Research Note 84-25

MEMORY ORGANIZATION-BASED METHODS OF INSTRUCTION: RATIONALE AND DEVELOPMENT

R. Gene Hoffman
Human Resources Research Organization

John E. Morrison, Contracting Officer's Representative

Submitted by

Donald F. Haggard, Chief
ARI FIELD UNIT AT FORT KNOX, KENTUCKY

and

Harold F. O'Neil, Jr., Director
TRAINING RESEARCH LABORATORY

U. S. Army

Research Institute for the Behavioral and Social Sciences

January 1984

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Research Note 84-25	2. GOVT ACCESSION NO. AD-A137504	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* MEMORY ORGANIZATION-BASED METHODS OF INSTRUCTION: RATIONALE AND DEVELOPMENT		5. TYPE OF REPORT & PERIOD COVERED Interim Report Feb. 83-Aug 83
		6. PERFORMING ORG. REPORT NUMBER --
7. AUTHOR(s) R. Gene Hoffman		8. CONTRACT OR GRANT NUMBER(s) MDA903-80-C-0223
9. PERFORMING ORGANIZATION NAME AND ADDRESS Human Resources Research Organization 1100 South Washington Street Alexandria, Virginia 22314		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q263743A794
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Ave., Alexandria, VA 22333		12. REPORT DATE January 1984 13. NUMBER OF PAGES 228
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)* --		15. SECURITY CLASS. *(of this report)* Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE --

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

--

18. SUPPLEMENTARY NOTES

Research performed by HumRRO, Fort Knox Office, P.O. Box 293, Fort Knox, Kentucky 40121, and monitored by John Morrison, ARI Field Unit at Fort Knox.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Memory (Psychology)	Military training	Job training
Recall	Army training	
Retention (Psychology)	Teaching methods	

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

An effort was made to improve training techniques in order to increase retention of procedural tasks common to armor crewmen. Based on an overview of principles of cognitive, information processing psychology concerning the structuring of information in memory and on research using various memory organization mnemonics, a general training strategy was described. The strategy began with a systematic structure analysis of tasks to be trained. Training was then designed to give students the organizing structure to aid

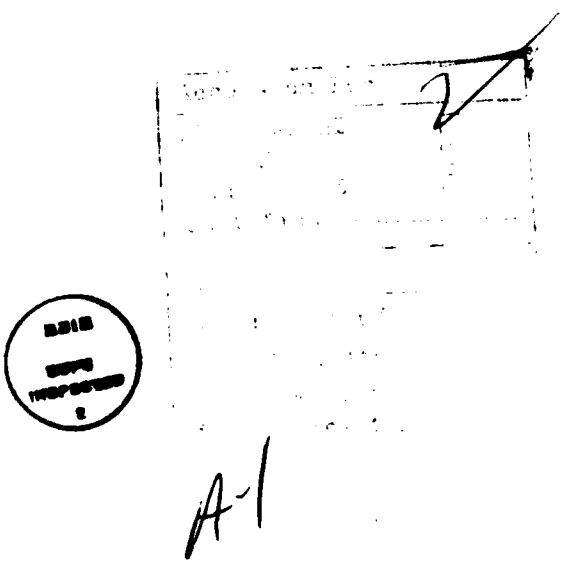
DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

20 (continued).

their recall of the task. Two alternative strategies for presenting the structure were developed: one in which the structure guided the presentation from the beginning of training, and one in which students were first allowed to have hands-on exposure to the task before being given the structure information. Training programs using these two training strategies, along with programs using the Army's standard performance-oriented training strategy were developed for four tasks performed by M1 (Abrams) tank crew members.



A-1

MEMORY ORGANIZATION-BASED METHODS OF INSTRUCTION:
RATIONALE AND DEVELOPMENT

CONTENTS

LIST OF TABLES

LIST OF FIGURES

MEMORY ORGANIZATION-BASED METHODS OF INSTRUCTION: RATIONALE AND DEVELOPMENT

INTRODUCTION

As new equipment is introduced into the Army's arsenal, training developers are confronted with the task of providing instruction for operating this equipment. One piece of equipment which has recently been introduced, the M1 (Abrams) tank, is a highly sophisticated, technologically advanced weapon system whose operation and maintenance requires a large number of systematic procedures. Task analyses conducted by HumRRO and ARI (Harris, Campbell, Kraemer, & Bessemer, 1980; Yore, Drucker, & O'Brien, 1981) detail the number of procedures required for M1 crew members. The magnitude of the training problem is exemplified by the relatively large number of tasks (68) which are performed by the loader, most of which are procedural in nature. Many of these tasks require specific responses for the tank to function properly.

Soldiers entering the Army and those in many of the advanced courses are instructed by a training strategy introduced a decade ago called performance-oriented training (How to Prepare and Conduct Training, DA Field Manual 21-6). Performance-oriented training (POT) streamlines the instructional process material by eliminating abstract and theoretical material that is peripheral to the execution of the task being taught. A central premise of this method of instruction is that learning is most effective when the student is actively engaged in the process of learning. The emphasis is on doing, that is, on practicing the steps of a task rather than on less relevant activities such as listening to an instructor talk about the task or on watching another person perform the task. Little time is devoted to explaining why a procedure must be performed in a particular way. Learning and retention of the procedure is expected to follow from repetition of the task during practice.

With its emphasis on practice of specific behaviors in response to specific cues, POT has as its genesis the learning theory tradition of behaviorism or associationism. This tradition emphasizes that memory of a task can be viewed as a series of pair-wise stimulus-response connections (Estes, 1976). These stimulus-response (S-R) connections are strengthened by repeated presentation of the stimulus with reinforcement or feedback given for correct responses. Thus, procedures are treated as chains of stimulus-response associations, with each response being the stimulus for the succeeding response until the procedure is complete (Cox & Boren, 1965; Gagne, 1965). In contrast, and arising in reaction to the behaviorist tradition is the information processing or cognitive approach (Diewert & Stelmach, 1978; Estes, 1976; Glaser, 1982). For the purposes of the present research, the primary difference is that in the cognitive approach, attempts are made to understand the cognitive or inferred mental processes that operate during learning and performance (Estes, 1976). Glaser (1982) has argued that although associationist approaches still tend to dominate applied learning strategies, cognitive psychology has become the dominant force in theoretical psychology. The focus of this research is on an application of theoretical cognitive psychology to an applied learning situation, specifically the instruction of armor procedural tasks with the expectation that acquisition and retention can be enhanced.

Before continuing it should be noted that S-R behavior theory, in general, is not viewed from a cognitive approach as incorrect, but rather as incomplete (Estes, 1976). That is, the cognitive approach argues that while we are learning S-R connections, we are also organizing those connections in memory in such a way as to facilitate retrieval of the connections. In the same way, POT may not be wrong, but it may be possible to improve POT by adding memory organization information to the basic POT instructional strategy.

This report will begin with a brief review of the research supporting the importance of memory organization in recall. It will then focus on methods and results of analysis of memory organization for armor procedural tasks. These tasks were used in an experimental evaluation of training which is augmented with memory organization information. Following a discussion of the task analyses, alternative training strategies which were used to present the memory organization information will be discussed. Finally, detailed specifications for training programs will be presented in the Appendixes. Results of the experimental evaluation of the training programs are reported in Hoffman, Drucker, Morrison, and Goldberg (in preparation).

THE COGNITIVE STRUCTURE OF MEMORY

Central to the study of the cognitive organization of memory has been the concept of clustering, and the related concept of subjective organization. Clustering is the tendency during or following learning to recall together items which are somehow related even though there is no requirement to do so (Shuell, 1969). Tulving's (1962) work is often cited (e.g., Diewert & Stelmach, 1978; Puff, 1979) for the discovery that subjects who are presented with seemingly unrelated words to learn, cluster the words. This clustering is called "subjective organization." That is, with each successive trial in a multitrial experiment, a subject's recall order becomes progressively more organized, even when the order of word presentation is random.

It is this tendency to cognitively organize information and the subsequent increase in recall capacity (Shuell, 1969) which leads to the suggestion that learning a procedural task may be related to the development of a cognitive organization of the steps of the procedure. For example, Glaser (1982) and Gilmartin, Newell, and Simon (1975) have suggested that novices and experts differ in their performance of various tasks due to how well they have organized task information in memory. Presumably experts' task proficiency is related to the accessibility of task information facilitated by an efficient organizational (Schvanelveltd, Goldsmith, Durso, Maxwell, & Acosta, 1982) schema for the information. The process of organizing takes time (Schvanelveltd, et al. 1982), and Pellegrino and Ingram (1979) have argued that it probably does not stabilize until "relatively late" during the learning process. In addition, persons apparently vary in their ability to effectively organize task information. For example, Weinstein, Underwood, Wicker and Cubberly (1979) found that Army recruits with high school educations or less tended to use less elaborate strategies for organizing task information than did those with more education. In addition, Glaser (1982) has suggested that the ability to efficiently organize material in memory may be one of the cognitive factors that underlies the relationship between traditional assessments of scholastic aptitude with measures of learning and

performance. Thus, for all individuals, organization of material is a process which develops over time, and for low aptitude persons, that development may be particularly time consuming.

