; all
other cues must be eliminated from the situation. As an added caution,
the assistant must never allow himself to become confused regarding the
relative locations of the S+ and S- samples.

The scope of daily scoretaking must be further expanded during
Phase II. An appropriate data sheet, illustrated in Figure 16, includes
the following information as a minimum:

        1)   identifying information

        2)   total number of trials conducted

3) number of correct detections (sits to S+)

4) number of false responses (sits to S- samples)

5) number of times S+ passed (not responded to without assistance)

6) comments and observations

The sample data sheet shown in the figure indicates that on 3 March, 1976, the dog Tiger was given 10 Phase II discrimination training trials with Comp. B making 7 correct detections, 2 passes, and 1 false response. A convenient summary of each dog's discrimination performance may be compiled in terms of a session-by-session plot of percentage correct, false, and pass responses as illustrated by way of example in Figure 17. A glance at this sample protocol reveals steady improvement over days of training even though errorless performance has not yet been achieved.

Tetryl, Comp. B, C-4, and TNT are used interchangably as positive samples within Phase II training sessions, but only one S+ is employed on any given trial. As the animal gains proficiency, the off-leash procedure described in Phase I is introduced. Training is continued with one S+ and one S- sample per trial until a criterion of at least 5 successive sessions of 95% or more correct detections is achieved as computed from the daily data protocols. The time allocated to each trial should be increased to 10-15 sec. to allow for the increased complexity of the Phase II discrimination task, and 40-50 trials per session is considered normal.

DOG: _TIGER_   DATE: _3 MARCH 1976_

HANDLER: _John D. Handler_   TRAINING PHASE: _II_

ASSISTANT: _George A. Sistant_

NO. OF S+ SAMPLES: _1_   NO. OF S- SAMPLES: _1_

TYPE OF S+ SAMPLE: _Comp. B._   TYPE OF CONTROL: _Empty Bottle_

Trial No.	Correct Detection	Pass	False Response
1	X		
2		X	
3	X		
4			X
5	X		
6	X		
7		X	
8	X		
9	X		
10	X		
Totals: 10	7	2	1
Percent:	70.0	20.0	10.0

COMMENTS:

Fig. 16. Sample data sheet used during Phase II and subsequent training stages.
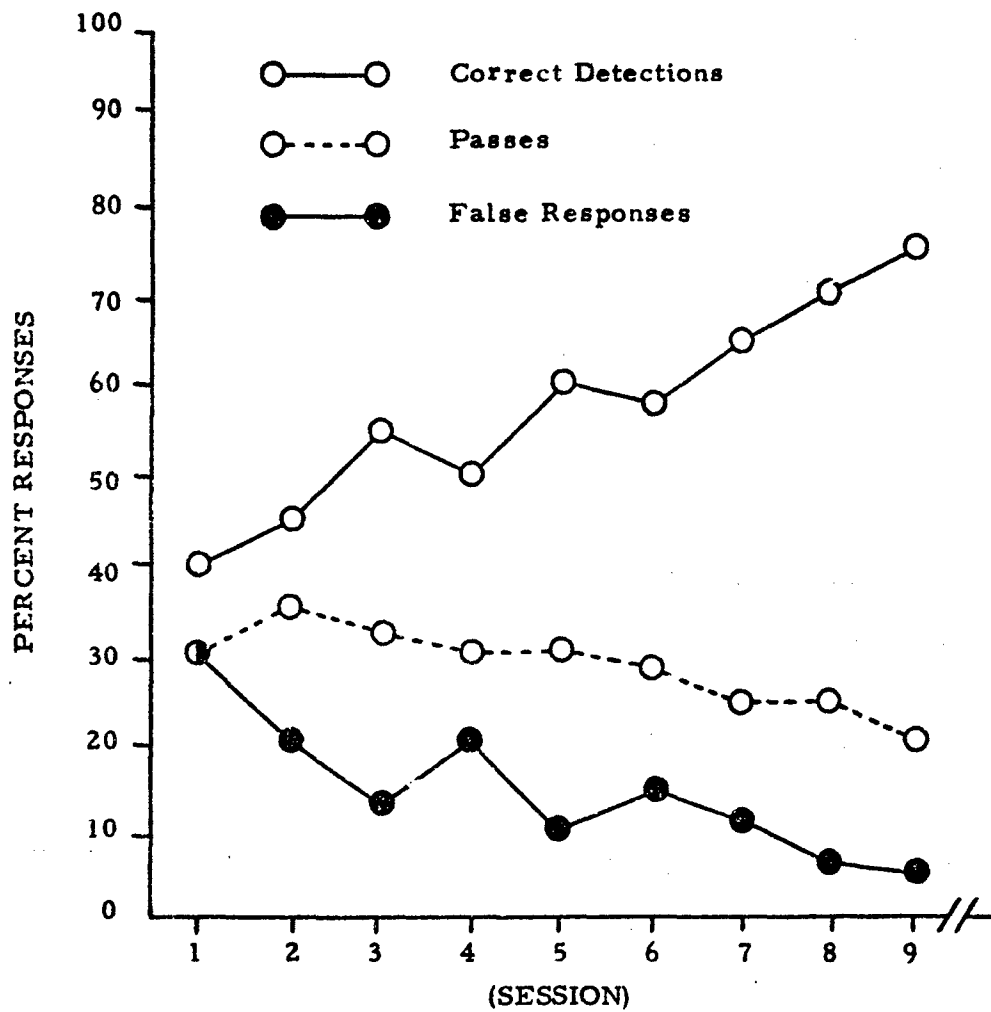
Fig. 17. Sample plot of percentage correct, false, and pass responses as a function of successive training sessions.

Once it is clear that the dog understands the requirements of the olfactory discrimination task as reflected by a high frequency of correct detections and a correspondingly low false response rate, it may be desirable to further reduce the incidence of false responding with occasional correction (i.e., negative reinforcement for erroneous responding). However, punishments for false responses must be administered with particular care. A stern "NO" and sharp tug on the leash are normally adequate as a reproval for incorrect responding. In no case should the animal be punished unless the handler is absolutely certain that its behavior was erroneous; one must never punish a dog for doing something wrong unless it already knows what is correct in that particular instance. It is important to realize that individual dogs vary enormously in their apparent tolerance for punishment. For example, even a mild verbal reprimand may seriously disrupt the performance of some dogs while having little or no effect on the behavior of others. Therefore, the nature and degree of punishment for false responding must be tailored to the individual animal.

The overuse of reprimands should be avoided since it may do more harm than good and can cast a permanent negative atmosphere over the entire training situation. As often as not, the need for excessive correction reflects insufficient mastery of an earlier phase of training on the part of the dog, poor training performance on the part

of the handler, or both.

When the 5-day, 95% correct discrimination criterion described above has been attained, the procedures are modified slightly by introducing a second S- bottle. Training proceeds exactly as before except that the dog must now identify the S+ from two S- samples. Each time criterion is achieved, another control bottle is added until finally the dog is reliably discriminating the S+ from among a set of five samples (one S+ and 4 S-).

The role of human odor presents no special difficulty during explosive discrimination training and, in a sense, is "controlled for" by the very impossibility of eliminating it. That is, due to the unavoidable and ubiquitous dispersal of human scent in any animal/handler training relationship, it cannot be prevented from spreading to positive training samples. In order to control for such "contamination" (i.e., prevent responding to human scent alone), human scent is deliberately and randomly distributed onto both positive and negative samples as well as onto irrelevant objects in the training milieu. By thus overloading the situation with human odor, this scent loses its status as a unique cue, and responding to human odor alone drops out as discrimination training proceeds.

Dogs in discrimination training frequently seek incidental (i.e., nonolfactory) cues regarding the location of the positive or "correct"

sample; for example, glancing at the handler or training assistant,
seeking indications of approval, hesitating before responding, and
numerous other idiosyncratic vascillations in behavior. The handler
and his assistant must therefore monitor their own behaviors carefully
and continuously to insure that they are not unconsciously telegraphing
information concerning sample identity to the animal. Such cues, some-
times called "body language," are extremely undesirable since most
dogs will quickly come to recognize these indications and learn to rely
on them rather than scent to "detect" the S+ sample. Among the most
common handler errors is a slight anticipatory movement of the hand
toward the food pouch as a positive target is approached. This move-
ment, however slight, represents a sure giveaway to the dog and must
be inhibited. Other cues in this category include pausing near positive
samples, holding of the breath, changes in facial expression, slight
shifts of grip on the leash, and a host of similar, sometimes extremely
subtle behaviors. Once a dog has learned to use incidental cues it may
be exceedingly difficult to eliminate his dependence upon them, and it
is the handler's responsibility to insure that they do not become estab-
lished in the first place. This cautionary note, of course, applies not
only during Phase II training, but also to all subsequent stages of training.

Before proceeding to Phase III training it is wise to conduct a
'blind" proficiency evaluation during which the handler receives no advance

information as to the relative location of the S+ sample from trial to trial. At least 50 discrete trials using all four explosive compounds should be run in the course of this performance evaluation. For the purposes of the proficiency check the training assistant informs the handler whether each response was "correct" or "incorrect" (false response) by so stating immediately _after_ the sit; reinforcements are delivered accordingly. If the animal's performance falls below the 95% criterion during the course of blind evaluation, it is very likely that the handler has fallen into the error of providing inadvertent cues of some kind during routine training exercises. These must be identified and eliminated at once. Training then continues under Phase II procedures until the blind proficiency examination has been completed successfully.

The potential advantages of partial reinforcement (PR) during training on subsequent resistance to extinction were discussed in Chapter II. These techniques, if utilized, may be introduced as the end of Phase II training is approached. A 50% random PR schedule is recommended as an ultimate goal for mine detection training applications. Under the constraints of such a schedule, a random 50% of all correct response trials are reinforced in the customary fashion, and the remaining 50% of the correct trials are not. (False responses or passes of the S+ are not counted in the computation of percentage reinforcement). Non-reinforced trials are treated just like any normal trial except that the usual rewards

(praise and food) are not administered. However, partial reinforcement must not be construed as some sort of "punishment." Accordingly, the handler must refrain from communicating any sense of reproval or dissatisfaction on non-rewarded trials; a quick pat on the head may be used to help eliminate potential "misunderstanding" on the part of the dog.

From a procedural point of view, the end-goal of 50% reinforcement should be approached gradually in order to ease the transition from continuous to partial reinforcement. That is, at least 90% of the correct response trials should be reinforced during the first several PR sessions. Once performance has restabilized, a shift to 80% reinforcement may be effected, and so on until a 50% schedule has been achieved. All other training procedures, including the criteria for performance evaluation, remain as before.

It should be noted that the introduction of PR techniques often results in temporary confusion and associated declines in performance. The handler should not become unduly alarmed unless this condition becomes chronic (i.e., in the absence of improvement after several PR sessions). Although limited, available data (5) indicate that dogs trained to detect mines under PR procedures function with reliability equal to that of animals trained with CRF despite the fact that initial training may require slightly longer. A final note concerning partial reinforcement procedures: each time a new phase of training is entered the animal

should be dropped back tc continuous reinforcement for the first several sessions. Thereafter, PR may be reintroduced in progressive steps as described above.

Before proceeding to the discussion of Phase III procedures it should be noted that an appropriately-designed olfactometer can be utilized to conduct explosive odor discrimination training. Basically, an olfactometer is a laboratory instrument for olfactory presentation of carefully-controlled quantities of volatile substances normally delivered as vapors diluted in an inert carrier gas. Such devices are unquestionably effective as a means of establishing the necessary discriminations and are indispensible for certain types of threshold studies, but it remains to be demonstrated that any unique advantage (e.g., accelerated training) accrues as a function of their use for routine, large-scale training purposes. Furthermore, olfactometers appropriate for dog conditioning applications are not readily available in off-the-shelf form from commercial manufacturers and must therefore be constructed by specially-trained personnel. In addition, quantitative calibration of sample concentration may prove to be extremely difficult with certain substances (e.g., TNT), and control of contamination and high maintenance demands generally pose tedious and time-consuming problems. In short, the use of a laboratory olfactometer has been found to represent an unnecessary complication for proper discrimination training in the mine detection context and is not encouraged. However, interested personnel can find additional information in appropriate

sources (e.g., 22).

<u>Phase III: Introduction to Land Mine Detection.</u> The objectives of Phase III are twofold: (1) to advance the dog from discrimination of raw explosive samples to detection problems utilizing actual live (DEFUZED) land mines and practice (inert) mines, and (2) to introduce outdoor training exercises. A selection of live (a term hereafter assumed to imply defuzed) and practice mines, three galvanized metal tubs, and three caster-mounted wooden bases (all described in Chapter V) are required during this stage of training; the procedures are essentially the same as those of Phase II.

Three training aids or "samples" must be prepared prior to each session: one dummy or "blank" sample, one inert or "negative" sample, and one live or "positive" sample. The blank member of this set consists of a freshly washed and dried metal tub filled 2/3 full with clean sand and situated atop one of the moveable bases. The inert sample is prepared in a similar manner with the addition of a practice mine placed on the surface of the sand. The positive sample is identical to the negative member except that a live mine is used instead of an inert device. As in the case of the training aids of Phase II, the positive sample should be prepared last to reduce the possibility of odor cross contamination. For similar reasons, the sand contained in positive tubs must be discarded after use. Furthermore, when a given tub has been used with live mines,

it must NEVER thereafter be employed as a blank or negative sample. A complete set of Phase III training aids is shown in Figure 18.

One additional control measure must be observed during preparation of Phase III samples due to the fact that live mines normally differ in color from their practice counterparts. It is true that dogs do not possess color vision; however, laboratory studies have clearly demonstrated that they can make fine visual discriminations on the basis of achromatic luminosity (i. e., shades of gray). From a practical point of view this means that the live and practice mines must be covered or disguised by some homogeneous material to prevent differences in apparent brightness from serving as a task-irrelevant cue in the detection process. To this end it has been found that a layer of clean coarse muslin draped over the mines and affixed to the bottom with masking tape is effective in preventing visual identification of live and inert devices, yet, by virtue of its relatively loose weave, does not significantly retard emission of distinctive odor elements. NEW muslin covers should be fitted each time a set of training aids is prepared, and in NO case may a section of material once used to disguise a live mine be used later with an inert device. Even thorough laundering may fail to remove all traces of contamination.

Phase III exercises are begun in the indoor training area. The handler and dog assume the customary starting position with the three samples stationed approximately 2 m apart on a line perpendicular to and
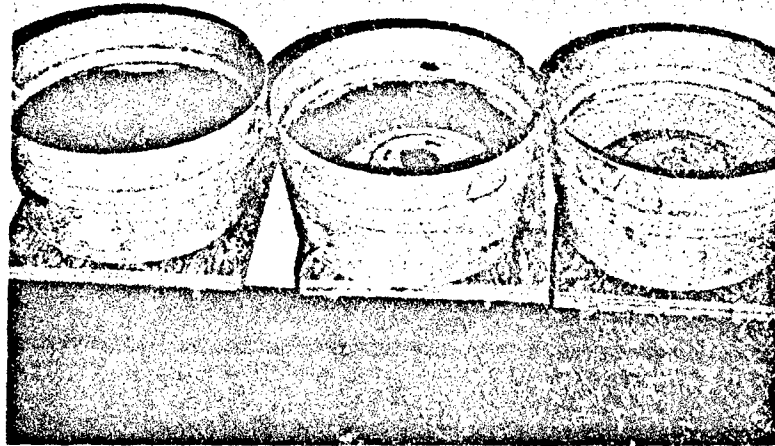
Fig. 18. Illustrative set of Phase III training aids showing (l to r)
sand only, inert mine, and live (defuzed) mine. (Muslin
covers removed for photographic clarity).

about 4 m in front of the dog/handler team. As in Phase II, the handler

and his assistant must devise a covert method for apprising the former

of the location of the positive sample on each trial. Upon receiving the

start trial signal from the assistant, the handler calls the dog's name,

gives the command "SEARCH," and advances toward the row of samples.

The dog is permitted to investigate each sample in sequence. If the dog

voluntarily sits at the positive sample, it is reinforced in the normal

manner. If not, he is coached into doing so with the command "SIT" fol-

lowed by reinforcement. The handler and dog then return to the starting

point thus completing one trial. Meanwhile, the assistant records the

dog's performance and randomly interchanges the positions of the three

samples in preparation for the next trial.

Training is continued according to the above procedures until the

standard 95% performance criterion has been achieved. However, a

shift from the on-leash to off-leash modes should be effected as soon as

permitted by the dog's behavior in order to reinforce the practice of re-

quiring the dog to advance several paces ahead of the handler.

The training team should recognize that the transition from the

simple discrimination of raw explosive samples in Phase II to the detection

of real mines in Phase III comprises a substantial increase in task difficulty

due, in large part, to a marked reduction in odor intensity. (The sealed

construction of land mines allows only minute quantities of explosives

vapor to escape). Therefore, the training team should not be discouraged if the dog's performance does not appear to exceed chance expectation during the first few sessions. If properly conducted, the earlier discrimination training will eventually be manifested as a positive transfer effect; as always, the key to success is patience and perseveration. Experience has shown that up to six weeks of daily sessions of 40-50 trials each may be required to complete Phase III training.