In order to improve training, instructional techniques may be designed to facilitate the development of cognitive task organizations. As a result, long-term performance may be improved, either from a direct effect of organization on retention (i.e., well organized material may be forgotten less quickly) or from improved initial acquisition (i.e., the task is learned better during the training period.).

Types of Organization

Much of the work in the area of memory organization has been concerned with elaborating the different types of strategies that might underlie organizing and clustering information (e.g., Battig & Bellezza, 1979, G. Mandler, 1979; J. Mandler, 1979; Shuell, 1969). G. Mandler (1979) has reduced the number of types of memory organizing strategies to three structures: coordinate, subordinate and proordinate. Memory organized as a coordinate structure implies that the relationships between pairs of items form the basis of a cluster, and that because of the limits on active memory, the size of these clusters is limited to as few as three items which are all related to each other in a similar manner. Subordinate structures are those in which items are clustered together because of common relationships to a superordinate (e.g., more abstract) concept. Proordinate structures are items clustered by temporal or spatial relationships. For both subordinate and proordinate structures, Mandler suggested that the number of items in any cluster is likely to be no more than five. Regardless of the type of organizing strategy used to form clusters, these clusters can themselves be organized in memory with any of the same three organizing strategies. That is, clustering of information has a hierarchical character and the type of organizing strategy can vary between levels of the hierarchy.

J. Mandler (1979) has distinguished two types of memory organization based on the type of stimuli being learned. Categorical organization refers to clusters of items based on class membership. Schematic organization refers to clusters of spatially or temporally related items. Procedural memory would seem to fit schematic organization rather than categorical organization. An important feature of schematic organization is the postulated existence of general schemata or sets of expectations about how things are ordered or what they look like. That is, we might have a general concept of a kitchen (to use Mandler's example) or a conventional ballistic weapon (to use a military example). Common sequences of events may also be represented as a general schema (Abelson, 1981). These schemata may influence our reaction to a new situation, event, or object.

Top-down Versus Bottom-up

Based on his review of the research, Shuell (1969) suggested that there is probably a variety of dimensions along which informational items being learned might be clustered. Similarly, J. Mandler (1979) in describing categorical organizing structures indicated that any judgment dimension (e.g.,

size, weight) on which items may be similar can be used to cluster items. Furthermore, "when an obvious form of organization is provided...the subject will usually use the organization provided. When no obvious form of organization is provided...the subject will find more subtle forms of organization to use" (Shuell, 1969, p 367).

Two learning tasks are apparent in these statements: (1) selecting an organizing strategy, and (2) applying the strategy to the items or material to be learned. Whether an organizing strategy is apparent in a set of material depends on the background of the individual learning the material. That is, learners can adapt structures which were previously mastered and whose characteristics match the material to be learned. In describing memory for semantic material, Ehrlich (1979) described these preexisting structures as permanent memory. Similarly, J. Mandler (1979) postulated the existence of general schemata. A general schema is a conceptual framework applicable to a variety of specific events or phenomenon. The existence of such structures implies that the major effort in learning new material is to code that material using the existing structure. J. Mandler (1979) termed this top-down processing. On the other hand, when no relevant schemata or permanent structures exist (as in the case of learning unrelated words), a bottom-up processing takes place. That is, in what may be viewed as a bootstrap process, a structure must be developed, and at the same time, the to-be-learned material must be coded into it. For training design, the implication is that learning may be facilitated to the extent that (1) general schemata based on prior experiences of individuals are utilized for learning new material (Glaser, 1982), or (2) memory organization mnemonics are presented which help students develop memory structures (Battig & Bellezza, 1979). A number of studies have been conducted using military personnel and/or military type tasks to examine the potential of teaching memory organization mnemonics to increase training effectiveness.

Military Applications of Memory Organization Mnemonics

Several studies have used the keyword or pegword mnemonic. Griffith and Actkinson (1978) taught army enlisted soldiers pegwords that rhymed with the numbers one to ten. These subjects then learned three separate lists of ten words each. For each word, subjects were instructed to form a mental image associating the pegword and the word to be learned. For example, bun was the pegword rhymed with one, and helicopter was the first word to be learned. Thus, a subject might have pictured a helicopter sandwich on a bun. After a fixed length practice interval, subjects were then presented with a sheet of paper with the numbers from one to ten listed. They were asked to recall as many of the 30 words to be learned as they could. Control subjects learned the lists of words without instruction in the use of pegwords. In general, results showed that only high aptitude soldiers (Armed Services Vocational Aptitude Battery, General Technical scores greater than 110) were able to use the pegwords to an advantage. Repeated use of a pegword, however, reduced memory for initially learned items even for those soldiers who were able to use the pegword mnemonic.

Griffith (1980) conducted another study using keywords and the mental images mnemonic. This time he examined acquisition of foreign language vocabulary. The mnemonic was the presentation of sound-alike English words

for each of a number of Korean words concerning military concepts or equipment. Army enlisted soldiers were instructed to form a mental image linking the English meanings of each Korean word to their respective keywords. Griffith (1980) speculated that the aptitude effect found earlier on the effectiveness of this type of mnemonic may have been the result of the controlled time interval for practice. For this study, learning of the Korean word meanings was self-paced, and results showed significant main effects for the use of the imagery mnemonic. Aptitude level was also significant but there were no interactions. Thus, soldiers at all aptitude levels presented with keywords learned the Korean words better than soldiers not presented with keywords. In addition, two different lists of Korean words were used in the study. One list was more difficult to learn than the other, but the imagery technique worked equally well for both lists.

Weinstein, Rood, Roper, Underwood and Wicker (1980) examined several mnemonic techniques. One was the type of mental imagery strategy examined by Griffith (1980) and Griffith and Actkinson (1978). A second technique was verbal elaboration, similar to the mental imagery strategy except that to-be-learned material was linked with verbal associations rather than imagined pictures. The final technique was grouping, which is an application of categorical clustering. Army enlisted subjects received a concentrated (90 minute) presentation on the use of these three strategies. The subjects were then given practice in applying them to reading comprehension tasks. Testing consisted of a free recall test, a paired associate test and two reading comprehension tests, all repeated at two different intervals (3 and 12 days) following training. No differences were found on any of the tests between soldiers who learned the mnemonics and those who did not.

The research conducted by Weinstein et al. (1980) is interesting in that it points to some potential boundaries in the use of memory organization mnemonics. Subjects were given only minimal group practice and no structured individual practice in using the mnemonics for the memory tasks, which may explain why no effect was found for the mnemonics on the memory tests. While memory is a component of reading comprehension, the two are generally considered to be in different cognitive domains. Thus, the failure to find any mnemonic effect on the reading comprehension tests may be due to the attempt to cross domains. Use of organization mnemonics may be most appropriate when the mnemonic is specifically designed for the type of task or material to be learned, and based on Griffith's work, when self-paced instruction and practice is given to each learner. These guidelines are based on the verbal learning studies; the extent to which these guidelines apply to the use of mnemonics in learning motor response procedures remains to be determined.

Organization Mnemonics and Motor Response Procedures

After conducting a review of the literature, Singer, Ridsdale, and Korienek (1979) found few studies which examined the use of organizing strategies in the acquisition of motor tasks. Nevertheless, they concluded that there might be some advantage in using organization strategies in learning procedural tasks. An apparatus was constructed with a variety of switches, dials, and buttons in various locations on a console. It was programmable so that any sequence of manipulations could be required. Three organizing strategies were examined: (1) an imagery strategy in which subjects were told

to imagine that the various dials and switches were bins in a warehouse, (2) chunking, similar to clustering but without category labels, in which subjects were told to group required responses into sets of three, and (3) rote verbalization, in which subjects were told to repeat out loud each action. Non-military subjects were divided into five groups, one group for each of the three strategies, one group given no strategy, and one group which was presented all three strategies and told to choose one to use in learning the procedures. After instruction and practice in the use of the organization strategies, subjects learned (i.e., were given practice trials) and were tested on a nine-step sequential procedure. They were then required to learn another procedure on the apparatus. The requirement to learn a second procedure was included to assess the extent to which learning to use an organizing strategy could transfer from one task to another. Three dependent measures were examined: (1) errors per trial, (2) total errors on each task, and (3) time to complete the procedure during each trial. Results did not consistently favor any one of the strategies over the performance of the control group (i.e. there were no strategy main effects). However, there was a significant strategy by task interaction. The imagery subjects appeared to have the largest number of errors while learning the first procedure, and the fewest number of errors while learning the second procedure. They were also the only subjects to show markedly fewer errors on the second procedure compared to the first. This improvement is deceiving because questionnaire data collected after the learning and testing phases were completed showed that subjects given particular strategies tended to abandon them and switch to a different strategy to learn the second procedure. Since the imagery and control groups performed similarly on the second procedure, the "improvement" for the imagery subjects may have been due to their using a memory strategy of their own choice for the second procedure such as the control subjects may be presumed to have done.

Singer et al. (1979) rightfully focused attention on the need to insure that students are fully trained in the use of a strategy before requiring them to apply it. This supports our criticism of Weinstein et al. (1980) who failed to give students adequate practice using memory strategies or memory tasks. Singer et al. (1979) also indicated that, to be effective, imposed strategies should not be inconsistent with any predisposition students may have to learn by a favored strategy.

A different type of approach toward facilitation of learning and recall of procedural tasks was examined by Smith and Goodman (1982). Their particular interest was in subjects' ability to read and comprehend written instructions about the steps in a procedure. Almost incidental to their major purpose was the use of categorical clustering of procedural steps. Smith and Goodman (1982) suggested that people may have difficulty executing the steps of a procedure because they do not understand what they are doing. That is, they do not have a conceptual schema for the tasks. This argument is similar to the findings reviewed by J. Mandler (1979) that acquisition and recall of sequential events or spatial phenomena are facilitated by the prior existence in memory of a general schema that represents the major characteristics of the to be learned event or phenomenon. Smith and Goodman's (1982) approach was to supply that general schema. Consequently, they constructed instructions for an electrical assembly procedure using two different conceptual schemata. One set of instructions, termed "functional" instructions, included information about electrical current flow. The other set of instructions relied on a

conceptual schema of assembly emphasizing that even simple assemblies often have several major components that themselves have to be assembled and then connected to each other. This latter set of instructions was termed "structural" instructions. For both of these instructional schemata, explanatory statements were interspersed throughout the presentation of the individual steps of the procedure. It was this insertion of explanatory material that created clusters of related steps. While students (non-military) using either of the two instruction sets did not differ from each other, those given the structural instruction did make fewer errors during initial execution of the steps than a group of control students who received the steps unclustered and without any explanatory material. For verbal recall of the assembly procedure, the difference in instructions approached significance (p .10), and favored the structural instructions.

However, for actual reconstruction of the assembly, there were no differences between either experimental or control students. Smith and Goodman (1982) attributed this latter finding to the relatively good performance of all groups.

While neither of these studies showed particular promise for the use of memory organizing strategies, the strength of the relationship between memory organization and recall of verbal materials argues strongly that the use of organizational strategies for procedural tasks be examined further.

Conclusions

From this review of relevant research, it seems clear that (1) memory organization is an important determinant of learning and recall, but (2) selecting an appropriate organizing strategy to teach students to use is more problematic. An approach suggested by Morrison (1982) may circumvent the latter problem. His suggestion was not to teach an organizing strategy to students for them to use in developing their own structure, but rather to first develop organization structures specifically for each task to be trained and then to teach those organization structures to all students. This suggestion appears to be particularly useful given the findings of Weinstein, Underwood, Wicker and Cubberly (1979) that Army recruits with high school educations or less tended to use fewer memory strategies, and some of them relied only on rote strategies of repetition. Since these soldiers are not accustomed to developing elaborate memory structures when learning new tasks, instruction in how to develop memory structures may appear to them to be equivalent to teaching electrical theory in order to troubleshoot tank firing circuits. That is, the relevance of the material is too obscure. Thus the approach of this project was to teach students a particular memory organization for each task, rather than to teach them how to organize tasks. Furthermore, even for students who can develop their own structure, that process occurs as a developmental sequence, over time, marked by changes in memory structure (Schvanelveldt, et al. 1982). That process of evolving a structure may not be necessary for learning if an efficient structure is provided. In addition, if structures developed for each task can be related to students' previous experience, this training strategy may be particularly useful (Glaser, 1982).

In summary, the following points have been made with regard to the use of memory research in training development:

1. The application of cognitive, information processing theories may improve instructional technology.

2. Attention should be focused on training techniques which facilitate the process of cognitively organizing procedural task information.

3. Learning may be facilitated to the extent that (a) prior experiences of individuals are utilized for learning new material, or (b) organizational mnemonics are presented which help students develop memory structures.

4. Use of organization mnemonics may be appropriate when the mnemonic is specifically designed for the type of task to be learned and when self-paced instruction is given on its use.

5. Not all students are equal in their ability to learn and apply organizing strategies.

6. For students not accustomed to using elaborate memory organization strategies (such as the Army's enlisted recruit population), learning a procedural task may best be facilitated by presenting an organization structure per se rather than teaching them how to develop a structure.

ANALYSIS OF MEMORY STRUCTURES FOR PROCEDURAL TASKS

For the suggested training approach to be implemented, models of memory structures must be constructed for each task to be trained. Morrison and Goldberg (1982) and Morrison (1982), have approached this problem in two ways - a rational approach and an empirical approach.

Rational Analysis of Structure

Morrison and Goldberg (1982) made the assumption that task steps are clustered by task subgoals and that these clusters are organized hierarchically. They further specified that the size of any cluster is limited to five steps; for higher order clusters, the limit is five lower order clusters. These limits are consistent with the research of others (e.g. see G. Mandler, 1979).

Morrison and Goldberg (1982) also suggested that task memory structures for procedural tasks may be represented by four hierarchical levels: (1) elemental steps organized into (2) "tactics" which are organized into (3) "strategies" which form the (4) task. (The labels tactics and strategies were adapted from Miller, Galanter, and Pribram (1960), and do not connote any military meaning.) At five units per cluster, a four level strategy is capable of processing 125 elemental steps (5 steps X 5 tactics X 5 strategies X 1 task). The tasks that Morrison and Goldberg (1982) analyzed contain many

fewer steps as do essentially all armor tasks which are to be performed without job aids. A three level memory organization (one level intermediate to the task and steps) could handle 25 steps (5 steps X 5 intermediate level clusters X 1 task). For a task of a given size, whether a four level organization or a three level organization is more effective for memory is unknown. Of course, for any particular task, as number of levels is reduced, the size of clusters must be increased. Battig and Bellezza (1979) examined extensively the relationship between number of units in clusters and number of clusters, but all clusters were assumed to be at the same hierarchical level. Their conclusion was that these relative numbers were less important than the amount of cueing between items that is created by the memory organization. Their conclusion is similar to the suggestion by J. Mandler (1979) that cueing between items is an important attribute of effective memory organization. For example, when items are clustered according to a schema that is already well known, well established relationships facilitate the recall of the new clusters. The success of using predeveloped memory structures in training procedural tasks may depend on the ability of the task analyst to construct models which can be tied to previous experiences that many students are likely to have in common such that task clusters can become self-cueing.

Empirical Analysis of Structure

Because the theoretical structure analysis approach is subjective, Morrison (1982) followed up his work with Goldberg (Morrison & Goldberg, 1982) with an empirically guided structure analysis. This analysis was based on a technique adapted from Friendly (1979) called "proximity analysis." Proximity analysis is based on the assumption that items which are stored together in memory as a cluster will be recalled more closely together than items in other clusters. Proximities between items were the units used for analysis. Morrison (1982) used two different, though related, proximity measures. For nonsequential tasks recalled without any particular order, recall order was recorded and the differences in order between each pair of steps were used as the proximity values. This corresponds to Friendly's approach. For sequential tasks, Morrison (1982) used response times rather than order. If response order had been used to analyze perfectly recalled sequential tasks, all adjacent steps would have been equal in proximity, even though some steps would have been assumed to belong to different clusters. Using the clustering technique explained below, it would not be possible to determine clusters. Therefore, time between recall of each pair of steps was used as the proximity value.

Following the determination of proximity values, Morrison (1982) then applied Johnson's (1967) maximum distance cluster analysis technique (as prescribed by Friendly's approach) to guide clustering of the procedural steps. Using this procedure, he first searched the set of proximity values. The two steps with the closest proximity were joined to form one unit. The two steps and their proximity were recorded. Proximity values between that new unit and each of the remaining steps were taken as the larger of the distances between each remaining steps and the two steps that were joined. The new unit was then treated just like any of the remaining steps. The above procedure was then repeated by searching for the remaining units and/or steps closest in proximity. The two steps or units were identified and combined, and proximity values were adjusted. The procedure was repeated with all steps

being combined into a successively smaller number of increasingly inclusive units until all were combined into a single unit.