Once the dog has become proficient in correctly detecting all types of live mines from the blank and inert controls, the detection task is made more difficult by gradually burying the live and practice devices in sand. This is accomplished by lowering the targets slightly further (e.g., in 3-5 cm increments) for each succeeding training session until they are entirely covered by a thin layer of sand. The rate at which complete burial can be attained is determined by the animal's performance. That is, if no deterioration is noted on training Day N, then the target depth may be increased by one increment on Day N + 1. If, however, detection performance is seen to fall off sharply on Day N, then the current depth must be retained until it returns to acceptable levels (i.e., 95% correct detection).

A maximum target depth of 2-3 cm. is adequate for Phase III exercises, and the use of muslin covers can be discarded once total coverage has been achieved. Covered samples should be allowed to age at least 24 hours, and preferably 48 hours, before use to permit the relevant

odor molecules to diffuse through the sand overlayer.

The emergence of "rooting" or pawing behaviors is commonly seen with the introduction of buried samples and is probably correlated with an attempt on the part of the animal to obtain a stronger olfactory sample. Such behaviors, if allowed to become established, may be difficult to eliminate later and must therefore be <u>firmly discouraged</u> from the outset. <u>The importance of early correction cannot be overstressed since, obviously, both dog and handler will be placed in imminent peril of their lives should the dog commence pawing or digging in the immediate vicinity of a live land mine or booby trap during actual deployment.</u>

The astute reader will recognize that proper correction of rooting and digging behaviors requires considerable handler finesse because, operationally, a reprimand for digging at positive samples cannot be distinguished from negative reinforcement of a potential correct detection. * Disruption of progress is certain to ensue if this undesirable contingency occurs with any degree of frequency. Therefore, the following corrective measures are recommended: if the dog attempts to root or paw at positive samples, he should be commanded to "SIT" and "STAY" immediately, followed by the customary reinforcement. In stubborn cases, the handler may wish to physically discourage digging by grasping the dog's paw. If rooting or pawing occurs to negative samples, the handler may proceed to issue a

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* The use of electric shock or other negative reinforcement procedures
  should be avoided for similar reasons.

verbal reprimand ("NO") accompanied by a sharp tug on the leash; the

animal should be led at once to the next sample position. If all else fails,

suspending a stiff hardware cloth cover (1/2" X 1/2" or 1.27 mm x 1.27

mm mesh) approximately 1 cm above the surface of the sand in all three

sample tubs may prove useful. The latter, by rendering rooting and paw-

ing totally ineffective, may cause these behaviors to extinguish through a

process of nonreinforcement.

Training continues with buried samples until a criterion of three

successive sessions of 95% or greater correct detections is observed. At

this point, out-of-doors training is undertaken using exactly the same pro-

cedures and sample arrangements. Normally, little disruption in pro-

gress will occur with the change in scenarios, although a certain degree

of distraction may be apparent at first. Once again, training proceeds

until a 5-day, 95% performance criterion is attained, followed by a

blind proficiency test conducted in a manner identical to that described

previously in the discussion of Phase II procedures. Assuming that the

latter is successfully passed, the animal can be advanced to initial field

training exercises.

Phase IV: Initial Field Training. The primary objectives to be accom-

plished during the fourth phase of training are three in number: (1) to

acclimatize the dog to field detection problems, (2) to instill the basic

trail search pattern, and (3) to commence booby trap trip wire detection

exercises. The first two objectives are undertaken in the outdoor train-

ing area and require the construction of simple trails containing surface-

deployed live and inert mines. Trip wire training is taken up as a separate endeavor.

The typical technique of deployment of land mine/booby trap detector canines requires the dog to advance on leash a few paces ahead of the handler searching back and forth in a kind of "S" pattern. This behavior is developed on straight training trails (or "lanes") approximately 100 m long and 3-4 m wide. These trails should be installed in open, preferably flat, grassy fields largely free of dense trees or brush. If the grass is high, suitable trails can be fashioned by simply mowing a 3-4 m wide pathway cutting down to a height of 6-12 cm. Trails constructed in this manner are most convenient for the purposes of Phase IV because the higher grass bounding the edges automatically delimits the sweep of search to the desired width. If however, the grass is already uniformly short then it will be necessary to install pairs of wooden stakes (see Chapter 5 for specifications) spaced 3-4 m apart at 15 m intervals over the length of the trail. These lines of stakes serve to define the practice trail and act as guideposts to dog and handler.

A random assortment of live and inert mines are then deployed on the surface within the trail boundaries. The following implacement guidelines should be observed:

1)   All available types of live and practice mines should be used.

2)   The intervals between target devices should be randomized

(i. e. , do not use a fixed distance between targets). A mean

intertarget interval of 10 m is appropriate.

3) Some mines should be installed along the trail boundaries,

others at random distances between boundaries.

4) Live and practice devices must be randomly interspersed

(i. e. , do not supply the first half of each trail with live mines

only and the latter half with inert units only).

5) All mines should be left in full view with no attempt at cam-

ouflage or concealment.

6) All live and practice mines must be fitted with clean muslin

covers as described previously to preclude visual identifi-

cation.

Diagrams of two sample trails are provided in Figure 19. It is recom-

mended that several such trails, each characterized by a different

sequence and distribution of live and inert devices, be made available to

each dog in training. Excessive use of any given practice trail can lead to

such problems as memorization, tracking, and related phenomena which

may confound the primary objectives of training. Adjacent lanes should be

separated by at least 25 m to minimize distraction during simultaneous

training of two or more dogs. (For similar reasons the dog should not be

permitted to urinate or defecate on practice lanes). Finally, a detailed map

or diagram of each lane showing the precise location and type identification
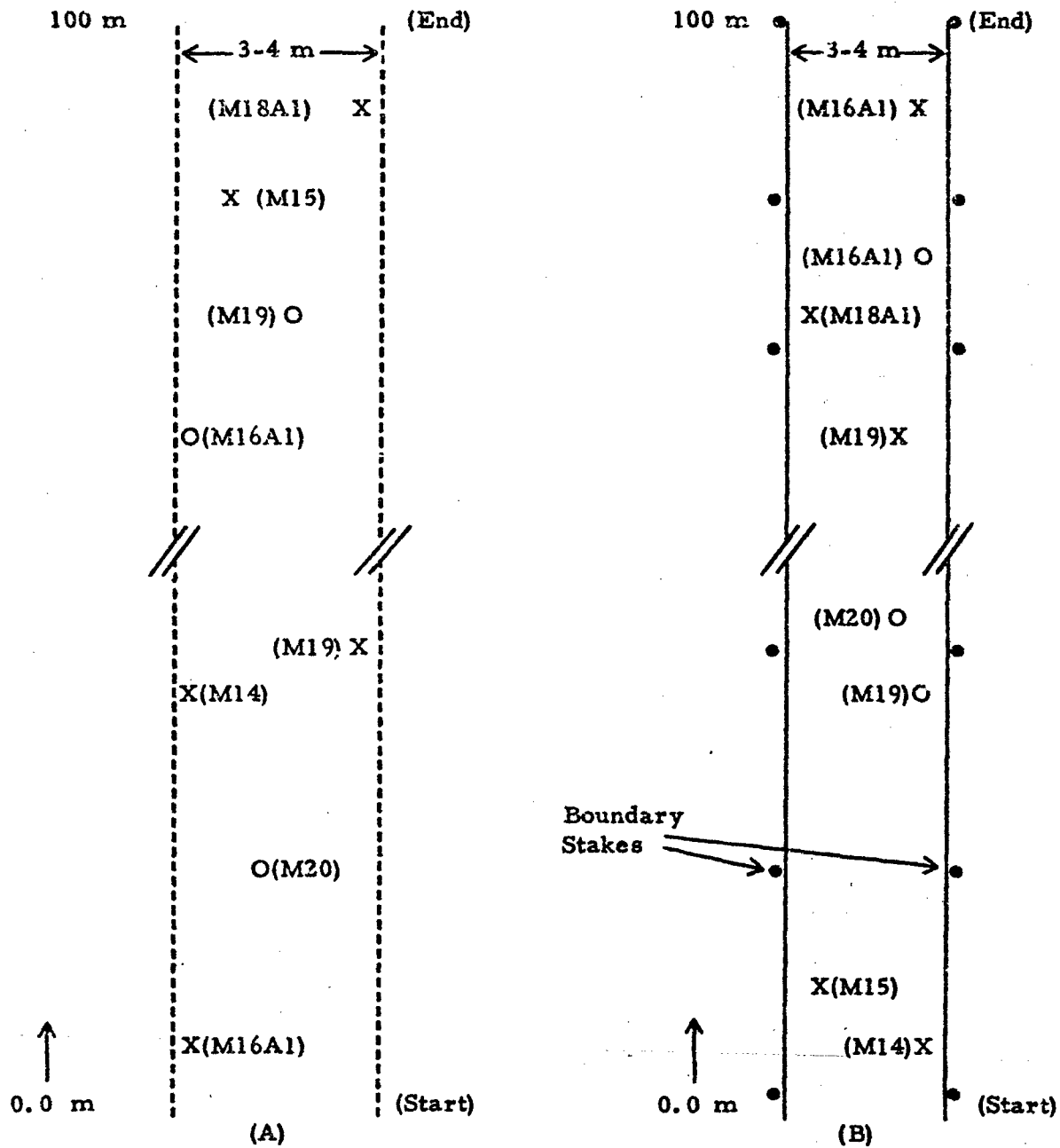
Fig. 19. Sample training trails to be used during Phase IV training.
Trail A cut through high grass; trail B delineated by bound-
ary stakes. X = live mine; O = inert mine. All target
devices deployed on surface. Drawing not to scale.

of all target devices must be prepared for scoretaking purposes during training exercises.

Phase IV training procedures are straightforward. The handler positions himself at the lane starting point with the dog on leash in the Heel/Sit position. When all is in readiness the training assistant gives the start command. The handler then calls the dog's name, commands "SEARCH," and begins advancing slowly down the lane. If the earlier training has been successful the dog should voluntarily move out several paces ahead of the handler. At this point the dog must be trained to search back and forth across the trail in a sweeping "S" motion progressing forward one or two steps for each crossing of the trail as shown in Figure 20. Many dogs will adopt this pattern of traverse naturally. if not, the handler can guide the animal back and forth with gentle pressure on the leash; it may be necessary for the handler to adopt a less extreme "S" pattern himself in such cases to assure that the dog covers the full width of the trail on each sweep. It is the handler's responsibility to insure that the dog screens all portions of the trail thoroughly. A slow walking pace must be set and controlled at all times by the handler; rushing through the search sequence will invariably lead to ineffective coverage and could result in passing up mines which would otherwise be detected during conditions of actual deployment. Similarly, the visibility of the target devices during Phase IV may give rise to the temptation to
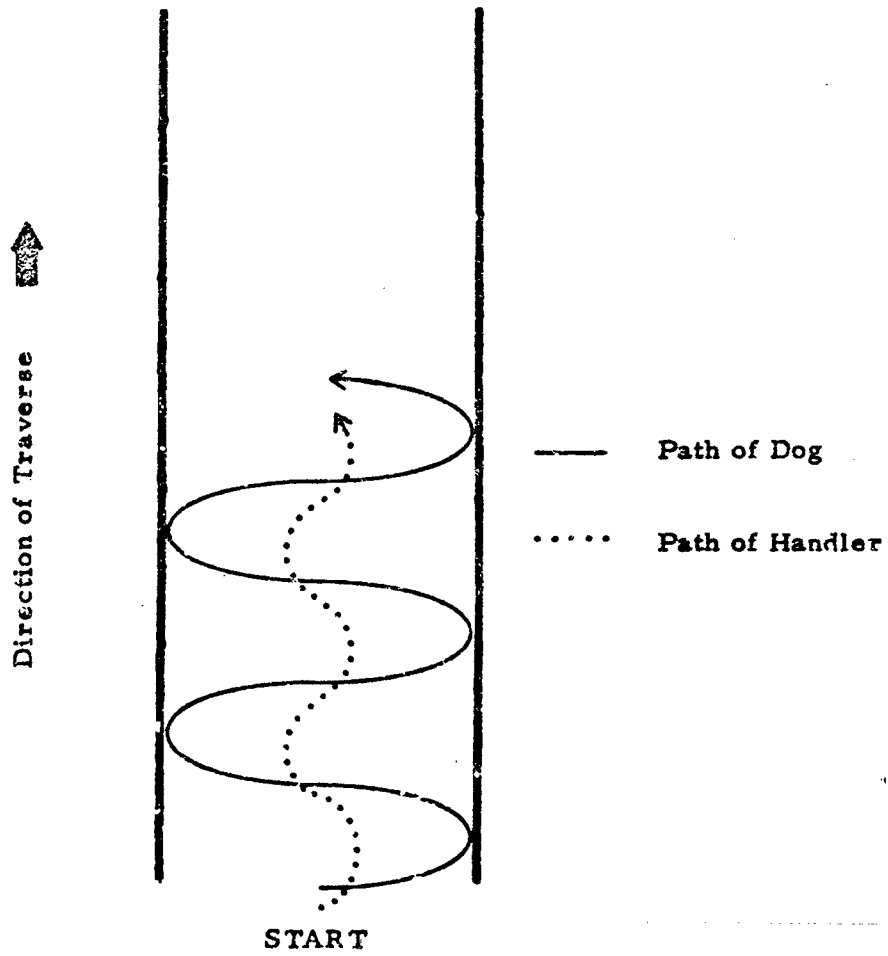
Fig. 20. Proper search pattern during trail traverse.

speed directly from one mine to the next thus aborting a proper search of the intervening areas. This false expediency must be inhibited; the dog must learn to search all portions of the trail with equal thoroughness. Given relatively open terrain, 1.25-1.50 km/hr. represents a reasonable rate of traverse.

The handler may find it necessary to reissue the "SEARCH" command and to give other verbal encouragement as the traverse proceeds. The dog is rewarded in the customary manner for searching out and responding to positive (live) targets. Inert mines are simply investigated and passed by without special action unless the animal persists in responding to such devices. In this case, the use of verbal reprimands is appropriate. Figure 21 illustrates the proper Phase IV procedure.

Consistency of reinforcement is insured by the training assistant who follows approximately 5 m behind the dog/handler team walking along one or the other trail boundaries. The assistant must determine whether each response was correct (response to live mine) or false (response to inert mine) by reference to the lane diagram. This information must be communicated to the handler IMMEDIATELY following the response so that the dog can be reinforced or reprimanded accordingly. The use of the terms "correct" and "false" is recommended for responses to live and inert mines, respectively. In any event, the assistant should avoid the word "NO" in the case of false responses since this term already has special meaning to the dog by virtue of its earlier obedience training.

Fig. 21. Phase IV training exercise. Note that dog is about to encounter M19 land mine at lower left corner. Training assistant follows dog/handler team with lane map and data sheet. (Muslin cover removed for illustrative purposes only).

Finally, the training assistant is responsible for item-by-item data recording on each practice exercise: type of target, nature of response (correct, pass, false), elapsed time of traverse. Appropriate data sheets should be prepared in advance.

The complete traverse of a training lane is counted as one practice "run." Under normal circumstances 3 to 4 runs on different trails comprise one day's training session for each dog; water and rest breaks should be scheduled between runs. The trails may be traversed in reverse sequence from time to time to add variety. As always the handler must remain alert to the possibility of transmitting inadvertent cues regarding target identity to the dog; it is imperative that this tendency, often unconsciously motivated by the handler's desire for his dog to perform well, be completely inhibited.

Occasional dogs may be slow to learn the proper side-to-side sweeping search pattern. The use of special training lanes involving closely-spaced targets alternated on left and right boundaries may assist in overcoming this problem. As suggested in Figure 22, the regular alternation of targets forces the animal to move sequentially back and forth across the lane. The lateral spacing of mines should be reduced from the normal mean of 10 m to an average of about 2 m, although the random distribution of live and inert devices must be maintained.