When recall order is used as the basis for determining proximity values, there would be no unique solution for tasks recalled in a fixed order. That is, with adjacent steps all equal in proximity, there would be no one unique starting place nor any unique iterative order for the clustering routine. To use recall order as the basis of the analysis, recall order must vary across trials for a given individual, or across individuals, who presumably share the same memory structure. That is, use of the technique requires variation among proximity values. Thus, even for non-sequential tasks which individuals habitually recall in a common fixed order (e.g., because they have received identical training), use of recall order is problematic. Use of recall time intervals would appear to be less troublesome because adjacent steps are likely to vary in time between their recall.

Results for two of the analyses conducted by Morrison (1982) are presented in Figure 1. These are for the same procedure, Clear the M240, a sequential task; but they are based on two different populations, one of soldiers near the end of the One Station Unit Training (OSUT) Basic Armor Training for M1 crewman, and one of soldiers assigned to an armor unit. The steps of the procedure are listed across the bottom of each graph. Because the example task is sequential, the left to right order of the task was selected to represent that sequence. The graphical structure represents the iterative formation of clusters. "Place in FIRE" and "release bolt" were the two steps in closest proximity across the OSUT soldiers examined. The two steps are joined with a horizontal connection drawn at a height of 1.8 seconds, which is the median time across twelve subjects between verbalization of the two steps. "Remove ammo" and the unit "lift feed tray/look and feel" are illustrative of a single step combined with a unit .

They are joined with a horizontal line at 3.5 seconds. That is the time between "remove ammo" and "look and feel" which is larger than the time between "remove ammo" and "lift feed tray" (2.2 seconds).

Once a graphic structure was prepared from the results of the Johnson (1967) cluster analysis, it was still necessary to interpret the results within the framework of assumptions made about memory structure. The first assumption, that memory is hierarchical, (i.e. steps are combined to form clusters and these clusters are combined to form superordinate clusters) underlies the use of the technique and indeed a hierarchical solution is forced by the cluster analysis. Related to this is the assumption that memory is organized by discrete hierarchical levels (Friendly, 1979; Morrison, 1982; Reitman and Rueter, 1980). Morrison (1982) made the further suggestion that memory for procedural tasks be described by two levels of clusters between the tasks and its elemental steps. A third assumption is that each memory cluster will contain no more than five subordinate units. These assumptions are important for the interpretation of cluster analysis results because the cluster analysis technique per se does not provide indicators of cluster boundaries or levels.

Based primarily on the UNIT results and an a priori memory analysis, Morrison (1982) built an interpretation of the Clear the M240 memory organization. This interpretation is presented in Figure 2. The subjective nature

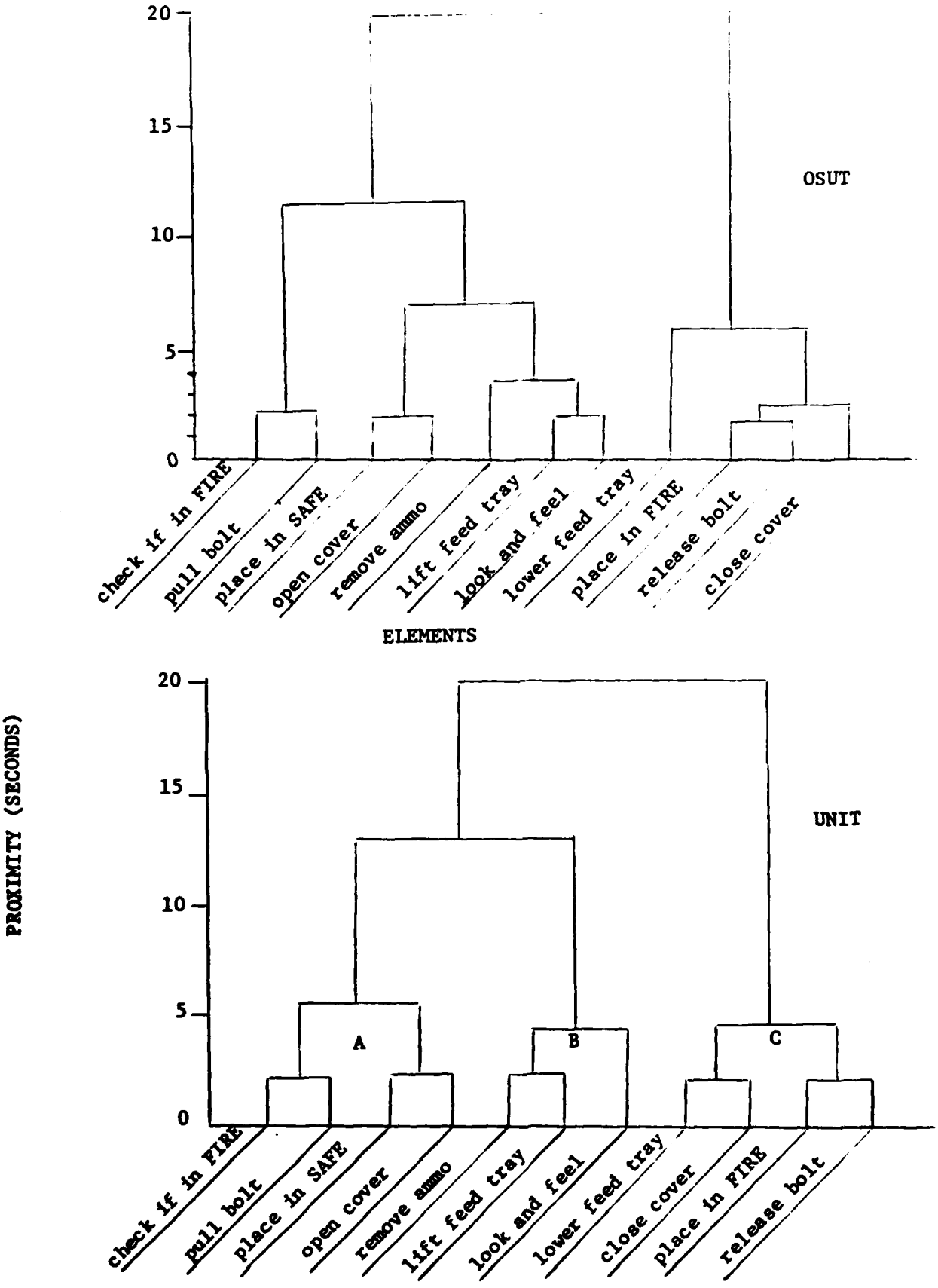


Figure 1: Hierarchical Structure for Verbal Recall of Clear the M240. (From Morrison, 1982)