Unless special difficulties are encountered, the dog should be
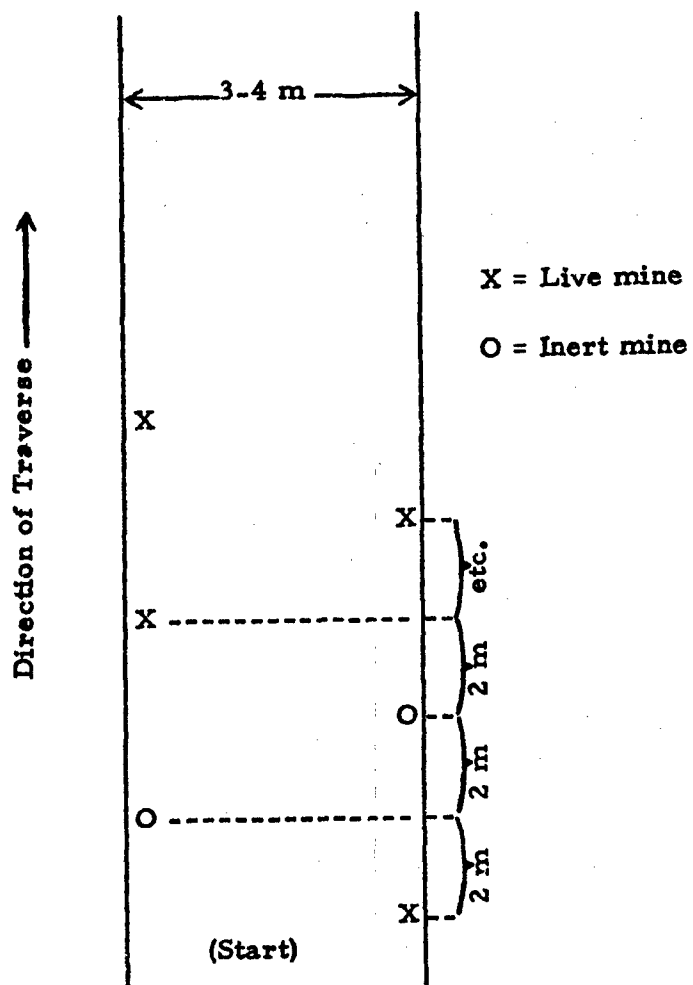
Fig. 22. Special trail for sweep pattern training.

advanced from Phase IV to Phase V training as quickly as possible. That is, as soon as the criterion of 5 successive training days of 95% or greater correct detection proficiency is attained. Unnecessary protraction of Phase IV exercises may lead to the development of reliance on visual cues due to the fact that the mines are deployed in full view on the surface of the ground.

As indicated previously, booby trap trip wire detection training is initiated during Phase IV. However, trip wire exercises should be conducted separately from mine detection sessions at this stage.

Although actual experience demonstrates that dogs can detect booby trap trip wires with high reliability, the exact means by which this detection feat is accomplished remains unclear. One theory asserts that the animal smells human scent or some other odor associated with the stringing or fabrication of the wire. A second maintains that vision plays the major role, while a third holds that auditory cues generated by wind-induced vibrations provide the basis for detection. While potentially amenable to experimental test, no conclusive evidence supporting one or another of these hypotheses is available; it is likely that a combination of these factors underlies the detection process.

Initially, the wire detection task is simplified by employing, as training aids, wires or strings somewhat larger in gauge than standard military booby trap wire. If necessary, strings which contrast sharply

with the surrounding terrain may be used to aid visibility during the first several trip wire training sessions (e.g., white strings in dark green foliage, black strings in dead grass, etc.). The use of exaggerated trip wires should be discontinued as soon as possible however.

At first, the simulated trip wires are strung directly across the trail in a readily detectable fashion — relatively high (at the animal's nose and eye level) and in open areas as shown in Figure 23. The preferred training procedure involves principles essentially similar to those employed for mine detection tasks; that is, operant reward conditioning utilizing praise and food reinforcers. The indicating response (sit) is likewise similar. Initially the handler and dog advance toward the training wire together. Upon approaching the string or wire, the handler stops, points out the wire to the dog, commands the animal to sit, and administers the standard praise and food reward. With repeated trials the dog should eventually come to detect the wire and stop and sit spontaneously. The customary rewards must of course be delivered at once on such trials. Mild corrections may be required to prevent the animal from breaking through the string or wire. As the dog gains proficiency, the training wires are gradually lowered to typical field deployment heights, conventional booby trap wire substituted for the training aids, and degree of camouflage increased.

Some animals may have difficulty mastering the trip wire detection task, continually breaking through the wires. In such cases it may be

Fig. 23. Initial trip wire training. Wire exaggerated for photographic clarity.

helpful to invoke a negative reinforcement paradigm by electrifying the training wires such that the dog receives a mild shock if contact is made with the wire. A common electric fence charger may be used for this purpose. Shock intensities should be held to the minimum level required to achieve the desired effect, and extreme caution is recommended lest the animal become excessively fearful and cautious with a consequent reduction in overall detection proficiency for land mines as well as trip wires. For similar reasons, electrified trip wires must never be used on regular mine detection training trails; a special training area should be reserved for this purpose. Experience has shown that even a few experiences with shock are often adequate to permanently break most dogs of ever again plunging into the wire; indeed, some animals may refuse to approach closer than 5 m on subsequent trials (5). Therefore, the use of electric shock should be discontinued as soon as possible.

Phase V: Intermediate Trail Exercises. The objectives and procedures of Phase V represent a straightforward extension of those of Phase IV, the only difference being that the dog is challenged with the task of detecting buried rather than surface-deployed mines. Burial is accomplished in gradual steps in a manner similar to that described for Phase III. Additional control and distractor targets are also introduced during this stage.

Phase V training and scoretaking procedures are essentially

identical to those of Phase IV as discussed above and therefore require

no further elaboration. However, the complexity of the detection task

is made more complicated by gradually burying and camouflaging the live

and inert mines until a condition approximating actual service deployment

is attained (refer to U. S. Army TM 9-1345-200 for details). This goal

is approached progressively over successive days of training. Specif-

ically, the first few Phase V exercises are conducted on newly-constructed

trails identical in overall layout to those used in the preceding phase with

the exception that the mines are partially buried. Initial depths should

be shallow such that the tops of the mines remain uncovered and flush

with ground surface contour. The use of muslin covers must be retained

at this point in training.

Routine training is continued until the dog becomes fully proficient

in detecting targets deployed in the partially-buried fashion described

above. The handler must further emphasize the proper "S" searching

pattern during these sessions. As the animal gains proficiency, the mines

are gradually covered with earth starting with little more than a light

sprinkling or dusting with fine dirt as shown in Figure 24. Thereafter the

depth of cover is progressively increased until the training targets are

completely covered. The depth of the holes must be increased by corre-

sponding amounts to prevent the development of a mound of earth over the

mines which would serve as an extraneous cue. The muslin covers may

be discarded after the stage of total burial is attained. Camouflage of the
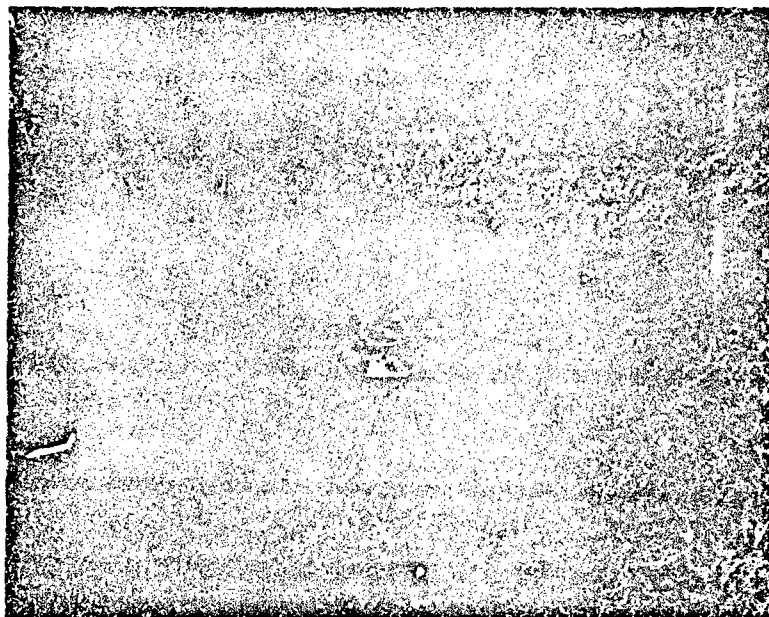
Fig. 24. Partially buried mine suitable for intermediate stages of Phase V training.

target sites is also undertaken at this time by sprinkling the areas with leaves, grass, or whatever is appropriate to the immediate terrain. The goal of this procedure is, of course, to prevent the dog from learning to detect patches of bare earth, a trait which will quickly develop in the absence of camouflage.

Randomly-placed blank (i.e., refilled) holes are also introduced in the training lanes at this stage in order to develop a discrimination against freshly disturbed earth. For related reasons, a variety of distractor items are added to the training trails, including freshly-fired small arms cartridge cases, urine, small pools of gasoline and/or motor oil. All of the latter materials fall into the category of "nuisance stimuli" commonly found in battlefield areas; the dog must be trained to ignore such distractions. Accordingly, the precise locations of blank holes and distractor stimuli must be included on the training assistant's lane map; responses to these irrelevant targets are counted as false alerts and are treated as such during training exercises.

The utilization of buried and camouflaged targets prohibits ready visual location and identification by dog, handler, and training assistant as well. Therefore, a more sophisticated lane mapping scheme must be developed to allow valid scorekeeping; permit accurate real-time decisions regarding reinforcement or nonreinforcement of correct and false responses, respectively; and to provide a record of target loci for use

during subsequent disassembly of training lanes. Obviously, any form of physical marking is unsuitable because of visual cues thereby introduced. However, the target location problem can be circumvented by the use of a simple two-dimensional Cartesian mapping system in which the precise locus of each live mine, practice mine, blank hole, and distractor item is specified by a "Y" and an "X" coordinate. The Y coordinate indicates linear distance from the starting point (i. e., 0. 0 m to 100. 0 m), and the X coordinate specifies lateral distance (0. 0 m to 4. 0 m) measured perpendicularly from the left trail boundary. Hence, a live M14 located in the middle of the lane and 50. 3 m downtrail from the starting point is assigned coordinates of Y = 50. 3 and X = 2.0. A short sample trail set up according to this system is shown in Figure 25. Accuracy of implantation and mapping is a must for both training and later recovery operations; therefore, the coordinate locations of all target devices should be determined with tenth-of-meter precision as a minimum.

It will be noted in Figure 25 that the stakes bounding the left edge of the trail have been numbered in increments of 10 m to correspond to the distance separating adjacent stakes. This practice is recommended as a convenience to the training assistant who, being unable to see buried and camouflaged targets, must accurately estimate the locations of --' item in the process of determining whether responses are correct or false or whether a live mine has been passed. The numbered stakes serve
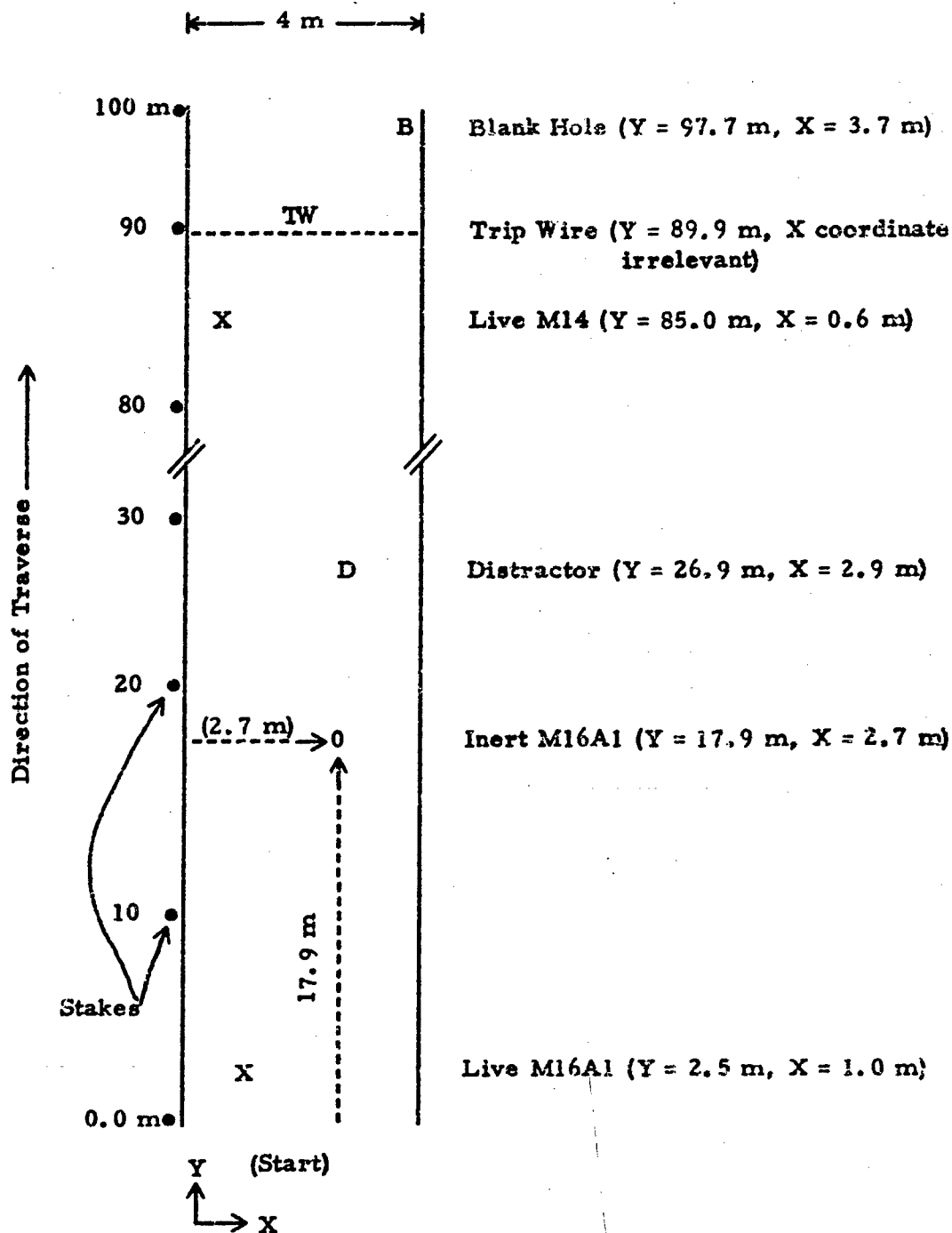
Fig. 25. Sample training lane showing use of target location coordinate system. The cocidinate of the second item (Inert M16A1) are shown as dotted lines by way of illustration. Drawing not to scale.

as Y-coordinate reference markers in this decision making operation. It
is imperative that the training assistant learn to estimate the location of
concealed mines with great precision in order to correctly evaluate each
response; 1/2 - m accuracy is easily attained given sufficient practice.

For the sake of convenience, the lane map format illustrated in
Figure 25 may be reduced to tabular form without sacrificing precision.
That is, a complete summary of any training lane requires a listing of
only 3 pieces of information: type of target, Y coordinate, and X coor-
dinate. Figure 26 provides such a tabular presentation of the sample
lane shown in Figure 25. It has been found that the tabular format is
easily interpreted by an experienced scoretaker (training assistant) and
minimizes confusion during practice and proficiency evaluation runs (5).

Once practice with buried and camouflaged targets has commenced,
a set of scoring rules, derived on the basis of statistical evaluation of
canine detection performance, must be invoked for two reasons: (1) the
training assistant cannot avoid a degree of variable error in his estimates
of response versus target locations, and (2) even the most proficient dogs
do not generally sit exactly on top of detected targets. (The latter behav-
ior is in fact undesirable since it could result in the detonation of certain
types of mines under real circumstances of deployment). For these rea-
sons, an imaginary "latitude of allowable error" or "confidence interval"
must be established with respect to each mine. Previous data (5) has

Target Item	Y Coordinate (m)	X Coordinate (m)
Live M16A1	2.5	1.0
Inert M16A1	17.9	2.7
Distractor	26.9	2.9
.	.	.
.	.	.
.	.	.
Live M14	85.0	0.6
Trip Wire	89.9	---
Blank Hole	97.7	3.7

Fig. 26.   Tabular presentation of sample lane shown in Figure 25.

shown that approximately 90% of all correct detections fall within a 3-m radius of actual live mine locations. Thus, any response occurring within 3 m of a live mine are scored as correct detections during practice and proficiency evaluation runs. Responses falling anywhere outside this radius are counted as false responses. Also, any response occurring within 3 m of an inert mine, blank hole, or distractor item is considered to be false. These scoring rules are used for data keeping and reinforcement decision making during Phase V and all subsequent stages of training. (The allowable distance should be increased to 5 m in the case of trip wires since a well-trained dog can often make detections on trip wires at this range).

The maximum depth of burial of live and inert mines used during Phase V (or at any point in training for that matter) should not exceed those described for each device in U. S. Army TM 9-1345-; 10 (23):

Device	Depth
M14	Flush with surface and covered with light sprinkling of soil.
M15, M19	1-1/2" (3.81 cm) between top of mine and surface.
M16A1;	3" (7.62 cm) between top of mine and surface.
M18A1	Surface deployed.

Techniques of land mine deployment are beyond the scope of the present document; the reader may refer to above-referenced technical manual for

details. Booby trap trip wires (nonelectrified only) should be included at random positions on Phase V training lanes. If indicated, remedial shock-avoidance trip wire training must not be undertaken on regular training trails; a special area should be reserved for such exercises.

The problem of undesirable "rooting" and digging in the vicinity of live mines was pointed out in the discussion of Phase III procedures. Similar behaviors are likely to emerge with the introduction of buried targets in Phase V and must be eliminated at once. Guidelines and techniques of remediation described previously are again relevant and should be applied as soon as these activities are detected.

With the exception of a somewhat artificial lane configuration, the techniques of target implantation achieved during the final stages of Phase V training are intended to approximate as closely as possible to these of actual service deployment. Therefore, it is imperative that the dog be fully proficient with respect to detection ability before entering the last formal phase of training. Accordingly, a more stringent performance criterion is applied. Specifically, the animal should not be advanced until it has demonstrated a minimum of 95% correct detections (using the 3 m allowable radius rule) on each of 8 successive training sessions each comprised of at least four 100 m trail exercises. This proficiency check should be conducted on a blind basis such that the handler has no advance information regarding target identities and loci.

Before proceeding to a discussion of the final phase of training, the handler should be made aware that dogs differ enormously in their "style" of search. The handler must learn to read the idiosyncratic behaviors of his dog, constantly watching for partial alerts, changes in sniffing rate or vigor, hesitation, sudden head turning, pricking of the ears, even changes in rate of tail wagging, all of which may serve as important supplemental indications that the animal has detected a suspicious scent. The handler and dog must function as an integrated team, and these subtle behaviors should not be overlooked inasmuch as they comprise a meaningful channel of communication.

The handler should also be aware that constant sniffing of the ground is not always necessary for detection of mines and booby traps. Some dogs seem to perform best when working in this fashion, while others of equally high proficiency rarely put their nose to the surface except in the immediate vicinity of a mine. Animals in the latter category apparently rely primarily on air borne scent.

Phase VI: Advanced Field Training. Phase VI represents a logical extension of the conditions of Phase V with the exception of longer and more complex trails. In essence, the purpose of this last stage of training is to provide practice in realistic scenarios similar to those which might be encountered during actual service deployment. Accordingly, longer trails (e.g., 0.5 - 1.0 km) incorporating random turns and various obstacles

such as fallen trees, ditches, gulleys, etc. should be prepared. All live and inert mines must be deployed in accordance with TM 9-1345-200 and appropriately camouflaged; booby trap trip wires and distractor targets previously described should be employed. The use of reference stakes and the associated coordinate location system must be continued despite the fact that most trails are no longer perfectly straight. Target density should be reduced to an average of 10 live devices per km.

Other training scenarios should also be prepared including unim- proved roadways, footpaths, random minefields, and railroad tracks (if available). TM 9-1345-200 may be consulted for mine deployment techni- ques appropriate to each scenario.

The training methods and data recording procedures are essentially identical to those of the preceding phase. Note, however, that searches of o] n fields pose a special problem with regard to scorekeeping. Due to the ab   a structured trail, a systematic procedure for thoroughly screening the entire area must be devised. It is recommended that the area of interest be subdivided into a number of sectors each no wider than the normal search sweep; length is largely arbitrary. Each sector must be searched in succession until the entire area has been cleared. It is the handler's responsibility to insure that all portions of the field are covered with equal effectiveness since it is he who controls and delimits the dog's path of traverse. Accordingly, a pass should not be counted against the

dog if he is not permitted to come within 2 m of the mine because of the

handler's actions. Such detection failures are the fault of the ha ller,

not the dog.

It will be wise to expose the dog to various distracting events such

as small arms fire, detonation of booby trap and artillery simulators,

passage of ground vehicles, etc. which are frequently encountered in front

line situations. The dog must learn to work with minimal disruption in the

face of these disquieting experiences. It is assumed that all dogs were

carefully tested for tolerance to gunfire during the initial selection process,

and, if so, few problems can be anticipated in adapting them to these events.

However, the habituation process must be accomplished in progressive

steps. That is, preliminary exposures to gunfire, simulators, etc. should

be from a great distance (100 m) gradually moving closer as adaptation

progresses. Do not install simulators within the actual boundaries of

practice trails since the explosive substances contained therein represent

a form of contamination. (If a dog should, however, locate and respond

to one of these devices he must not be reprimanded nor charged with a

false response).

Phase VI training should be continued for a minimum period of 12

weeks using a broad variety of practice trails and scenarios. Once an

animal has become an accomplished performer on Phase VI exercises,

his detection training may be regarded as essentially completed. However,

a final proficiency evaluation must be passed before declaring the dog ready for service deployment.

Final Proficiency Evaluation. A set of new, previously unused trails is needed for the final performance evaluation. All types of live and inert mines, blank holes, distractor items, and trip wires should be incorporated. It is recommended that each dog be run on 8-10 different lanes during the course of testing, and at least 50 valid targets (e.g., 40 live mines of all types plus 10 trip wires) will be required for a meaningful data sample. No more than two 1-km lanes should be run per day of evaluation.

A proper proficiency evaluation demands that the dog and handler have no advance information regarding target identities and loci. Test runs are accomplished according to procedures basically identical to those used during Phase V and Phase VI training. However, to assure scoring objectivity and to minimize guesswork on the part of the training assistant regarding whether each response is correct or false, the handler should be provided with a set of response marker flags as described in Chapter V. One of these markers is inserted into the ground immediately following each response. The handler must use his best judgement concerning the precise location being indicated by the dog. In most cases this point will fall about 30 cm ahead and on a line between the forepaws.

All responses, including false alerts, are so marked. The assistant
must, of course, still rely on his subjective estimates to inform the
handler whether or not to reinforce the dog immediately after each re-
sponse. However, computation of the dog's evaluation performance
is based on a comparison of the respective coordinate locations of
response marker and actual target position. Any response marker
falling within a 3 m radius of the actual location of a _live_ mine (or
within 5 meters of a trip wire) indicates a correct detection. Response
markers located outside this radius correspond to false responses.
Percentage correct detection is computed by dividing number of correct
detections by total number of live mines employed during final evaluation.
An overall test score of 95% or higher correct detections is considered
acceptable. Dogs which achieve this evaluation criterion may be advanced
from training to service status; those which do not must be continued in
training. If after 6 weeks of additional practice the animal still fails to
pass the final proficiency examination he should be assigned to tasks less
demanding than land mine/booby trap detection.

Performance Maintenance. The performance of complex learned behaviors
deteriorates in the absence of reinforced practice. Therefore, it is im-
perative that well-trained land mine/booby trap detector canines receive
periodic refresher sessions to prevent a gradual decline in search and
detection proficiency. A minimum of two 120-minute practice sessions

per week are recommended for each animal. Preferably, such refresher exercises, conducted according to Phase VI training procedures, should meet the following criteria:

1) Whenever possible review sessions should be undertaken in settings which approximate as closely as possible anticipated operational scenarios.

2) A random selection of live and inert mines, booby trap trip wires, blank holes, and distractor items should be employed to insure sufficient generality in detection proficiency.

3) Frequent use of the same practice lane must be avoided.

4) Refresher sessions must be conducted by the dog's regular handler.

Finally, animals maintained on an "on-call" status will require careful scheduling of rations to assure maximum motivation during periods of operational deployment.

CHAPTER VII

GENERAL CONSIDERATIONS AND SPECIAL PROBLEMS

Most of the common problems specific to a given phase of land mine/booby trap detection training have already been identified and treated at appropriate points in the preceding chapter entitled Detection Training. The problems and considerations discussed below are of a more general nature and, in many instances, could be encountered at any stage of training. Some have been suggested earlier, but are repeated here because of their importance. The inexperienced handler would be wise to acquaint himself with these issues before attempting to undertake the training of any dog for land mine/booby trap detection tasks.

General Considerations

1)   Handler/Dog Relationship. Prior to the initiation of training, the handler must completely rid himself of the notion that he is dealing with a household pet. A land mine/booby trap detector dog is a working dog and must be treated as such. It is almost universally agreed among professional trainers that the roles of household pet and working dog can seldom be combined effectively, and the detector animal, whether still in training or an accomplished performer, must not be allowed to share the handler's quarters at any time. It would appear obvious that if an animal receives a large amount of fussing and attention outside the working situation, then his performance in the working context is likely to decline.

In other words, best performance will result if praise and attention are made contingent upon good working performance. This note of caution should not be misconstrued to mean that the handler should not interact with his dog on nonworking days. Quite the opposite is true, but the nature of the working relationship must not be compromised.

It has already been pointed out that my dogs possess a remarkable ability to sense and react to the attitude and emotional disposition of their handler. A handler who approaches his training responsibilities with an air of boredom, disinterest, or sullen resignation is likely to elicit mediocre performance on the part of the dog as well. In contrast, the handler who radiates an optimistic and enthusiastic aura may well find that his personal attitude contributes favorably to his dog's motivation and performance.

Finally, the training session must never be permitted to degenerate into a contest of wits or stubborn game of willpower between the dog and handler. Forcing an animal to perform a task which it does not understand will accomplish no useful purpose and may lead to a setback in the normal progression of training. It must be recognized at all times that the mine/booby trap detection problem comprises a team effort with dog and handler working toward a common objective. Therefore, the handler must refrain from irrational outbursts of temper striving always to insure that the training situation remains a positive experience for both handler and dog.

2)   Motivation.   It has already been pointed out that it is

necessary for the dog to be somewhat hungry at the beginning of each

training session due to the fact that food reward constitutes a major com-

ponent of reinforcement in the present detection training strategy.   This

requirement is achieved by means of careful regulation of the animal's

daily food intake.   Amount of food received as rewards during each train-

ing session must be counted as part of the total daily ration and the regular

evening feeding adjusted accordingly.

Restriction of food intake cannot, of course, be carried to

the point of improper nourishment.   In general, maintenance of a proper

feeding schedule will require:

1)   Accurate weighing or measurement of total
daily food intake.

2)   Precise and frequent monitoring of the
animal's body weight.

3)   Observation of the animal's physical condition.

4)   Behavioral observation (e.g., poor motivation
in the training context may reflect overly
generous rations).

The effects of motivational level as manipulated by system-

atic adjustment of food intake upon performance has been investigated as

part of an ongoing canine mine detection research program (5).   Briefly,

15 well-trained dogs were randomly divided into three groups, and pro-

jected ad libitum weight (weight which would be obtained if free access to

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TABLE 1

Data Summary: Motivation (Food Deprivation) Experiment

Group	No. Mines	No. Correct	% Correct	% Pass	No. False Responses
I (85%)					
Apache	21	19	90.5	9.5	5
Eve	24	21	87.5	12.5	14
Tiger	16	15	93.7	6.3	14
Quickie	21	18	85.7	14.3	7
Val	22	19	86.4	13.6	5
Group Means	20.8	18.4	88.5	11.5	9
II (90%)					
Angus	17	14	88.3	11.7	2
Bretta	20	18	90.0	10.0	5
Casey	15	14	93.3	6.7	9
Warp	18	17	94.4	5.6	4
Winchester	23	19	82.6	17.4	14
Group Means	18.6	16.4	88.2	11.8	6.8
III (ad lib.)					
Duncan	20	18	90	10	0
Dusky	17	15	88.2	11.8	3
Ernie	15	12	80	20	2
Rex	20	16	80	20	2
Whop	22	21	95.4	4.6	2
Group Means	18.8	16.4	87.2	12.8	2

other hand, marked differences in mean number of false responses may be observed among the three experimental conditions with an average of 2 false alerts in the ad lib. group, a mean of 6.8 false responses in the 90% deprivation group, and an average of 9 false responses in the 85% deprivation condition. Group mean number of false responses and percentage correct are summarized in Table 2.

TABLE 2

Percentage Correct and Mean No. False Responses

	Group 1 (85%)	Group 2 (90%)	Group 3 (ad. lib.)
Percentage Correct	88.5	88.2	87.2
False Responses	9.0	6.8	2.0

An analysis of variance of number of false responses revealed that the differences observed between groups are statistically reliable (F = 4.21, df = 2/12, $p < .05$). Subsequent pair-wise comparisons indicated that Group 1 differed significantly from Group 3 (t = 3.26, df = 8, $p < .05$), that Group 2 differed marginally from Group 3 (t = 2.18, df = 8, $p < .10$), but that Group 1 did not differ significantly from Group 2 (t = 0.74, df = 8, $p > .10$).

Subjective observations regarding the behavior of the animals during test runs were consistent with the quantitative data reported above. For example, Group 1 animals, which scored the highest rate of false responding, also displayed considerable evidence of excessive activity and excitability which in some cases made the dogs difficult to control effectively during search trials. The observation of increased general activity level as a function of food deprivation is consistent with numerous similar laboratory findings reported in the literature of experimental psychology (e. g., 24, 25, 26, 27). In contrast, animals maintained on full rations, although yielding respectable detection scores which did not differ overall from the other deprivation groups, showed symptoms of poor general motivation and lack of incentive. Considerable coaxing and encouragement were frequently required to sustain effective search behavior in non-deprived animals.

Based on the range of deprivation conditions investigated in the present study, maintenance of an intermediate working weight (i. e., 90% of ad lib. body weight) would appear to represent the most effective strategy for mine booby/trap detector dogs trained to work for food reinforcements inasmuch as full rations (non-deprived) result in difficulties with respect to maintenance of sustained performance, while more severe conditions of deprivation are associated with unacceptably high rates of false responding.

3)   _Temporary Declines in Performance._ It should be apparent to the reader that each successive phase of training involves presentation of a more complex detection task as the animal is advanced from mere recognition of raw explosive samples to detection of concealed and camouflaged mines in realistic scenarios. Accordingly, initial confusion and temporary declines in performance are normal during the first several sessions following introduction of each new phase. The training personnel should be aware of this phenomenon and not become discouraged unless no improvement is seen after a number of sessions. In the latter case the dog should be returned to the previous phase of training for additional practice.

4)   _Distance of Traverse._ Unless the conditions of climate are extreme, a well-trained land mine/booby trap detector dog can be expected to effectively cover a distance of about 2 km per day searching a 3-4 m wide trail. Thereafter, a gradual decline in proficiency may occur as a result of fatigue. A low density of positive targets may also lead to a loss in efficiency of varying degree probably due to a lack of sufficient numbers of reinforcements and a consequent decline in incentive. Similar phenomena are sometimes observed in narcotic and contraband detector canines. The usual remedial action in such cases involves occasional presentation of a surrogate positive target which the animal is allowed to "detect." The associated reinforcement appears to bolster the animal's flagging motivation

thereby restoring performance to normal levels.

Previous research has shown that unfuzed live M14 land mines may be used as surrogate targets to sustain motivation over long periods of deployment. However, this practice is unacceptable during in-service utilization since it would require the handler to carry about a potentially hazardous ordnance device. Accordingly, an attempt was made to devise and evaluate a more practical surrogate target (5). The most useful device developed to date consists of a 0.8 cm x 2.25 cm plastic capsule filled with Comp. B dust and Plaster of Paris mixed in a 1:1 ratio. Such ampules are readily detected by well-trained dogs, pose a minimal hazard, and are easily transported in quantity by the handler.

Seven special trails were constructed to test the effectiveness of the above-described surrogate targets in sustaining detection performance in situations characterized by long time intervals and extended traverses between positive targets. The mean length of these trails was 2.5 km with an average of 3 live mines per lane. All targets were widely spaced with an intertarget interval exceeding 1.6 km in some instances. As expected, baseline data (no surrogate targets) revealed evidence of slight declines in motivation and detection proficiency on the latter portions of the longer trails. This trend appeared to be aggravated by hot weather.

Subsequent tests with surrogate targets presented by the handler when, in his judgment, incentive and search proficiency began to

decline, produced equivocal results. In some cases the desired "remotivating" effect was clearly observed; in others it was not. The major problem in the latter instances appeared to stem from the fact that these dogs consistently refused to respond to the surrogate devices. At least two explanations of this unexpected behavior are possible: (1) the surrogate targets are not easily detected, or (2) a subtle discrimination between live mines and surrogate targets was formed during the course of the experiment. The latter alternative appears most reasonable since quantities of pure Comp. B considerably smaller than those employed in the surrogates are reliably detected. In any event, the validity of the surrogate target concept remains sound inasmuch as experience has shown that M14 mines fulfill this function with considerable reliability. Thus it would appear that further research directed toward development of a more practical surrogate target is indicated.

5) <u>Age of Targets</u>. An important practical consideration in the overall canine mine detector concept relates to the potential effects of target age (i.e., elapsed time since implantation) on probability of detection. Unfortunately, no data are available regarding detection of mines implanted for periods of 9 or more months prior to search. However, a series of formal evaluations conducted at Ft. McCoy, WI, and Yuma Proving Ground, AZ, found no substantial differences in detection accuracy for mines im-

planted for periods of 48 hours, 5 months, and 8 months. *

Implantation times of less than 24 hours appear to constitute an unusual and interesting case. Specifically, an experiment was undertaken to determine the detection proficiency of well-trained dogs against mines which had been implanted for periods of 2, 24, and 48 hours under otherwise identical conditions (5). Although the number of data points are limited, the findings revealed a direct, negatively-accelerated function relating time since implantation and detection performance: 55.55%, 92.31%, and 100.00% detection for the 2-, 24-, and 48- hour intervals, respectively. It is significant to note that the detection rate of only 55.55% against 2-hour targets is substantially lower than the normal average detection proficiency of the group of dogs participating in this study. While the exact reason for this unusually low detection score remains unclear, one plausible explanation of this outcome rests on the assumption that at least 24 hours is required for explosive odors to penetrate the freshly laid soil overburden. Such an interpretation is consistent with the low vapor pressures of most explosives, and it is unfortunate that there is no reliable method of independently quantitating the time course of diffusion of explosives molecules

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*Recent data collected at Yuma Proving Ground (June 1976) revealed that the overall detection rate against mines implanted for approximately 8 months tended to be somewhat higher (about 10%) than that observed in an identical test conducted 7-10 days following initial installation of the same experimental minefield. It is possible that the observed difference can be explained by higher saturation of the overlying soil with explosives odors resulting from the longer period of implantation.

through soil overlying buried land mines. Finally, the relatively poor detection of freshly laid mines provides strong evidence that the detector dogs were not responding to human scent or recently disturbed earth.