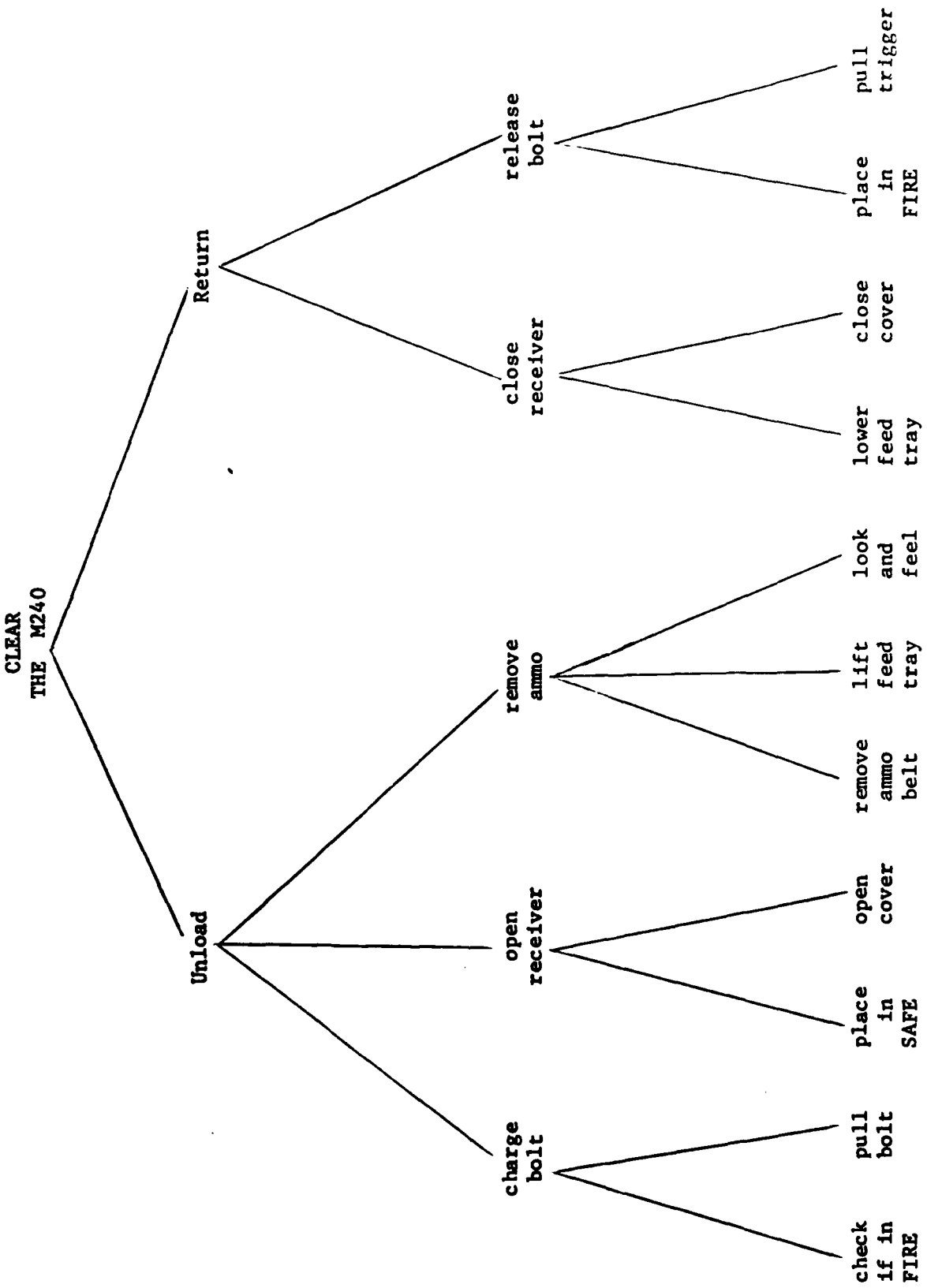


Figure 2: Modified Goal Structure for Clear the M240. (From Morrison, 1982)

of interpreting graphic structures and the significance of the underlying assumption can be illustrated by closer examination of Figure 2, and comparison with Figure 1. For example, the degree of within cluster similarity for clusters labeled A, B, and C in Figure 1 is approximately the same. Furthermore, the similarity of clusters A and B (which are joined with a proximity value of 12.0 seconds) was not greatly different from the similarity of cluster B and C (13.0 seconds, a value not given on the graph). However, Morrison treated the A/B combination as one cluster on the same hierarchical level as the C cluster. By relaxing the criteria for number of levels an alternative interpretation would be to consider a three level hierarchy. That is, clusters A, B and C would represent one intermediate level of clusters between the task and its elemental steps. These clusters might be labeled "open," "check ammo," and "close," respectively. These clusters are no less subjective, but they do seem to better represent a specific instance of a common general schema, which is removing something from a container. However, within clusters A and B, a distinct and logical organization is discernible. Cluster A, the "open" portion of the task, has four steps which based on the cluster analysis and logically can be seen as two pairs of steps. That is, first the safety switch must be in "fire" in order to pull the bolt and second, for safety then switch must be in "safe" before the cover is open. Similarly, cluster C, the "close" portion is empirically and logically two pairs of steps. That is, first the feed tray must be down in order to close the cover, and second the safety switch must be in "fire" before the bolt can be returned. Therefore, for the structure to be logically presented in an instructional program, the steps in clusters A and C were each divided into two subordinate clusters. On the other hand, the three steps in cluster B are all related: there are two places to look for and remove ammunition and after checking in one place the feed tray must be lifted to check the other. Figure 3 presents this alternative organization and presents the one selected for use in this research.

In addition to the ambiguity of cluster boundaries, Friendly's (1979) use of the Johnson (1967) cluster analysis has been criticized for not explicitly recognizing the sequencing that may occur in a set of responses (Reitman and Rueter, 1980). Morrison (1982) solved this by determining the transition probabilities among task elements. For any two elements in a cluster, the element most likely to be recalled first was placed to the left on the graphic structure. The resulting structure represents the probable order among all elements even for pairs of elements with relatively equal chances of being recalled in either order. Although this approach may create specifications for structure organization which are not actually present in the memory organization of the subjects providing the recall data, it should be remembered that the purpose of the analysis is to develop one memory structure to be presented in training. The addition of ordered sequences of performance to tasks which do not need to be performed in sequence for successful task completion will simplify communication of the structure to students. Furthermore, to the extent that ordered schematic memory structures tend to have better recall then nonordered (categorical) structures (J. Mandler, 1979), the added order may facilitate learning and retention.

A second task analyzed by Morrison (1982), Operate the AN/VRC-64 Radio, appears in Figure 4. It is of a non-sequential task which because of soldiers' tendency to recall steps in a fixed order takes on a fixed sequential structure. The order of the steps resulting from the empirical analysis