6)   Decisions to Terminate. It is an inevitable consequence of natural biological variability that not all canine candidates will successfully complete a program of land mine/booby trap detection training — some will fall victim to an inherent lack ... .ty, others to unacceptable vagaries of temperament. It is equally inevitable that the ultimate decision to terminate a dog depends largely on the subjective judgment of the trainer — since each dog is an individual characterized by a unique combination of virtues and faults, no hard and fast rules for termination can be decreed. Nevertheless, a number of guidelines would appear relevant to the handler's deliberations. Obviously, a dog which cannot master the basic odor discrimination problem, fails to acquire an acceptable alerting response, or fails to achieve criterion at any stage of training should not be continued. Furthermore, any dog whose day-to-day performance reveals extreme variability or is characterized by a lack of consistent motivation will probably prove unreliable under operational conditions. Finally, aggression, hostility, or other symptoms of emotional instability are obvious cause for dismissal.

Despite careful preselection, experience has shown that fewer than 50% of the dogs enrolled in the present training regimen will master the complete sequence and go on to pass the final proficiency examination.

Special Problems

1) <u>Poor Performance.</u> Broadly speaking, poor performance at any stage of training can be traced to learning or performance factors. Under normal circumstances, learning deficiencies can be corrected by additional training trials on the specific task or phase where difficulty is first encountered. Performance factors include more general considerations such as motivation, fatigue, boredom, sample contamination, excessively harsh punishment, and a variety of other nonassociative factors which may be difficult to specify.

Successful remediation of poor performance depends upon accurate identification of the source of difficulty. Although each dog represents a unique case, the following procedures and suggestions have general relevance with respect to identification and correction of training problems:

A) Continue training at the most complex stage achieved for several further sessions. If a simple learning deficiency is at cause, additional trials should result in improvement. If not, one or more performance factors should be suspected (e.g., poor motivation, sample contamination, etc.).

B) The sudden emergence of poor performance in a dog which has previously demonstrated normal progress suggests a problem related to performance variables. The following corrective measures should be explored in turn:

i) check for sample contamination,

ii) increase motivational level via systematic decreases in total daily rations (see guidelines previously enumerated),

iii) increase magnitude of reinforcement per trial (additional praise and larger food rewards),

iv) temporarily suspend training for a rest period of 2 - 3 days' duration.

C) Successively drop back through successive phases of training until normal performance is observed. Reinitiate training at this stage.

D) Reassign the dog to different handler and training assistant. This may be the only effective cure in cases where the dog has come to distrust or fear a handler who has administered reinforcements inconsistently or has indulged in excessively harsh reprimands.

2) Odor Contamination. One of the most troublesome problems encountered during olfactory detection training is odor contamination. Since one is dealing with an organism which can detect odors far below human threshold, it is frequently impossible to determine objectively if, for example, a particular "false response" was in fact false. That is, a trace of the target odor may have actually been present. If in such a case the handler reprimands his dog for alerting on some object or area where the training odor is actually present — via accidental transfer or inadvertent contamination — then in reality he is punishing the animal for responding correctly to trace quantities of the target substance. Should

this kind of inconsistent treatment occur frequently, confusion will ensue and the dog's performance will almost certainly deteriorate.

Unfortunately there is no simple solution to the ever present problem of odor contamination. However, the risk can be minimized by constant vigilance on the part of the handler and his assistants who must take every imaginable precaution against contamination. Frequent hand washing will substantially reduce one common source of accidental odor transfer, and the importance of thorough scrubbing immediately following handling of training stimuli cannot be overemphasized. Thorough washing and high temperature drying of sample containers is also critical. It has already been emphasized that negative training aids must be prepared before positives at all stages of training; furthermore, positive and negative samples must never be permitted to come into physical contact.

3)   Handler Requests for Target Verification. Many handlers fall into the habit of repeatedly telling the dog to "Show me" or requesting "Where is it?" immediately following an initial response in an attempt to verify correct detections and/or elicit a more precise indication of target locus. Most dogs quickly learn the meaning of these phrases, and the practice is acceptable if not overdone. However, requiring that the animal repeatedly verify detections prior to reinforcement may result in confusion regarding task demands and at the same time introduces an undesirable delay of reward. The proper procedure involves immediate reinforcement of the

first response (assuming it is correct); only thereafter is a request for verification appropriate, followed, of course, by additional reinforcement. Finally, some dogs become excited or agitated by frequent requests for verification: the practice is counterindicated in such instances.

4)   Hyperactivity. Excessive excitement and hyperactivity is sometimes seen in highly motivated dogs upon successful detection of positive training samples. Such behaviors are extremely undesirable due to the possibility of inadvertent detonation of certain types of booby traps and land mines — especially AP devices requiring low detonator load pressures. Thus a properly-trained dog is one which sits immediately upon detection of a live mine and remains essentially motionless until led in a controlled fashion to a region of safety by the handler.

Remediation of hyperactivity may prove exceedingly difficult if allowed to develop into a full-blown syndrome. Therefore, prompt corrective action should be undertaken as soon as symptoms of this type of behavior are noticed. Procedurally, this objective can normally be accomplished by commanding the dog to "SIT" and "STAY" immediately following the initial sit response. The handler thereupon advances to the dog's side; leads it 2-3 m away from the detection site at a slow, controlled pace; and then delivers the customary reinforcement. The slight delay of reward occasioned by this practice is of little practical consequence under the circumstances. Punishment of hyperactive behavior following

detection responses is ill-advised since the effects of the reprimand may generalize to the sit response itself.

5) **Excessive Utilization of Training Trails.** Overuse of the same training trail by the same or multiple dogs can lead to the development of two phenomena, both of which may act to confound the primary objective of training: tracking and lane memorization.

Many dogs learn naturally to follow their own trail or that left by other dogs when the same training lane is used for repeated practice exercises within a short period of time, and there is some evidence to suggest that animals may leave a distinctive scent at the locus of positive targets. The development of reliance on such extraneous cues is clearly undesirable since it tends to impair the dog's true detection capabilities on new trails or in virgin territory such as will be encountered during service deployment. Tracking can often be diagnosed by running the animal on the same trail several times in succession. If the same mines are detected consistently while others are not, self-trailing behavior should be suspected. Likewise, tracking of other dogs can usually be detected by allowing the dog to search a given trail shortly after it has been used with another dog. If the former animal displays the same pattern of correct, pass, and false responses as the latter, the possibility of tracking is indicated.

Unfortunately, there is no simple solution to the tracking problem.

Optimally, each new training lane should be used only once, a procedure which, while most nearly approximating the conditions of actual service deployment, becomes quite impractical in a large scale training endeavor. By way of compromise, repeated utilization of the same trail by a given dog must be conscientiously avoided, and, in any case, a "cooling-off" period of at least 48 hours (preferably longer) should be scheduled between successive runs by the same or different dogs. Furthermore, operation of a suitable training site requires that used trails be disassembled and new lanes constructed as frequently as is feasible to minimize excessive utilization.

Memorization of target identities and loci can occur as a consequence of multiple runs over the same trail by a given dog, and the relative contribution of such memory cues to the overall detection process has been investigated experimentally (5). Eleven adjacent pairs of special training lanes were constructed for this purpose. The "a" member of each pair contained various experimental targets at precisely specified coordinate locations, while the "b" member (dummy test lane) was comprised of refilled holes only located at identical coordinate positions. The experimental site was a flat, homogeneous, grassy field selected to minimize irrelevant visual cues.

During Phase I (memorization training), a subset of dogs was randomly assigned to each pair of test trails and 10 successive runs were

made on the first member. As was expected, high levels of detection performance were observed on the last several memorization trials for each dog. These data are summarized in Table 3 which shows mean percentage correct detections averaged over the 10 memorization runs for each dog. Observation of the dogs' performance by handler/trainer personnel revealed several interesting patterns in search behavior. For example, some animals displayed evidence of tracking their own trails following the first few memorization runs. In this regard, it is significant to note that detection of positive targets approached 100% after a few repetitions, thus suggesting that both mine odor and other cues were being exploited by the animals; in contrast, repetition of false responses at specific loci were observed far less frequently. In addition, dogs working off leash were occasionally observed to traverse one or the other trail edge, moving into the lane to respond only at Y-coordinate points corresponding to positive targets. If a strong breeze was blowing across the lane from either right or left, dogs working off leash tended to traverse the leeward edge entering the actual lane per se at the loci of positive plants.

Upon completion of Phase I memorization trials, each dog was run on three successive days on the second ("b") member of each pair, which, as indicated previously, contained only refilled blank holes located at the same coordinate positions as the targets in the corresponding "a"

TABLE 3

Mean Percentage Correct Detections
Averaged Over 10 Memorization Runs

Dog	Number Positive Targets	Number Correct Detections	Percentage Correct Detections
Angus	40	32	80.0
Apache	40	35	87.5
Bretta	60	58	96.7
Casey	50	49	98.0
Duncan	60	52	86.7
Dusky	40	38	95.0
Ernie	60	58	96.7
Eve	50	45	90.0
Quickie	50	44	88.0
Rex	60	56	93.3
Tiger	40	40	100.0
Val	40	35	87.5
Warp	60	49	81.6
Whop	60	56	93.3
Winchester	60	45	75.0
TOTAL	770	692	89.9

lane (Phase II). Every attempt was made to work the dogs on dummy test lanes in a manner identical to that utilized on live lanes in order to preclude potential bias due to subtle handler cueing, etc. For example, if an animal hesitated at a blank hole he was neither encouraged nor discouraged from responding. Actual responses were not rewarded; nor was the animal reprimanded in such cases. The Phase II data are presented in Table 4 where it may be seen that 10 of the 15 dogs tested made no responses whatsoever during b-lane test runs. The remaining 5 dogs alerted a total of only 15 times at b-lane coordinate positions corresponding to positive target loci in the respective "a" lanes. The low rates of responding to blank holes demonstrates that the animals' earlier training to reject disturbed earth was highly effective, but fails to confirm the predictions of the memorization hypothesis.

Upon completion of Phase I data collection, the positive targets in the "a" series lanes were removed. The soil surrounding positive targets was excavated during the removal process and replaced with uncontaminated earth in order to minimize potential confounding due to residual mine-related odor elements. Following a three-week "cooling off" period, additional runs on the "a" series lanes were undertaken as a further test of the memorization process (Phase III). Each dog was permitted to search only the lane to which he had been assigned during Phase I (memorization).

TABLE 4

Responses to b-Lane Holes Corresponding to
a-Lane Positive Target Loci

Dog	Number of "Target" Sites*	Number of Responses	Percentage Responses
Angus	12	0	0.0
Apache	12	0	0.0
Bretta	18	0	0.0
Casey	15	0	0.0
Duncan	18	2	11.1
Dusky	12	0	0.0
Ernie	18	6	33.3
Eve	15	2	13.3
Quickie	15	1	6.7
Rex	18	0	0.0
Tiger	12	0	0.0
Val	12	0	0.0
Warp	18	0	0.0
Whop	18	0	0.0
Winchester	18	4	22.2
TOTAL	231	15	6.5

* A "target" site refers to a blank refilled hole located at a coordinate
location corresponding to a live target in the respective "a" lane.
Members of the "b" series lanes contained no live mines.

The results of Phase III were mixed with response rates ranging from 0% to 100%. (Technically, it would be misleading to label these responses as "false responses" since it is possible that a small amount of odor contamination remained despite the excavation and "cooling off" procedure). A few dogs totally ignored the now-blank target sites, others paused and investigated prior target loci but did not respond, still others appeared unsure and made hesitating responses, and one dog persisted in responding at all locations. Furthermore, some animals responded frequently on the first Phase III trial followed by a decreasing rate of alerts on subsequent runs; curiously, the opposite pattern was observed in a few dogs despite the fact that Phase III responses were never rein- forced. The data are summarized in Table 5.

In summary, the results of the memorization subexperiment remain inconclusive. The Phase II (b-lane) data suggest that memori- zation of sheer physical position does not occur; however, it is highly likely that the dogs were able to differentiate readily between a- and b- series lanes on the basis of other cues despite their visual similarity. In contrast, the results of Phase III clearly demonstrate that highly- trained dogs may respond reliably to blank loci which previously contained positive targets. Whether this phenomenon occurs as a result of memori- zation or is due to residual odor contamination remains uncertain pending additional research.

TABLE 5

Responses to Previously-Valid Target Loci Three Weeks Following Removal of Positive Targets

Dog	Number of Target Loci*	Number of Responses	Percentage Responses
Angus	12	11	91.7
Apache	12	9	75
Bretta	18	15	83.3
Casey	15	12	80.0
Duncan	18	15	83.3
Dusky	18	0	0.0
Ernie	18	17	94.4
Eve	15	0	0.0
Quickie	15	9	60.0
Rex	18	5	27.7
Tiger	12	11	91.7
Val	12	6	50.0
Warp	18	13	72.2
Whop	18	18	100.0
Winchester	15	11	73.3
TOTAL	234	152	65.0

* Actual target removed 3 weeks prior to test runs.

It should be reemphasized that the use of memory cues to assist detection during training of mine/booby trap detector canines represents an undesirable phenomenon since it acts to confound the overall training objectives. That is, development of reliance on memory cues during training may act to reduce subsequent detection proficiency on fresh lanes or during actual deployment when no memory cues will be available. Therefore it is recommended that further research be undertaken in an attempt to clarify the memory hypothesis. As a first step in this direction, a series of experiments involving progressive increments in the length of the "cooling off" period should be initiated. In this way it may be possible to identify and perhaps eliminate potential confounding due to cues arising from residual odor contamination.

6)   Noncontingent Reinforcement. As discussed in Chapter II, the acquisition of simple and complex learned behaviors is based on the principle of repeated positive reinforcement of the desired response. Fastest learning and highest reliability of asymptotic performance demands a consistent pattern of (a) reinforcement of correct behaviors and (b) non-reinforcement of erroneous responses. For this reason the handler must meticulously refrain from noncontingent administration of reinforcement at any time during training. The handler may believe that occasional "free" rewards will act to maintain rapport and attention, but any advantage thereby gained will almost certainly be offset to a disproportionate degree

by undesirable behavioral side-effects. In particular, capricious reinforcement may lead to confusion regarding specific task demands and to acquisition of irrelevant, potentially competing behaviors. A working dog must never learn that it can elicit approval and reinforcement or evade execution of a given training exercise by engaging in extraneous acts of supplication and related diversionary behaviors.

7)   Interludes in Training. Although brief and infrequent interruptions of training are of little practical consequence, sustained interludes invariably lead to a progressive deterioration in proficiency. Response extinction in the strict technical sense is unlikely, but prolonged lack of practice is known to be associated with memory remission and a consequent decline in performance. Thus, lengthy interruptions of the training sequence should be avoided at all costs.

Disruption of normal progress will be most severe if an interlude occurs as the dog is making the transition to a more advanced phase of training. In such cases it may be necessary to drop back one or more phases and reinitiate training with an earlier, previously mastered sub-task.

8)   Fatigue. Fatigue may at times interfere with normal training progress — especially under conditions of extreme heat or cold. The animal may continue to search under these circumstances, but its detection efficiency will be significantly impaired. The most practical remedy for

fatigue is to avoid its initial development by not forcing the dog to work for extended periods without rest. Periodic access to water is also imperative.

9) **Illness.** A dog should not be worked if it appears ill. There may be times, however, when the animal is in fact ill and yet does not display frank symptoms. Poor search behavior, low motivation, and lack of normal enthusiasm are frequently observed in such cases. If illness is suspected, the animal should be referred for veterinary examination.

10) **Loss of Ordnance Devices.** Daily utilization of live land mines as training aids in the detection training sequence requires strict adherence to a rigidly-formalized set of rules and regulations designed to safeguard against their theft or inadvertent loss. The problem of theft is a matter for duly authorized security personnel. However, prevention of accidental loss or mislocation of field-deployed training devices remains in large measure the responsibility of the regular training staff. An updated inventory showing the status and location of every live device must be maintained at all times, and precision coordinate mapping of all trail-deployed mines is required for both training and recovery purposes. These maps should be double checked for accuracy by independent observers at the time of preparation.