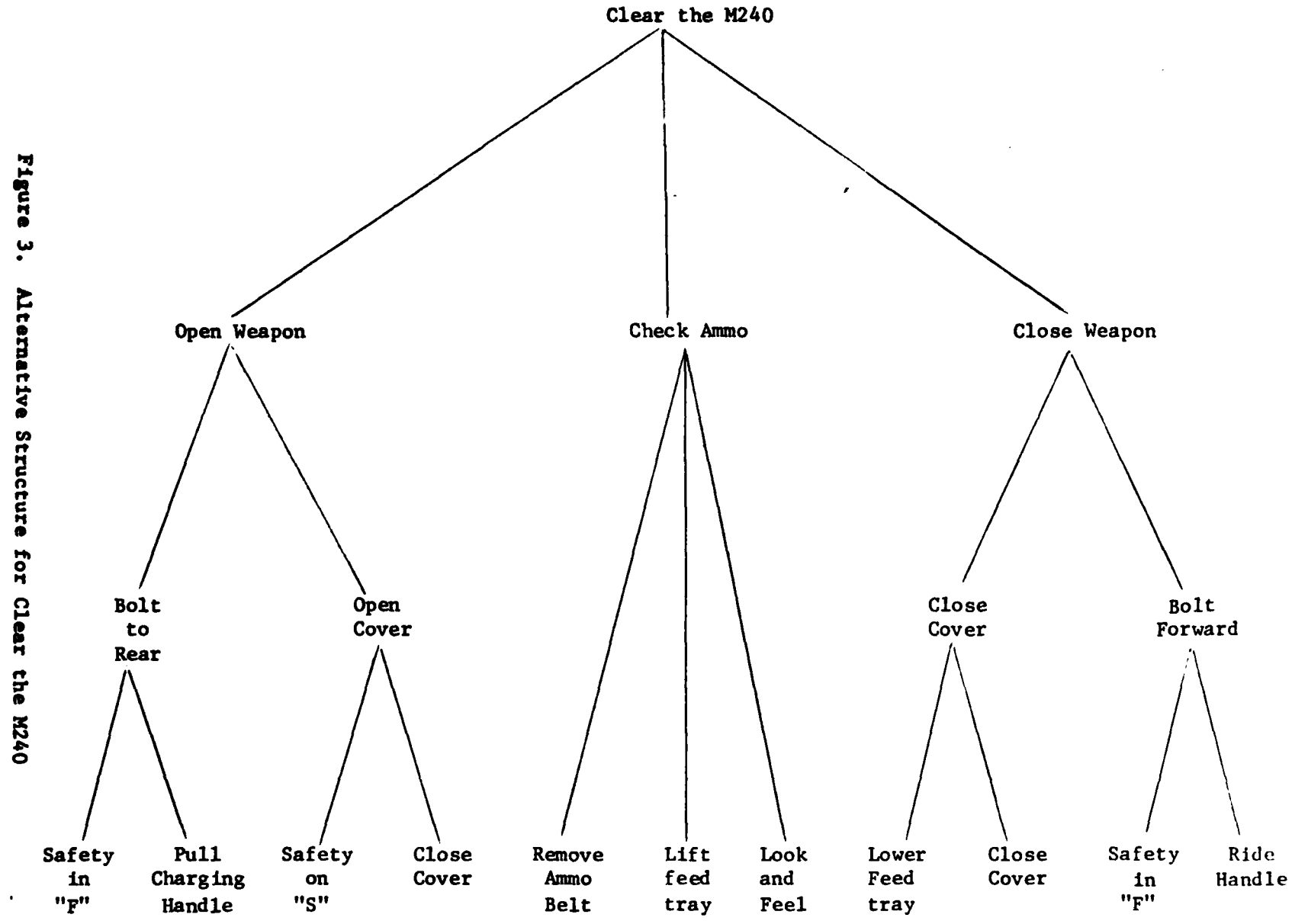


Figure 3. Alternative Structure for Clear the M240

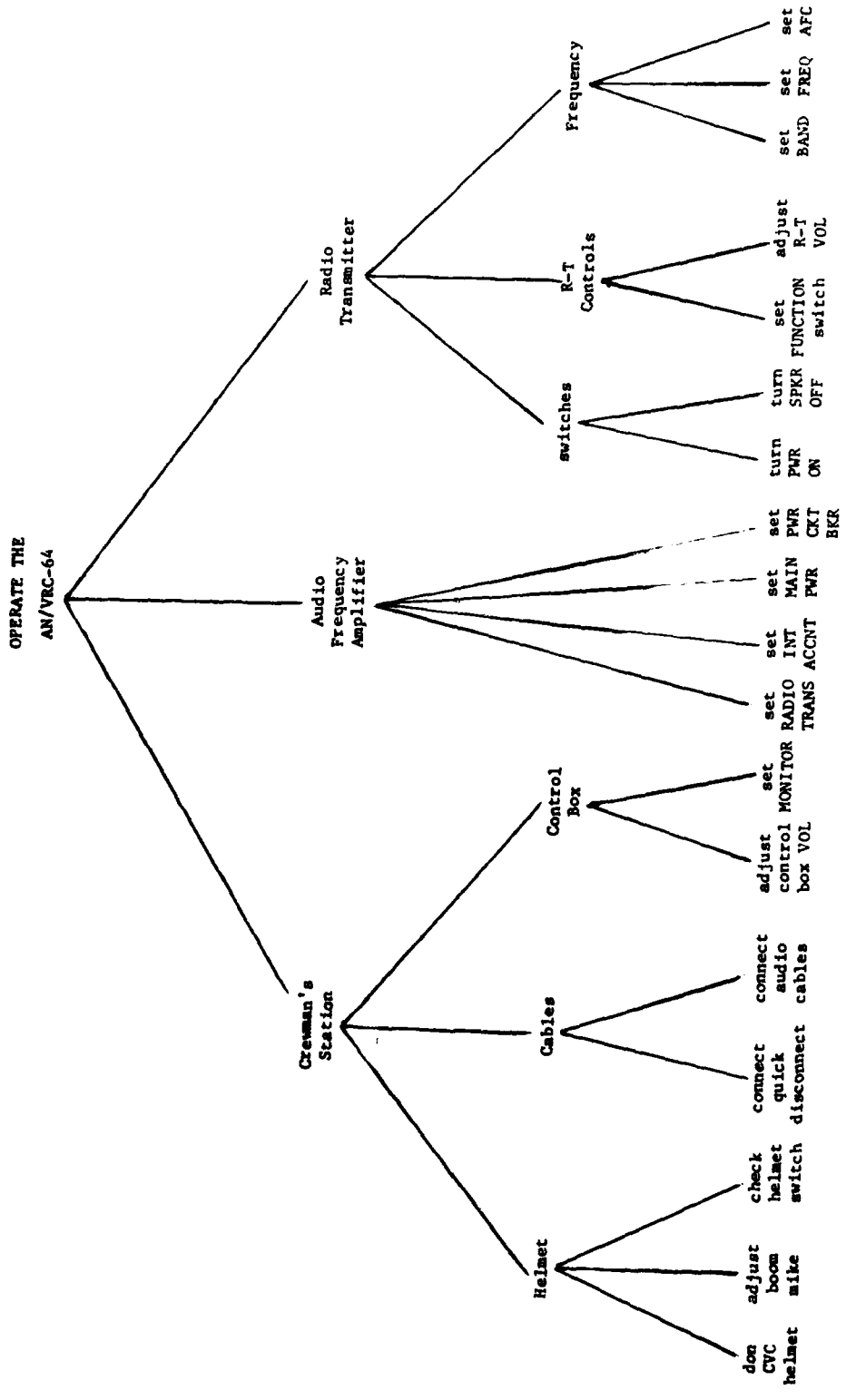


Figure 4. Modified goal structure for Operate the AN/VRC-64. (From Morrison, 1982)

of transitional probabilities was identical to that identified in Morrison and Goldberg's (1982) a priori analysis probably because their a priori analysis was based on the same instructional information as that given to the soldiers who provided task recall protocols for the empirical analysis. Morrison's (1982) structure for Operate the AN/VRC-64 Radio, will be used to guide the instruction in present research.

Friendly's (1979) proximity analysis technique appears to be a workable approach to the analysis of memory structures that may be used for training procedural tasks. This statement is qualified by the recommendations concerning interpretation of the graphic structures which are discussed above. One further assumption should be elaborated. By averaging recall or performance response patterns (i.e. time intervals) across individuals prior to applying the Johnson (1967) cluster analysis, Morrison (1982) implicitly assumed that there is a stereotypic memory structure for each task which was shared by all of the respondents. This is not an unreasonable assumption from the viewpoint of Gestalt psychology, which also assumes "that an optimal or natural organization exists for all situations or any given situation" (Diewert & Stelmach, 1978, p. 244). Certainly if there is a tendency for persons to organize a task the same way, it is the stereotypic structure that should guide instruction of the task.

Selection of Tasks for Analysis and Training

Tasks performed by M1 crewmen include a wide variety of procedures that can be categorized by a number of different dimensions. Because the major thrust of this research was to test training strategies which might have more general application than to just the specific tasks employed by this research, it is important to insure that tasks were selected with relatively wide divergence on the most relevant of these dimensions. The ideal approach would have been to have available a task taxonomy based on the optimum information processing strategies needed, as suggested by Gilmartin et al. (1975). Tasks could then have been selected that were representative of the dimensions of the taxonomy. Unfortunately, such a taxonomy was not available. However, previous research in the structure and organization of memory suggested a number of relevant categories which were considered.

In Morrison's (1982) analysis of M1 crew procedural tasks, a memory structure difference was observed between sequential and non-sequential tasks. Sequential tasks tended to be organized temporally, while nonsequential tasks were organized spatially. Thus, it seemed important to represent both of these categories. The tasks Clear the M240 and Operate the AN/VRC-64 Radio, which were analyzed by Morrison (1982), were selected for inclusion in the experimental evaluation phase of this research as representations of sequential and non-sequential tasks.

For sequential tasks, another dimension may be whether the procedure is strictly linear or if it requires decision making and branching at various points in the procedure. Branching is common in complex procedures, but it has not received commensurate attention in research on memory organization. There may be principles governing organization of procedures with branching that do not apply the linear procedures. For example, the branching points may provide natural organization boundaries. Thus, one additional task for

featuring branching was selected for the research. That was setting the headspace and timing on the M2 machinegun. Both parts of the task, i.e., the headspace procedure and timing procedure, involve several steps preparatory to a check. From the check point, the procedure is branched depending on the outcome of the check. For the timing portion, the check may show that timing is early, late or correct. The adjustment steps for early and late timing are identical. For the headspace portion, the headspace may be too large, too small or correct. The adjustment steps vary slightly depending on whether headspace is too large or too small.

For the non-sequential task Operate the AN/VRC-64, Morrison and Goldberg (1982) had hypothesized that steps would be organized by functional goals and subgoals. Smith and Goodman's (1982) clustering of an assembly task, by explanations concerning what the various steps were to accomplish, is a similar approach. Morrison's (1982) empirical analysis of the radio task, however, showed that task steps were organized spatially. Post hoc, spatial organization of the steps appears very logical for that task. On the other hand, given the long tradition of training by task objectives which organizes instruction by hierarchically related objectives and subobjectives, and the theoretical credibility given to goal hierarchy schemata (Abelson, 1981), it seemed premature to dismiss the potential existence of such goal structures on the basis of Morrison's (1982) failure to find one for the radio task. Thus, a second additional task selected for this research was one expected to show a hierarchically goal-oriented memory structure.

The series of tasks referred to collectively as Respond to Master Warning Light (M1 Operator's Manual, DA Technical Manual 9-2350-25510-2) is typical of many M1 procedures in that checks may lead to responses to immediately correct the problem, to perform trouble shooting, or to decide that organizational maintenance must be called. The tasks have both branching, and a goal and subgoal orientation. One task in that series is to Operate the Engine Compartment Fire Extinguisher. This procedure consists of steps which have the goal of extinguishing the fire and steps which have the goal of protecting personnel and equipment.

In summary, four tasks were selected for this research: Operate the AN/VRC-64, Clear the M240, and Adjust headspace on the M2 Machinegun and Operate the Engine Compartment Fire Extinguisher. These are tasks that soldiers are expected to know and be able to perform without reference to a Technical Manual or Soldier's Manual. Also, they are tasks that are relatively difficult because of length, because the steps are not cued by the task's components, or because the specificity of the required responses makes it unlikely that the soldier could make a correct guess at the response. These conditions would put the greatest load on soldier's memory capacity, and therefore are the tasks for which improved training would have the greatest benefit.

Two of these tasks were previously analyzed by Morrison (1982). The two remaining tasks needed analysis to develop structures for memory organization.

Empirical Structure Analysis: "M1 Engine Compartment Fire" and "M2 Headspace and Timing"

Subjects and Procedure. Following the method of Morrison (1982), seven subject matter experts (SMEs) were interviewed. M1 tank commanders were selected as persons familiar with both tasks. SMEs were asked to describe step by step, without elaboration how to do each procedure. Their verbal protocols were tape recorded. For the M2 machinegun task, SME were shown several black and white pictures of the M2 machinegun with various parts labeled. The pictures per se served as visual stimuli for recalling the task. The part labels were provided to avoid problems that subjects might have in naming parts while describing the procedure. For the fire extinguisher procedure, SMEs were shown black and white line drawings of the M1 driver compartment alert panel and instrument panel. The panel lights which would indicate an engine fire were colored and the SMEs were asked to describe what they would do, in the role of M1 driver, if they saw the pattern of lights depicted. In addition to the machinegun and fire extinguisher procedures, SMEs were also asked to recall procedures for three additional tasks. Protocols for these tasks were recorded for use in the event that tasks were needed in addition to or instead of the original task procedures selected for study. The entire interview lasted approximately 30 minutes for each subject.

Prior to conducting hierarchial analyses, protocols were scored for recall accuracy. Using information from technical manuals and lesson plans, the steps for performing the fire extinguisher procedure and for setting the headspace and timing on the M2 machinegun were listed. Because of the length of the task and the anticipated lengths of time available for training in the evaluation phase of the project, the timing adjustment portion of the M2 machinegun task was eliminated from further analysis.

Results

Tables 1 and 2 present the steps recalled and their order for each of the SME's two trials. Also indicated is the percent of steps recalled by each SME, regardless of order of recall. Recall accuracy was low for each SME. The average percent of steps recalled (across trials and SMEs) for the machinegun task was 44.3%. For the fire extinguisher task, average recall was 3.6%. The accuracy of these recall protocols was judged insufficient for using the hierarchical cluster analysis procedure. Therefore, development of memory structures for use in training were based on rational analyses of tasks.

There was some similarity apparent in recall patterns across the seven SMEs, and these similarities were considered in the rational development of the memory structures.

Rational Development of Memory Structures: "M2 Headspace" and "M1 Engine Compartment Fire

In lieu of an empirical clustering approach, task steps for the M2 machinegun and the engine compartment fire procedures were clustered rationally. The guidelines suggested by Morrison and Goldberg (1982) were adopted

Table 1

Order of Responses from Recorded Protocols - M2 Machinegun

Steps	SME:	1		2		3		4		5		6		7	
	Trial:	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Open Cover				4	4			5	3		1				
Retract bolt to notch		2	1	3	2			2		1	2	1	1	1	1
Screw in barrel		3	2	1	1	1		1/3	1	2	3	10	4	2	2
Screw out barrel two clicks		4	3	2	3	2	9[b]	4	2	3	4	11[a]	5	3	3
Cock or charge & return handle		1	4				1								
Retract handle 1/16"				7	5	3	2		4						
Raise extractor															
Insert NO GO gage		5	5	6	6	4	3/10	6	5	4/9	5	2	2-2/9	4/11	4
If doesn't fire (Step 16)		8	8	8	7	5	4/11	7	6	5/10	6	3[a]/ 7	3/10	5/12	5
If does fit (Step 10)		6	6												
Retract bolt to notch												8			
Screw barrel in one click		7	7												
Return bolt															
Retract bolt 1/16"															
Repeat (go to Step 8) until NO GO doesn't fit															
Insert GO gage		9	9	5/9	8	6	5/12	8/14	7	6/11	7	4[a]/ 5[a]	6/11	6/13	6
If does fit (Step 24)		10	10	10	9		15		8	12	11[a]	9[a]	7[a]/ 12[a]	14	
If doesn't fit (Step 19)			11	11[a]		7	6/13	9		7	8			7	7
Retract bolt to notch						8	7/14	10	9					8	9
Unscrew barrel one click			12			9	8	11	10	8	9	6[a]	8	9	8
Return bolt						10								10	
Retract bolt 1/16"						11									
Repeat (go to Step 16) until GO fits			13			12		12	11		10				10
Recheck NO GO gage after GO fits						13	15	13							
Set (GO fits, NO GO doesn't)		11	14		10	14			12	13				15	
PERCENT OF STEPS RECALLED:		44	56	40	40	56	44	48	48	40	44	36	36	48	40

[a]SME then skipped to steps in the timing procedure.

[b]Started over in the middle of the procedure.

Table 2

Order of Responses from Recorded Protocols
Operate the Engine Compartment Fire Extinguisher

	SME:	1		2		3		4		5		6		7	
Steps	Trial:	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Detect flashing master warning light				1	1							1	1	1	1
Detect engine fire light		1	1	2	2	1	3			2	3	4	4	2	
Detect 1st shot light		2	2	3			2			1	2	3	3		2
Notify TC/Alert Crew						3	1			4	5	2	2	5	4
Pull engine fire handle[a,b]						4									
Recheck engine fire light[a,b]			3	4											
Notify TC[a,b]													5		
Turn into the wind															
Haved turret moved											6				
Idle			4												
Stop						2	4			3	4	5	6	4	5
Set parking brake															
Put transmission in neutral															
Check master power[a]															
Use second shot switch[a]		3	5	5			5	1	1	5	7	6		3	3
Wait and recheck fire light[a]											8				
Master power off[a]		4				5	6								
Exit, on command[a]						6		2		6	10	7			
Pull outside engine fire handle[a]							7				9				
PERCENT OF STEPS RECALLED[c]		23	23	23	12	29	41	12	6	35	59	41	35	29	29

[a]The necessity of these steps are contingent on the outcomes of previous actions.

[b]Given the configuration of lights presented to SME in the stimulus materials, these steps would not be executed.

[c]Steps noted with a sub "b" were not included in this calculation.

with some additional stipulations. The rules given by Morrison and Goldberg (1982) were as follows:

1. the organization must be strictly hierarchical with no overlapping relations or cross-classifications;

2. each hierarchical node and its subordinate branches must relate to some meaningful objective;

3. each node can consist of no more than five branches (page 5).

Their guidelines also called for construction of a four level hierarchy (i.e., two levels of clusters between the task name and each steps.)

The set of guidelines used to structure the M2 Headspace and M1 Engine Compartment Fire Procedures are summarized in Table 3. They called for beginning with a list of task steps and dividing them into clusters of no more than five steps each. Steps within a cluster should all be related to a recognizable activity. Clusters should be named to indicate the objective of the steps in the cluster, with an action verb used in each of the cluster names. Morrison and Goldberg's (1982) guidelines also called for structure development to be both bottom-up and top-down. That is, from the top-down cluster labels should be descriptive of the task, and from the bottom-up, steps within each cluster should be logically related to each other. To achieve that result, it may be necessary to arrange clusters and cluster membership from the bottom-up, check their meaningfulness from the top down, and them make adjustments in clusters and cluster membership.

Morrison and Goldberg's (1982) suggestion of constructing a four level hierarchy (i.e. two levels of clusters between the steps and the task name) was relaxed to three levels wherever it appeared that the task could be meaningfully structured using fewer levels of clusters.

Because both the machinegun and engine compartment fire procedures included branching, the branching points were used to define task subgoals and clusters of steps. Use of branching points reduced the subjectivity of interpolating task subgoals from information about the overall purpose of the task and descriptions of the individual steps in the task by providing a decision rule for determining cluster boundaries.