Antipersonnel mines such as the M14 pose a special problem due to their small size and are painfully difficult to recover if accidently

mislocated during installation. To complicate matters, experience has shown that wild animals are attracted to these devices (possibly because of the distinctly sweet odor of tetryl), occasionally dislodging, gnawing, or even carrying them off. The latter possibility can be largely elimi- nated by tying the attached cord (normally supplied with M14 mines) to a metal pin driven into the earth directly beneath the mine. This arrange- ment also minimizes the danger of displacement by runoff during periods of heavy rainfall.

CHAPTER VIII

EMPLOYMENT*

Handler/Dog Team Concept. For practically all tasks to which highly trained canines may be assigned, the significance of the handler/dog team concept cannot be overemphasized. This consideration is of particular importance in detection applications where neither dog nor man can function effectively alone. Dog and handler must work together in a smooth and efficient manner, an objective which cannot be achieved without mutual confidence, understanding, and continuous coordinated practice. While the dog's olfactory system provides the basic mechanism of detection, the handler must know his dog and be able to read the subtle reactions and idiosyncratic behaviors peculiar to the particular animal. It cannot be assumed that a given dog will function effectively with any handler (or vice versa) immediately after being assigned to work as a team. Even in the case of a well-trained animal and experienced handler, a period of practice and acclimitization is necessary to permit the melding of a smooth and efficient working partnership. Some handler/dog pairings may never achieve compatibility. Furthermore, the handler should not rely solely on the ears, eyes, and nose of the dog, but must use his own wits and senses to assist in the overall detection process.

Functioning and Emplacement of Land Mines. Since the canine land mine/ booby trap detector concept is based on a cooperative man/dog team

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*The reader should refer to Volume III of this series, "User's Guide: Land Mine and Booby Trap Detector Dogs," for a more detailed treatment of the techniques of employment of land mine/booby trap detector dogs.

relationship in which the handler may contribute substantially to overall detection proficiency, it is necessary that he be well acquainted with the rationale, strategy, and techniques of land mine warfare. Accordingly, it is strongly recommended that all handler personnel be exposed to a formalized course of instruction dealing with the function and emplacement of mines and booby trapped devices. Of particular significance is a thorough knowledge of typical emplacement strategies and patterns of deployment. Preferably, the required course of instruction will emphasize any special devices and emplacement procedures employed by the enemy forces against whom the handler/dog team will be called to serve.

An extensive treatment of the strategy of land mine warfare is beyond the scope of the present manual, and the reader should refer to relevant U. S. Army field manuals for detailed discussions of these matters (e.g., 28). However, the following guidelines typify locations commonly selected for land mine and booby trap deployment:

1) In and adjacent to established trails and natural pathways.

2) In potholes, road patches, or soft spots in surfaced roadways.

3) Under the edges of road surfacing at its junction with the the road shoulder.

4) On road shoulders in locations where easily laid and camouflaged.

5) At locations which block logical bypass routes around blown bridges, cratered roadways, or similarly obstructed avenues.

6) Around the edges of craters and ends of damaged bridges or culverts (antipersonnel mines are sometimes placed in craters or natural depressions which might offer cover from artillery fire or air attack).

7) Along barbed-wire entanglements, wire fences, and other obstacles such as abandoned vehicles, or along felled tree trunks and limbs lying across roads and trails.

8) Near unusual objects which may indicate an enemy mine-field marker.

9) In vehicle turn-outs, parking lots, and in front of entrances to buildings, narrow defiles, and airfield runways.

10) In the vicinity of attractive artifacts such as pistols, field glasses, liquor bottles, etc.

11) In likely bivouac or assembly areas and in or near buildings suitable for use as headquarters or observation posts.

12) In likely helicopter landing zones, especially those areas to be used for combat assaults and new major enemy assembly areas.

Radius of Detection. As was indicated previously, even exceptionally well-trained dogs rarely pinpoint the precise location of concealed land mines — in part because of their deliberate training to avoid disturbing or sitting directly on top of these devices. Furthermore, prevailing winds or capricious eddy currents may create substantial drift of odor elements thereby producing displaced alerting responses. In general, surface-deployed devices will be located with greater precision than buried mines.

In view of the variable error described above, it is necessary to invoke a statistically-based "zone of probable hazard" approach to the

interpretation of canine detection responses. The analysis of an extensive sample of experimental canine mine detection data collected under simulated tactical conditions (5) has revealed that approximately 90% of all detection responses occurred within a radius of 3 m of the actual mine location; roughly 80% of the observed responses fell within 2 m of the valid target locus. Thus, the "region of maximal hazard" may be defined as a circular area 3 meters in radius whose center lies at the indicated detection site. However, the handler must be cautioned that a residual probability, small but nevertheless real, remains that a detected mine may lie outside the region of maximal hazard (strong winds or unusual terrain features are often involved in such remote detections). These relationships are illustrated in Figure 27. Finally, the handler must not lose sight of the fact that booby trap trip wires will sometimes be detected at ranges exceeding 5 m.

4)   Acclimatization. If a dog must be transported a considerable distance from his base duty station for deployment in some remote area, it will be desirable to allow 24 to 48 hours for the animal to recover from the rigors of travel in order to insure maximal working efficiency. This period also permits the dog to acclimatize to prevailing local climate conditions. Dogs with extensive travel experience generally require less time to recover from travel stress and to adapt to local conditions than do novice animals.

Response Locus

80% of Actual Mine Locations

90% of Acual Mine Locations
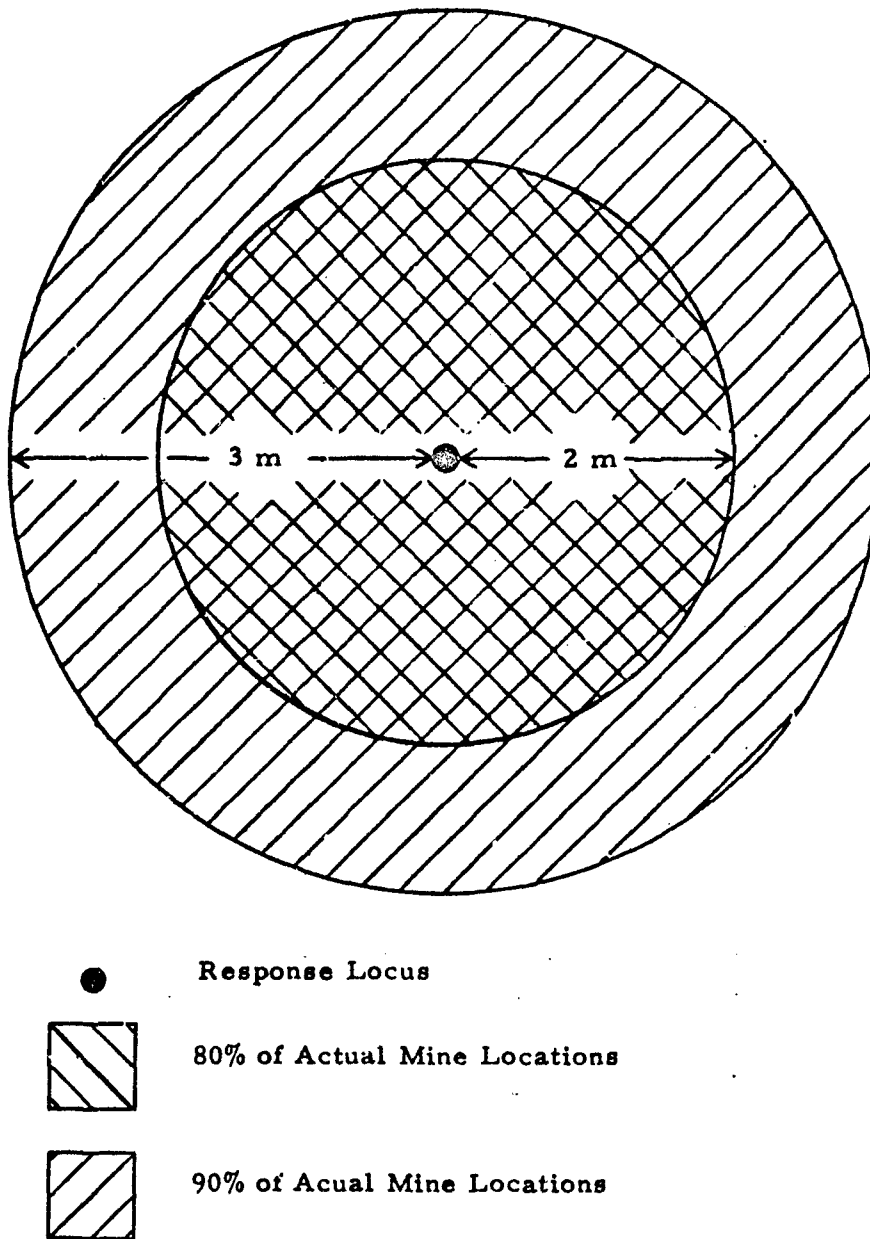
Fig. 27. Distribution of actual mine locations with respect to locus of response.

Overall detection proficiency in novel regions will also be improved if the dog is permitted to engage in several practice sessions on local terrain prior to actual service deployment. Live (defuzed) mines or appropriate surrogate targets may be used for practice exercises.

It is recognized that logistic constraints may not always allow time for recovery, adaptation, and practice purposes. Circumstances permitting, however, these procedures are strongly recommended.

5)   Trail Clearing Operations. The basic procedure for trail clearing involves a sweeping S-pattern in which the dog casts back and forth in tight loops as he proceeds ahead of the handler. The dog should be worked into the wind whenever possible. The handler must set the pace of search maintaining control so that the dog thoroughly covers the pathway or area of interest and does not range ahead too quickly. For obvious reasons, the handler must remain behind the dog at all times never advancing ahead into unscreened territory for any reason. Similarly, the handler must take care not to step on spots which have not been carefully searched.

Although some dogs work effectively off-leash, data available to date suggest that better control can be maintained in the on-leash mode which permits more thorough screening, helps delimit the region of search to areas or pathways of interest, and prevents the dog from ranging ahead too quickly. (Various off-leash command and directional control

systems, e.g., silent vibrotactile signals delivered by radiotelemetry, are currently under study, but require considerable further research and development. The ability to covertly communicate with the detector animal and to completely control its search pattern from a remote, concealed area has obvious advantages in terms of handler safety). If feasible, however, the dog should be worked with a relatively long leash such that a reasonable distance is maintained between animal and handler. Note that if a leash 4 m in length is employed and the dog continuously ranges ahead at this distance, the handler will tend to be positioned outside the region of maximal hazard (see Figure 28). Maintenance of this relationship will significantly reduce the probability of the handler's inadvertently detonating a mine or booby trap with the exception of instances in which (a) a live device is passed by the dog, or (b) the animal has been allowed to develop a habit of backtracking. (The latter practice should have been discouraged in training).

All responses during service deployment must be marked by the handler with a highly visible flag or similar indicator as described previously. These markers serve to warn other troops of the possible presence of a land mine or explosive booby trap (i.e., delineate a region of maximal hazard) and also indicate the approximate locus for subsequent removal or neutralization operations.

Absolute discipline must be enforced at all times during search operations, and the dog must be prevented from jumping over obstacles

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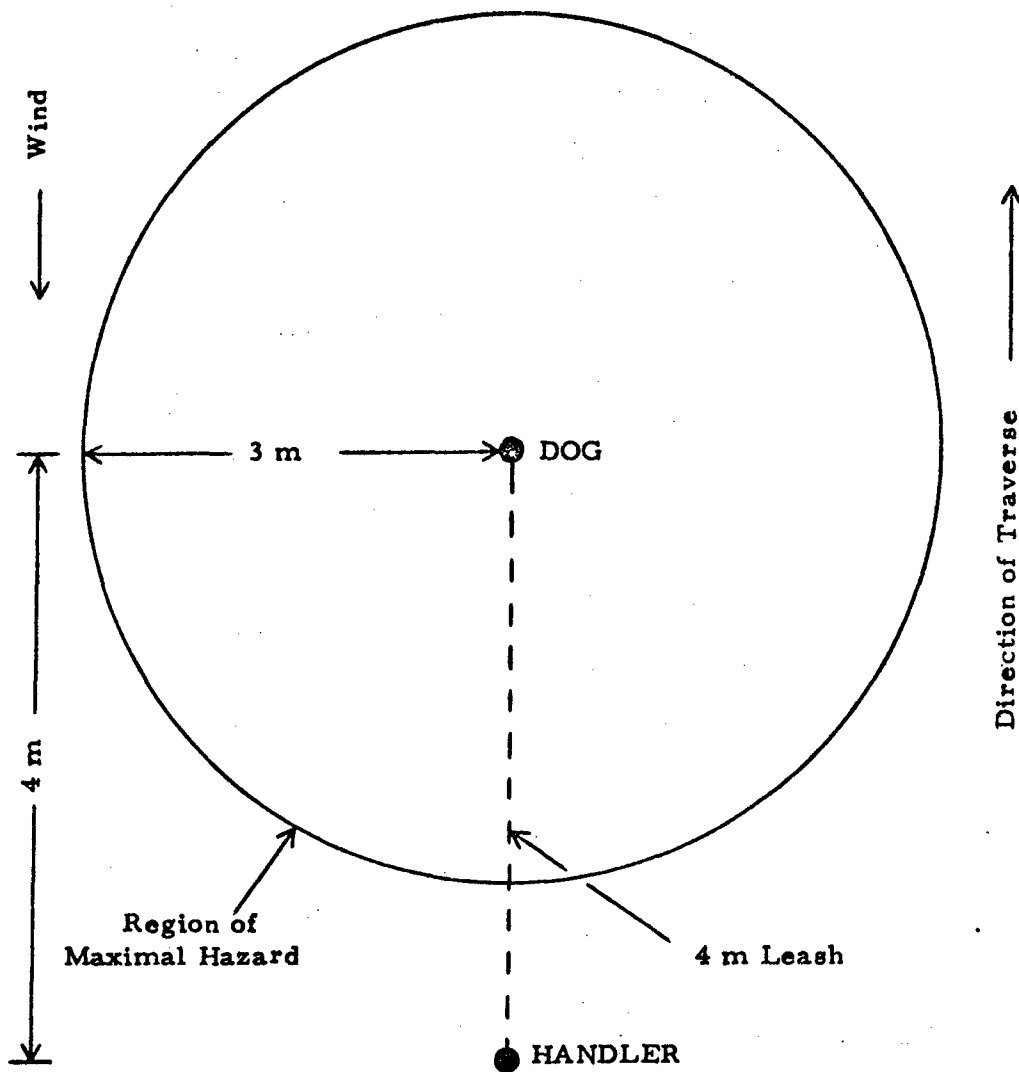
Fig. 28.   Relative positions of dog and handler with respect
to region of maximal hazard during normal traverse.

such as fallen logs, bushes, large rocks, etc. lest he alight on a mine or booby trap concealed on the opposite side.

The handler must constantly observe the dog for subtle behavioral changes or partial alerts. If the animal hesitates or appears uncertain, the area should be marked with warning flags and carefully circumvented. Continued searching of suspicious areas represents an extremely hazardous practice and should be avoided whenever possible.

6)   Roadway Searches. The procedures for searching both unimproved and surfaced roadways are essentially the same as those employed for trail clearing operations. Narrow roads (i.e., 4 m or less) can generally be covered in one pass; wider roads require two or more parallel sweeps. For example, the right lane may be searched first followed by a clearing of the left lane (or vice versa). Both passes must be made in the same direction — into the wind whenever possible. Accordingly, upon completion of the search of one lane, the handler and dog should return to the starting point (taking care to remain in the portion of the road just cleared) and commence a parallel screening of the other lane. The downwind lane must always be searched first in the case of crosswinds.

If it is necessary to clear long stretches of relatively wide roadways, the overall search operation may be broken into pairwise increments. That is, search the left lane (or right lane depending on prevailing

wind conditions) for a distance of 100 m, then return to the starting

point and screen the right lane for the same distance. This sequence

is then repeated (starting at the end of the 100 m interval just cleared)

until the total distance is covered. Note that two dog/handler teams

working parallel lanes will reduce total clearing time by one-half.

However, multiple teams should be staggered by approximately 50 meters

to minimize interference as well as for protection should one team inad-

vertently detonate a mine.

In most instances hard-surfaced roadways can be cleared more

rapidly than their unimproved counterparts since, in the former case, a

knowledgeable handler can visually identify probable mine location sites

(e.g., along the boundary of the road surface and shoulder; in potholes,

craters, or similar breaks in the surfacing material; etc.). Such clues

may not b^ readily apparent on unpaved roads. Shoulder areas must also

be carefully screened.

7)   Railroad Clearing. Railroads are cleared in a manner similar to

that utilized for wide roadways (i.e., multiple parallel passes in the

same direction). The downwind shoulder should be searched first, fol-

lowed by the area bounded by the rails and crossties, and completed with

a third pass over the upwind shoulder.

The most common locations for installing mines in railroad beds

are in the vicinity of culverts, bridges, sharp turns, tunnels, and steep

grades (28). These areas should be searched with particular care.

Note that properly-trained dogs are uniquely suited to railroad mine clearing operations since they do not false alert on the rails or other extraneous metal fixtures as is the case with conventional metal-sensing mine detectors.

8)   <u>Field Breaching</u>. If the objective of the mine detection operation is to clear a corridor through a known or suspected minefield, procedures similar to those used for trail searches are employed. This can be accomplished in one pass if only a narrow pathway is required (e.g., 4 m or less). Wider passages can be developed in multiple parallel passes or by simultaneous deployment of two or more dog/handler teams. The handler should strive to maintain a straight course across the area of interest deviating only to bypass obstacles or suspicious locations.

It is necessary that the lane of safe passage be clearly demarcated in an unambiguous, easily recognized manner. Mine tape, string, or some similar marking system which will provide a continuous line of guidance may be deployed for this purpose by the handler during the course of traverse. Mine tape or string should be securely fastened at frequent intervals (e.g., tied to bushes, weighted down with rocks, fastened with metal pins, etc.) to prevent its displacement by wind or other elements. As always, warning marker flags must be installed at the locus of each response.

9)   Field Clearing.   Total clearing of open fields is normally undertaken in areas not under enemy observation or fire and often follows a simple breaching operation.   Large fields must be cleared by systematic screening of adjacent sectors each approximately 4 m in width and of variable length.   Downwind sectors are always screened first other circumstances permitting.

Sectioning of the field must be accomplished before clearance operations are begun, a procedure which requires that the handler improvise and install a set of reference markers to delineate successive sectors and to guide his movements during the actual search.   The handler should also evaluate the local terrain, establish wind direction, identify unusually suspicious areas, and determine the optimal order in which to screen successive sectors prior to initiating the search.   It will be helpful to draw a rough sketch of the area to guide the clearing oper- ation and to provide a means of recording which sectors have been screened and which have not.   A sample configuration is shown in Figure 29.   A slight overlapping during the search of adjacent sectors is recom- mended to insure that no areas are skipped.

10)   Helicoptor Landing Areas.   A standard sequence is employed during mine clearing of improvised helicoptor landing areas and is discussed and diagrammed in U. S. Army FM 20-32 (28).   A similar system, summarized below, may be used with mine detector dogs:
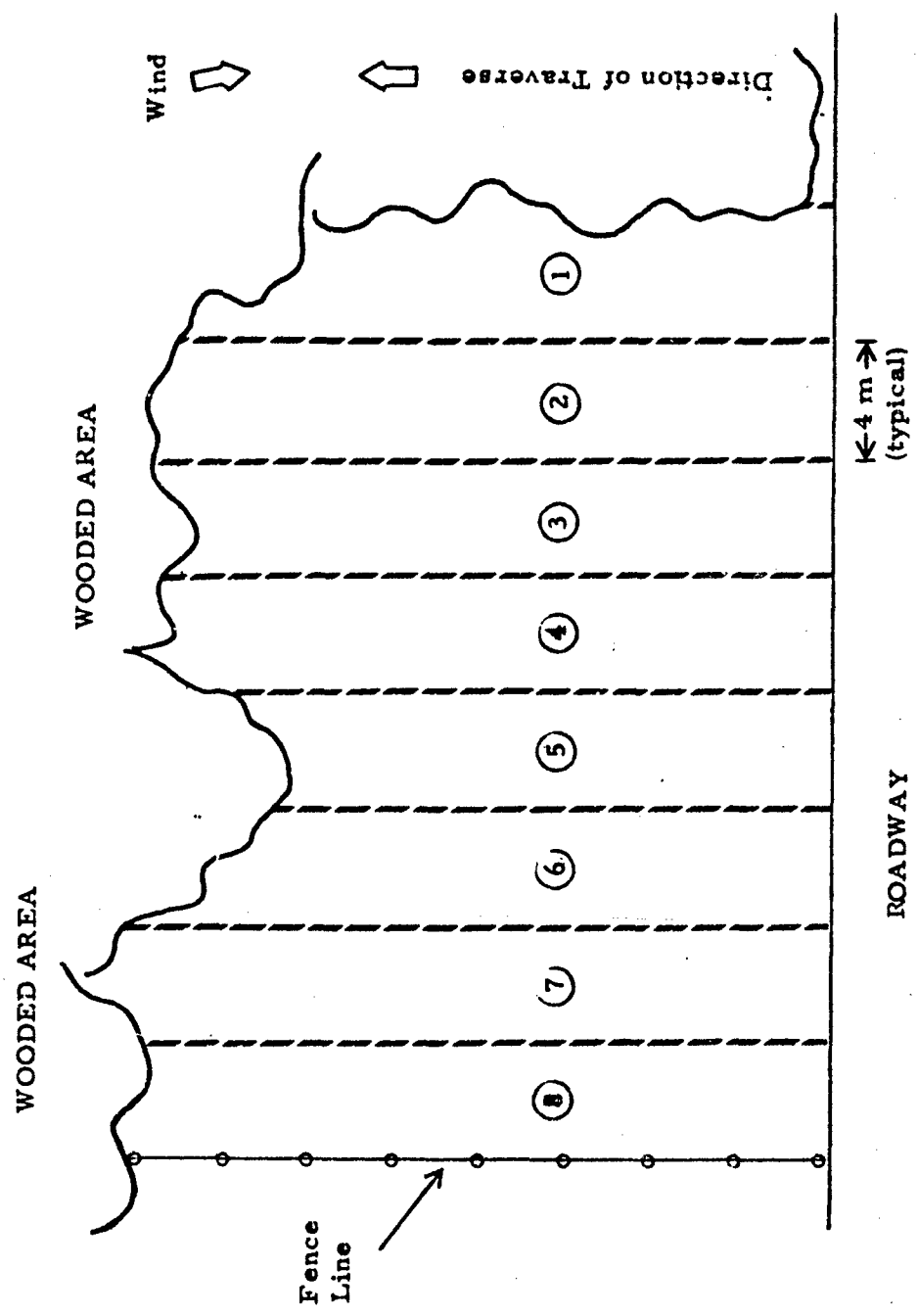
Fig. 29. Sectoring for clearance of open field. Circled numbers indicate correct order of sector clearance. Note wind bearing and indicated direction of traverse.

a) Clear and mark two diagonal strips each 10 m wide across the heliport area.

h) Clear and mark one helipad at the intersection of the diagonal strips.

c) Clear and mark a 5 m wide strip completely around the landing site.

d) Clear and mark additional helicoptor landing pads as space allows.

e) Complete clearance of the remaining area enclosed by the perimeter strip.

11) Response Interpretation. During periods of service deployment the handler will generally have no real-time knowledge as to whether a given alert on the part of the dog is correct (i.e., a response to a live mine) or false (unless the mine is surface-deployed or imperfectly camouflaged). Therefore, the handler must assume that every response is indicative of a hazardous condition; all response sites should be marked with a warning flag for subsequent verification by trained EOD personnel. No response may be dismissed as false unless the reasons are clearly obvious; for example, artillery shell fragments, small arms cartridge cases, spent signal flares, etc.

After installing the marker flag, the handler and dog must move quickly but cautiously out of the radius of maximal hazard and proceed

with the search. The handler should never probe or disturb suspected
mine location sites unless he has had specialized training in the function
and emplacement of land mines and booby traps; EOD support should be
requested. Furthermore, the handler should assume that all mines
regardless of type are booby trapped or equipped with antihandling/anti-
lift devices. It has already been pointed out that repeated searching of
suspicious locations represents an extremely dangerous practice.

The fact that the handler cannot readily ascertain whether a
given response is correct or false during service deployment presents
a special problem in reinforcement. Indiscriminate reinforcement of
all responses does not comprise a viable option since frequent reward
of false alerts will tend to increase the future probability of false re-
sponding. The only acceptable compromise is simply to not reinforce
in the conventional sense any responses which occur during field deploy-
ment. However, the handler may wish to pat the dog on the head,
scratch its ears, or otherwise indicate that he is not displeased by its
performance. In any event, the handler must not communicate a sense
of disapproval following an in-service response. Most highly trained
dogs can tolerate nonreinforcement for a work period of normal length
without a significant adverse effect on performance, and the potentially
beneficial effects of partial reinforcement during training have already
been discussed. Should the handler note a decline in apparent search

efficiency as a function of nonreinforcement (as indexed, for example, by lethargic behavior, loss of apparent enthusiasm, distractability, a need for constant coaxing, etc.), he may wish to temporarily interrupt the search and allow the dog to respond to a surrogate target, followed by lavish reinforcement. This procedure is often effective in restoring lost motivation.

Finally, if the dog has been required to work for extended periods without reinforcement, a reinforced practice session should be conducted as soon as possible to counteract potential extinction effects.

12)   Conditions Affecting Search. The environmental conditions which may affect olfactory detection systems are so many in number and interact in such complex ways that comprehensive treatment of all possibilities becomes virtually impossible. However, the predominant factors include: wind, precipitation, temperature, humidity, and terrain features.

A)   Wind: Wind is probably the single most important factor to be considered by the handler since it may carry the scent of a mine or booby trap a considerable distance from the actual source. Wind tends to disperse odor away from the point of origin in a cone-shaped pattern whose included angle widens inversely with wind velocity as shown in Figure 30. Whenever possible, the dog/handler team should work into the wind. A downwind traverse represents a very risky procedure and should be avoided if possible since, in moderate to strong breezes, the odor cone will disperse downtrail relative to dog and handler. In such a case, it may not be possible for the dog to obtain an adequate olfactory
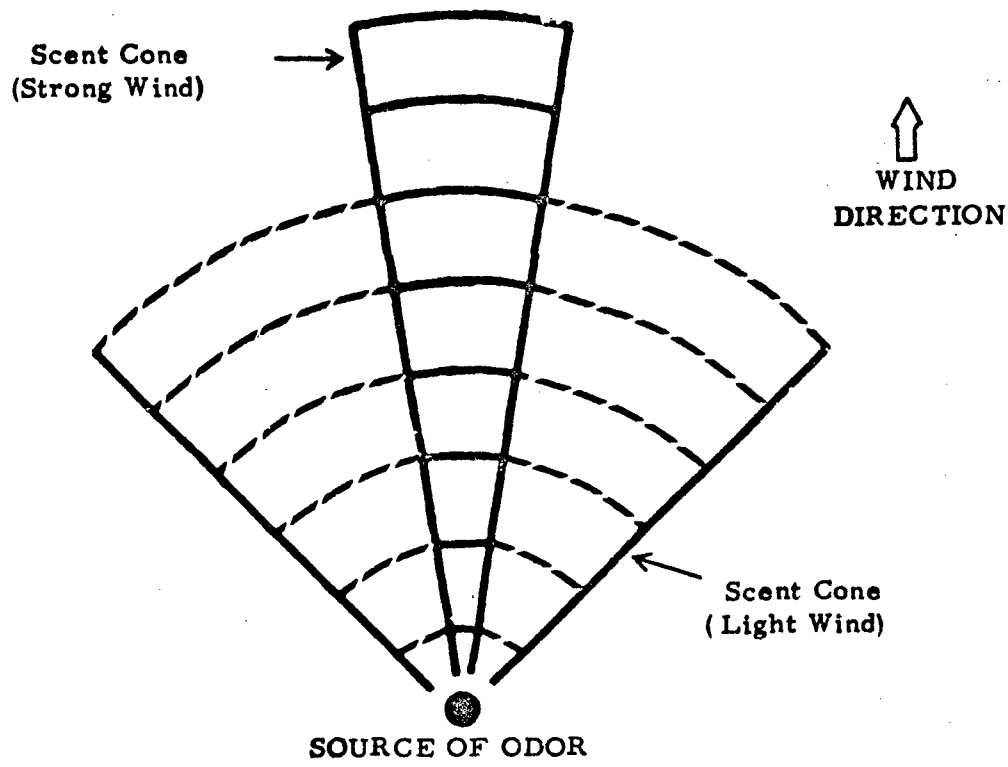
Fig. 30. Dispersal of scent in light and strong winds.

stimulus until after its nose has passed over the mine or booby trap.

Unfortunately, wind effects are notoriously capricious, highly affected by local surface conditions, and thus extremely difficult to assess or predict. Furthermore, the effects of surface eddy currents on the performance of land mine/booby trap detector dogs are not fully understood. In any event, the handler must pay close attention to terrain features, ground cover, as well as natural and man-made obstacles which can influence dispersion of odor. For example, surface irregularities and vegetation may exert a significant local influence on air flow patterns and eddy currents with consequent effects on concentration and dispersal of scent. The handler must learn to recognize these phenomena and use them to advantage whenever possible. He must also develop an accurate sense of wind direction and velocity. If sufficient light is available, wind parameters can be estimated by dropping small bits of grass and watching the direction of drift, or, alternatively, by dangling a 20-25 cm length of light yarn from one end and observing the angle of deflection. These expediencies will be of little use in total darkness however. With practice, most people can learn to judge wind direction fairly accurately by turning the head from side to side and sensing an evaporative cooling effect on the forehead. The latter technique is, of course, effective both day and night.

B)   Precipitation: The ideal surface for olfactory mine detection is an open field comprised of moderately loose, porous soil of medium moisture content and covered with short, damp vegetation. As a general rule, a hard-packed dry surface is thought to have an unfavorable effect

on the retention of overlying scent. However, data collected in tests at Yuma Proving Grounds indicate that well-trained land mine/booby trap detector dogs can perform very successfully despite extremely low soil moisture levels as long as the ground surface is not heavily crusted or compacted.

Finally, heavy rainfall may quickly wash away scent traces, whereas a damp surface due to light rain or dew tends to favor the retention of relevant odors. Experimental studies conducted at Ft. McCoy, WI, have demonstrated that mine detector canines can work with unimpaired proficiency in light rainfall (5).

C) Temperature and Humidity: Experimental studies of land mine/booby trap detector dogs suggest that, other factors equal, optimal detection performance can be expected when the ground surface and overlying air are moderate in temperature. Furthermore, intermediate humidity tends to be associated with improved scent detection. If practical, search missions should be scheduled at times of day which are characterized by an optimal combination of temperature and humidity factors (e.g., early morning, or late afternoon/early evening hours).

13) Effects of Extreme Climates. In order to assess the effects of unusually harsh climates on the performance of land mine/booby trap detector dogs, a series of extensive evaluations was conducted on specially-prepared experimental minefields located at Ft. McCoy, WI, and Yuma Proving Ground (YPG), AZ. Five formal evaluations have been conducted to date:

A) Ft. McCoy, January 1975

B)   Ft. McCoy, February/March 1975

C)   Ft. McCoy, May/June 1975

D)   Yuma Proving Ground, October 1975

E)   Yuma Proving Ground, June 1976

The first two tests at Ft. McCoy were designed to assess detection performance under extremely harsh winter conditions, while the third was conducted as a logical follow-up to examine detection capabilities of the same set of dogs during temperate weather. The YPG evaluations were intended to assess detection proficiency in an extremely hot, arid climate — an objective which was largely subverted during the first YPG mission by an unexpected period of relatively moderate temperatures. Seasonally normal weather conditions prevailed during the second YPG evaluation (June 1976). A total of 11 German Shepherd and 4 Labrador Retriever dogs participated in these evaluations. Further details regarding the first four tests may be found elsewhere (5); a preliminary summary of the second YPG evaluation is given in the pages which follow.

Although data analyses remain incomplete as of this writing, preliminary inspection of the results indicates that harsh winter weather seriously impairs performance whereas favorably high rates of detection can be expected in temperate weather.

A comparison of the animals' performance under the two conditions of climate suggests that heavy snow and ice rather than cold weather per se were the primary causes of the low detection rates scored during the

winter tests. Problems negotiating the deep snow and injuries inflicted by ice crusts appeared to constitute the major sources of difficulty. Few symptoms of distress resulting directly from cold were observed, and the levels of proficiency attained during the May/June Ft. McCoy and October YPG missions (temperate weather) indicate that the animals possess the essential detection capability. Therefore, it is felt that provision of a reasonable interval for physical conditioning/adaptation to snow and ice coupled with a period of training under such conditions would lead to marked improvements in winter performance. It is also recommended that breeds of dogs especially adapted to cold environments be considered for training and deployment in artic or near-artic regions.

The June 1976 YPG hot weather evaluation was conducted on a specially-prepared experimental minefield consisting of 60 lanes each 10 feet (3.048 m) wide and 1300 feet (396.24 m) long (50 formal test lanes and 10 practice lanes). Each lane contained an average of 3 live land mines and/or booby trap trip wires installed at random positions within the lane plus an assortment of inert mines and various distractor items (refilled holes, small arms cartridge cases, oil/gasoline, fertilizer, urine, and canine sex attractant). Each of 15 dogs participated in 7 runs for a total of 105 tests. To preclude potential memory or self-tracking effects, dog/lane assignments were adjusted to insure that no animal received more than one trial on any given lane. Run assignments were also adjusted to eliminate disproportionate frequency of utilization of any lane.

Blind test procedures were employed at all times. That is, the handler was provided no information whatsoever regarding number, type, or location of test targets, and was simply instructed to cause his dog to systematically and thoroughly search the assigned 10-foot wide lane. The handler was also required to place a small response marker flag at the locus of each sit response regardless of whether that response proved to be a correct detection or a false alarm.

An evaluator or "scoretaker" followed the dog handler/team at an average distance of 10 meters, trying whenever possible to remain slightly outside the left edge of the test lane in order to minimize extraneous odor contamination. In addition to his data recording duties, the scoretaker provided verbal guidance to the handler to prevent loss of directional orientation and to assure that the full width of the test lane was covered on every search sweep.

Information regarding target types and coordinate locations was issued to the evaluator immediately prior to the initiation of a given lane search, but not before. These data were used to permit wind readings at passed targets and to provide feedback to the handler as to whether a given response was correct or false so that appropriate rewards could be delivered to the dog in real time. Response feedback information was given only after the response had been completed and marked by the handler.

Raw data recorded by the evaluator included X and Y coordinates of all responses (whether correct or incorrect), wind direction and velocity, and various other weather parameters. A notation was also made to indicate presence of a booby trap trip wire. If the dog proceeded down trail, reversed course, and subsequently responded by sitting, the maximum distance of "target overrun" was estimated and recorded (termed "Y overrun" on data sheet). A sample data sheet is reproduced on pages 212 and 213.

In order to control for the effects of wind direction, each run was accomplished in two segments of 650' (198.12 m) each. Specifically, a search trial started at stake "0" and proceeded downtrail until the midpoint was reached (198.12 m). Thereupon, the test team moved into a buffer zone separating adjacent lanes and walked directly to the far end of the experimental field. After a short rest break, the search was resumed and continued in the opposite direction until the midpoint was encountered once again. Having thus covered the entire length of the relevant lane, the trial was terminated.

Although formal analyses of the June 1976 hot weather data are incomplete and will be reported elsewhere, a preliminary summary of the results (using a 3-meter allowable radius of detection) appears in Table 6 which displays mean detection performance as a function of day of evaluation. Day-by-day performance breakdowns presented in terms of individual dog and test lane number are shown in Tables 7 - 16.

MINE DETECTION DATA SHEET

(Page 1 of 2)

ETP-76-2
SwRL/USAMERDC

CONTRACT NO. DAAK02-73-C-015u

Evaluation Site: _____ Date: _____ Time of Day(start): _____

Dog: _____ Breed: _____ Sex: _____ Lane No.: _____

Handler: _____ Evaluator: _____ Group: _____ Reinforcement _____

Soil Moisture: _____% at _____ (time of day).

Soil Characteristics:

	START	FINISH
_____ Gravel/Shale	Ground Surface Temp. _____	_____
_____ Sand	Temp. 12" Above Surface _____	_____
_____ Clay	Temp. 36" Above Surface _____	_____
_____ Loam	Relative Humidity _____	_____
_____ Hardpacked	Barometric Pressure _____	_____
_____ Other, specify _____		
_____		

Surface Conditions (rain, mud, etc.) _____

Total Elapsed Search Time _____ Minutes

Start Time (1st half): _____
Stop Time (1st half): _____
Elapsed Time (1st half): _____

** Take Wind Reading @ Ground Level Once During Run. Enter in Comment Column.

FIRST 650 FEET (Stakes 0-65)

Response			Trip Wire E = present	Wind		Stake No.	Comments	Response Reinforced?
Y coordinate	Y overrun (Maximum)	X coordinate		Bearing	MPH			

Start time (2nd half): _____
Stop time (2nd half): _____
Elapsed time (2nd half): _____

Dog's Name: _____

Lane No.: _____

Date: _____

(Page 2 of 2)

SECOND 660 FEET (Stakes 130 - 65)

Response			Trip Wire E = Present	Wind		Stake No.	Comments	Response Reinforced?
Y coordinate	Y overrun (Maximum)	X coordinate		Bearing	MPH			

TABLE 6

Overall Performance Summary
YPG Canine Land Mine/Booby Trap Detection Evaluation

Date	Detection Performance *	Percentage Detections **
6/8/76	31/33	93.94
6/9/76	29/32	90.63
6/10/76	31/35	88.57
6/11/76	30/33	90.91
6/12/76	30/31	96.77
6/14/76	27/32	84.38
6/15/76	33/35	94.29
6/16/76	27/29	93.10
6/17/76	26/26	100.00
6/18/76	34/36	94.44
OVERALL	(298/322)	(92.55)

* Number Correct Detections/Number live mines.

** Three-meter allowable radius of detection used for all computations.

TABLE 7

Daily Performance Summary, June 8 , 1976
YPG Canine Land Mine/Booby Trap Detection Evaluation

Dog	Lane No.	Detection Performance *	Percentage Detections **
Tiger	4	1/2	50
Apache	9	4/4	100
Rex	14	1/1	100
Duncan	19	3/3	100
Ernie	22	4/4	100
Warp	29	2/2	100
Eve	34	2/3	67
Val	39	4/4	100
Quickie	44	4/4	100
Dusky	49	1/1	100
Casey	45	5/5	100
TOTAL		(31/33)	(93. 94)

*Number Correct Detections/Number live mines per lane.

**Three-meter allowable radius of detection used for all computations.

TABLE 8

Daily Performance Summary, June 9 , 1976
YPG Canine Land Mine/Booby Trap Detection Evaluation

Dog	Lane No.	Detection Performance *	Percentage Detections **
Angus	7	2/2	100
Bretta	1	6/6	100
Winchester	12	2/3	67
Whop	17	3/3	100
Tiger	24	4/4	100
Apache	27	1/1	100
Rex	32	1/1	100
Duncan	37	5/5	100
Ernie	42	1/1	100
Warp	47	1/1	100
Val	15	3/5	60
TOTAL		(29/32)	(90. 63)

*Number Correct Detections/Number live mines per lane.

**Three-meter allowable radius of detection used for all computations.

TABLE 9

Daily Performance Summary, June 10, 1976
YPG Canine Land Mine/Booby Trap Detection Evaluation

Dog	Lane No.	Detection Performance *	Percentage Detections **
Quickie	2	2/3	67
Casey	6	3/4	75
Dusky	11	2/2	100
Angus	16	1/1	100
Bretta	21	3/3	100
Winchester	28	5/6	83
Whop	33	2/2	100
Tiger	38	6/6	100
Apache	43	3/3	100
Eve	48	3/4	75
Ernie	18	1/1	100
TOTAL		(31/35)	(88.57)

*Number Correct Detections/Number live mines per lane.

**Three-meter allowable radius of detection used for all computations.

TABLE 10

Daily Performance Summary, June 11, 1976
YPG Canine Land Mine/Booby Trap Detection Evaluation

Dog	Lane No.	Detection Performance *	Percentage Detections **
Rex	3	2/3	67
Duncan	8	2/3	67
Eve	13	3/3	100
Warp	20	3/4	75
Val	25	4/4	100
Quickie	30	1/1	100
Casey	35	3/3	100
Dusky	40	5/5	100
Angus	46	2/2	100
Bretta	26	3/3	100
Winchester	50	2/2	100
TOTAL		(30/33)	(90.91)

*Number Correct Detections/Number live mines per lane.

**Three-meter allowable radius of detection used for all computations.

TABLE 11

Daily Performance Summary, June 12, 1976
YPG Canine Land Mine/Booby Trap Detection Evaluation

Dog	Lane No.	Detection Performance *	Percentage Detections **
Whop	5	2/2	100
Tiger	10	3/4	75
Apache	15	5/5	100
Rex	22	4/4	100
Duncan	27	1/1	100
Warp	32	1/1	100
Ernie	36	2/2	100
Eve	41	4/4	100
Val	45	5/5	100
Quickie	29	2/2	100
Angus	49	1/1	100
TOTAL		(30/31)	(96.77)

*Number Correct Detections/Number live mines per lane.

** Three-meter allowable radius of detection used for all computations.

TABLE 12

Daily Performance Summary, June 14, 1976
YPG Canine Land Mine/Booby Trap Detection Evaluation

Dog	Lane No.	Detection Performance *	Percentage Detections**
Dusky	4	2/2	100
Duncan	9	3/4	75
Winchester	14	1/1	100
Whop	21	3/3	100
Ernie	25	3/4	75
Rex	38	5/6	83
Bretta	43	3/3	100
Casey	31	2/2	100
Apache	48	2/4	50
Tiger	34	3/3	100
TOTAL		(27/32)	(84.38)

*Number Correct Detections/Number live mines per lane.

**Three-meter allowable radius of detection used for all computations.

TABLE 13

Daily Performance Summary, June 15, 1976
YPG Canine Land Mine/Booby Trap Detection Evaluation

Dog	Lane No.	Detection Performance *	Percentage Detections **
Eve	1	6/6	100
Val	6	3/4	75
Quickie	12	3/3	100
Casey	17	3/3	100
Dusky	23	4/4	100
Angus	47	1/1	100
Bretta	33	2/2	100
Winchester	37	5/5	100
Whop	42	1/1	100
Tiger	28	5/6	83
TOTAL		(33/35)	(94.29)

*Number Correct Detections/Number live mines per lane.

**Three-meter allowable radius of detection used for all computations.

TABLE 14

Daily Performance Summary, June 16, 1976
YPG Canine Land Mine/Booby Trap Detection Evaluation

Dog	Lane No.	Detection Performance *	Percentage Detections **
Apache	7	2/2	100
Rex	2	1/3	33
Duncan	13	3/3	100
Ernie	19	3/3	100
Warp	24	4/4	100
Eve	36	2/2	100
Val	31	2/2	100
Quickie	41	4/4	100
Casey	44	4/4	100
Dusky	50	2/2	100
TOTAL		(27/29)	(93.10)

*Number Correct Detections/Number live mines per lane.

**Three-meter allowable radius of detection used for all computations.

TABLE 15

Daily Performance Summary, June 17, 1976
YPG Canine Land Mine/Booby Trap Detection Evaluation

Dog	Lane No.	Detection Performance *	Percentage Detections **
Angus	3	3/3	100
Bretta	11	2/2	100
Winchester	20	4/4	100
Whop	8	3/3	100
Tiger	16	1/1	100
Apache	46	2/2	100
Rex	26	3/3	100
Duncan	30	1/1	100
Ernie	35	3/3	100
Warp	39	4/4	100
TOTAL		(26/26)	(100.00)

*Number Correct Detections/Number live mines per lane.

** Three-meter allowable radius of detection used for all computations.

TABLE 16

Daily Performance Summary, June 18, 1976
YPG Canine Land Mine/Booby Trap Detection Evaluation

Dog	Lane No.	Detection Performance *	Percentage Detections **
Eve	10	3/4	75
Val	5	1/2	50
Quickie	23	4/4	100
Casey	18	1/1	100
Dusky	29	2/2	100
Angus	34	3/3	100
Bretta	45	5/5	100
Winchester	40	5/5	100
Whop	48	4/4	100
Warp	38	6/6	100
TOTAL		(34/36)	(94.44)

*Number Correct Detections/Number live mines per lane.

** Three-meter allowable radius of detection used for all computations.

As may be seen in Table 6, daily performance ranged from a low of 84. 38% to a high of 100% with an overall mean detection rate of 92. 55%. This degree of detection proficiency is considered highly gratifying and compares extremely favorably with other types of detectors now available — particularly those intended for use against non-metallic land mines.

Table 17 presents the mean performance of each of the 15 dogs participating in the June 1976 YPG evaluation. Inspection of the table indicates that only 4 animals scored lower than 90% correct detection (lowest detection rate = 80. 95%) and that 4 dogs maintained perfect detection scores (100%) throughout the 10 - day test sequence — a degree of proficiency exceeding that observed in all previous evaluation missions. It should be noted that symptoms of overheating were observed in a number of cases, but no dog was unable to success- fully complete a given search trial due to this effect. However, it would appear that large quantities of water and additional rest breaks must be provided for land mine/booby trap detector canines deployed in hot, arid climates.

Finally, in order to assess detection efficiency against AT mines deployed at abnormal depths, 10 M19 and 5 M15 mines were installed at depths of 6" (15. 24 cm), 9" (22. 86 cm), and 12" (30. 48 cm) on practice lanes 51-55. (Lanes 1-50 were not used for this purpose to prevent potential con- tamination of the primary evaluation data). Each of the 15 dogs received an

TABLE 17

Mean Detection Performance for Each of 15 Dogs
YPG Canine Land Mine/Booby Trap Detection Evaluation, June 1976

Dog	Detection Performance*	Percentage Detection**
Angus	13/13	100.00
Apache	19/21	90.48
Bretta	24/24	100.00
Casey	21/22	95.45
Duncan	18/20	90.00
Dusky	18/18	100.00
Ernie	17/18	94.44
Eve	23/26	88.46
Quickie	20/21	95.24
Rex	17/21	80.95
Tiger	23/26	88.46
Val	22/26	84.62
Warp	21/22	95.45
Whop	18/18	100.00
Winchester	24/26	92.31
OVERALL	(298/322)	(92.55)

*Number correct detections/number live mines.
**Three-meter allowable radius of detection used for all computations.

additional special run on one of these 5 lanes during the June 1976

YPG evaluation. The results of these supplemental trials are shown

in Table 18 which reveals an overall detection rate of 96.43% against

all live mines on lanes 51-55. (Lanes 51-55 included a random

assortment of AT and AP mines deployed at normal depths as well

as 3 each AT mines at depths of 6", 9", or 12"). Surprisingly,

none of the AT mines installed at abnormal depths went undetected

as shown in Table 19; the three detection failures which were observed

during the special depth tests occurred to mines deployed at normal

distances below the surface. Although suggestive of the potential

capabilities of well-trained land mine/booby trap detector canines,

the present depth-of-detection data are extremely limited and must

be interpreted with caution in view of two potential sources of con-

founding. First, the 15 abnormally-deep AT mines were installed

only a few days prior to testing whereas all other mines had been

implanted approximately 8 months earlier. Second, lanes 51-55

were employed for preliminary practice sessions and may have been

contaminated due to excessive utilization. Either or both of these

factors may have contributed to the dogs' unexpectedly high rate of

detection of mines deployed at 6", 9", and 12" as observed during

the special series of depth-of-deployment trials. Additional depth

experiments involving systematic manipulation of time since implan-

tation and frequency of lane utilization are recommended.

TABLE 18

Performance Summary
Special Runs: Depth of Implantation Tests
YPG Canine Land Mine/Booby Trap
Detection Evaluation, June 1976

Dog	Lane No.	Detection Performance *+	Percentage Detections **
Angus	55	8/8	100
Apache	55	8/8	100
Bretta	51	4/5	80
Casey	52	6/6	100
Duncan	52	6/6	100
Dusky	53	5/5	100
Ernie	53	5/5	100
Eve	52	6/6	100
Quickie	51	4/5	80
Rex	51	4/5	80
Tiger	55	8/8	100
Val	53	5/5	100
Warp	54	4/4	100
Whop	54	4/4	100
Winchester	54	4/4	100
TOTAL		(81/84)	(96.43)

*Number correct detections/number live mines.

+Includes mines deployed at normal depths as well as those installed at 6",
9", and 12".

**Three-meter allowable radius of detection used for all computations.

TABLE 19

Performance Summary
Special Runs: Detection of M15 and M19 Mines Deployed at Abnormal Depths
YPG Canine Land Mine/Booby Trap Detection Evaluation, June 1976

Depth of Deployment	Detection Performance *	Percentage Detection**
6" (15.24 cm)	15/15	100
9" (22.86 cm)	15/15	100
12" (30.48 cm)	15/15	100
OVERALL	(45/45)	(100)

*Number correct detections/number of live mines.

**Three-meter allowable radius of detection used for all computations.

14)   <u>Motivation.</u> The handler must attend carefully to the general performance and motivation of his dog. Flagging motivation can frequently be improved by rest periods or the use of incentive or surrogate targets. If motivation remains at a low level, the animal should be examined for illness or other symptoms of physical distress.

15)   <u>The Multipurpose Concept.</u> Olfactory detection by canines of land mines and bocby traps is an extraordinarily complex task and, as has been seen, requires extensive and sophisticated training. The consequences of a lapse in performance, however momentary, can be severe for both dog and handler, and nothing in the dog's training history or mode of deployment should be permitted to encourage this eventuality. For this reason, the concept of a multipurpose military dog (i.e., an animal which can perform detection, sentry, patrol and related tasks) is strongly discouraged. While it is true that animals can be trained to execute a variety of unrelated tasks, it is equally well known that maximal performance on any one task will be obtained if training is concentrated on that unique problem. Specific difficulties which may be anticipated in the multiple training approach include:

A)   Task competition or interference.

B)   Protracted training time.

C)   Production of aggressive tendencies undesirable in certain applications (viz., mine detection).

Furthermore, a dog deployed in mine clearing operations is likely to attend to and be distracted by extraneous activities and personnel if it has also been trained for patrol and sentry duties. In short, a dog selected for land mine/booby trap detection service should be trained for that purpose and that purpose only.

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