M2 Machinegun Headspace Structure. From the M1 Operator's Manual descriptions of the steps required for the task, the following is apparent. The objective of the procedure is to adjust the size of a gap, called the headspace, between two parts of the machinegun. The size of the gap is adjusted by turning the barrel of the machinegun in or out. A flat gage, called the headspace gage is used to measure the headspace, The two ends of the gage are calibrated with one end slightly larger than the other. The size of the headspace is correct when the small end of the gage (marked with the word "go") can be inserted in the space but the large end of the gage (marked with the words "no go") cannot be inserted. Thus, if the small or "go" end of the gage cannot be inserted into the headspace, the size of the gap must be increased by turning the barrel out. Conversely, if the larger "no go" end can be inserted, the size of the gap is too large and must be decreased by turning the barrel in. Thus, the structure of the task can be represented as a

Table 3
Guidelines for Task Structure Development

1. Determine the overall and subobjectives of the task.

2. Divide task steps into clusters of related steps.

3. Cluster should have no more than five steps each.

4. Clusters should represent a recognizable activity or subobjective of the task.

5. Any branching points in the task should be used to define clusters.

6. Clusters should be named, using an action verb, to describe its activity.

7. Clusters should form a hierarchy of goals and subgoals describing the entire task.

repetition of checking the headspace and adjusting the barrel. However, before checking the headspace, a number of steps are specified in TM which place the mechanical parts of the M2 in a configuration such that the headspace can be checked. Thus, the structure of the task was interpreted as having a "set-up" cluster of steps, and "check and adjust" clusters of steps.

Within each of these clusters, subordinate clusters were identified. For the set-up portion of the task, three separate subgoals were identifiable: (1) positioning the barrel in an initial starting position, (2) retracting the firing pin by cocking the weapon and returning the bolt forward and (3) exposing the headspace gap by opening the cover and raising the extractor. For the check and adjust portion of the task, four clusters were identifiable: (1) checking with the go gage, and (2) adjusting the barrel out if needed; then (3) checking with the no go gage and (4) adjusting the barrel in if needed.

The M2 headspace adjustment procedure structure is presented in Figure 5 in tree diagram format. The diagram is incomplete in that the branching of the task is not depicted. The tree diagram format did not lend itself to representation of the non-sequential relationships between clusters. Alternative presentation formats were explored in the development of diagrams for use in training. Training diagrams are presented later in this report.

Engine Compartment Fire Structure

The M1 Operator's Manual presented two versions of operating the engine compartment fire extinguisher: an automatic and a manual mode. The difference between the two versions is only in the initial few steps of the procedure. The automatic mode should occur when the M1 tank is powered-up and the fire extinguisher system is fully operational. The manual mode must be used by the driver if the tank is not powered-up or if the fire extinguisher system is not fully functioning. Thus, the driver does not select which mode to use; it depends on the condition of the tank at the outbreak of the fire. Therefore, the two versions were treated as one task which could be initiated in either one of two ways. The procedure for responding to a fire in the engine compartment is different from the tasks described above in that it requires continual monitoring of environmental stimulus events which are not controlled by the performer of the task but which initiates the procedure and are branching as the procedure continues. The sequence of occurrence of these cues determine much of the structure of the task.

The engine compartment of the M1 contains fire detection sensors and two fire extinguishers. The driver's compartment contains several warning lights which must be monitored by the driver and several switches and controls which must be manipulated in the appropriate sequence. Of course the obvious objective of the task is to extinguish the fire. But that objective is subordinate to the objective of protecting, as much as possible, personnel and equipment. Thus, there are several parts of the procedure designed to directly affect the safety of personnel and equipment. Based on these observations, and the detailed task information available in the Operator's Manual and supplemented by information supplied by the Office of the TRADOC System Manager for M1, four distinct clusters of tasks were identifiable.

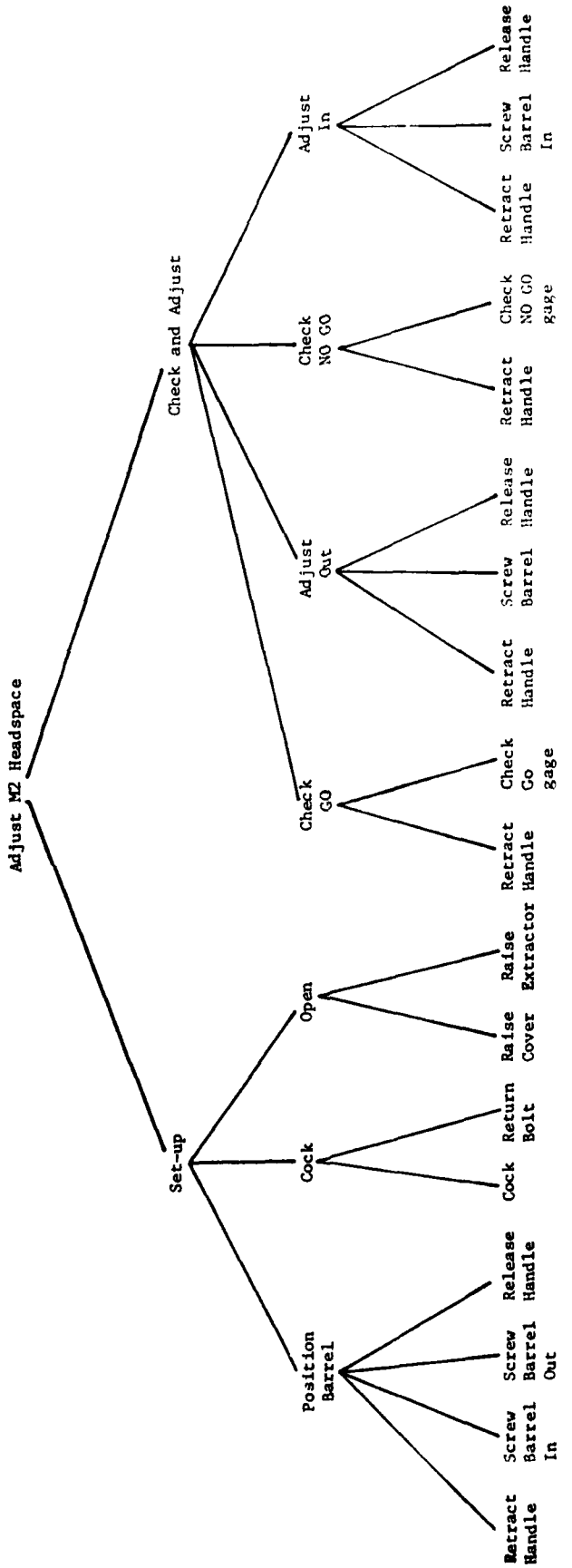


Figure 5. Structure for adjusting the M2 machinegun headspace.

In the automatic mode when a fire is detected by the sensors, the first extinguisher is discharged and warning lights are illuminated in the driver's compartment signalling the event. If a light is detected and the first fire extinguisher is not automatically discharged, warning lights indicate a fire but do not show the first fire extinguisher begin discharge. In this case the driver manually discharge the first fire extinguisher using a control handle in the driver's compartment. In either case, the driver alerts the tank commander that a fire has been detected and the first extinguisher discharged. Thus, this first cluster of steps labelled the "detect and discharge" phase.

The first fire extinguisher may or may not put out the fire. If not, the second fire extinguisher is used. However, discharging the second extinguisher automatically shuts down the engine, therefore prior to discharging the second extinguisher is a cluster of steps which has as its objective the moving of the tank to a safe position, away from other equipment, in a cover position if in combat, and positioned such that smoke or extinguisher gas are blown away from the crew. Because of noxious odors of the extinguisher gas and the potential need to investigate the origin of the fire, this cluster of activities, which was labelled the "position tank" phase, is executed whether or not the first extinguisher puts off the fire.

During the "position tank" phase, the driver monitors the warning lights to determine whether or not the fire is extinguished. If it is extinguished the task is completed as soon as the driver alerts the task commander that the fire is out. If the fire is not extinguished, the driver activates the second extinguisher, listens for it to discharge, and monitors the warning lights to determine whether or not the fire is extinguished. The cluster of steps was labelled the "use second shot" phase ("shot" being the technical manual's abbreviated name for fire extinguisher).

After the use second shot phase, if the fire is out the task is completed as soon as the tank commander is alerted. If the fire is not extinguished, the last cluster of steps are to shut-down and evacuate the tank. These steps were labelled the "exit" phase.

Figure 6 presents the tree structure diagram for the steps needed to respond to a fire in the engine compartment of an M1 tank. The cluster is in three labels except for the position tank steps. The steps "idle" through put "transmission in neutral" were essentially the same as stopping a care and were clustered together under the label "stop." As with the procedure for adjusting the M2 headspace, the tree structure fails to show the branching within the task. An alternative presentation format was prepared for use in training the procedure, and appear later in this report.

DEVELOPMENT OF TRAINING STRATEGIES

Purpose

The major thrust of this research was to examine the hypothesis that providing students with memory organization information for a task can facilitate learning and retention of that task. As an applied research project, it was desirable to be able to draw some conclusions directly applicable to

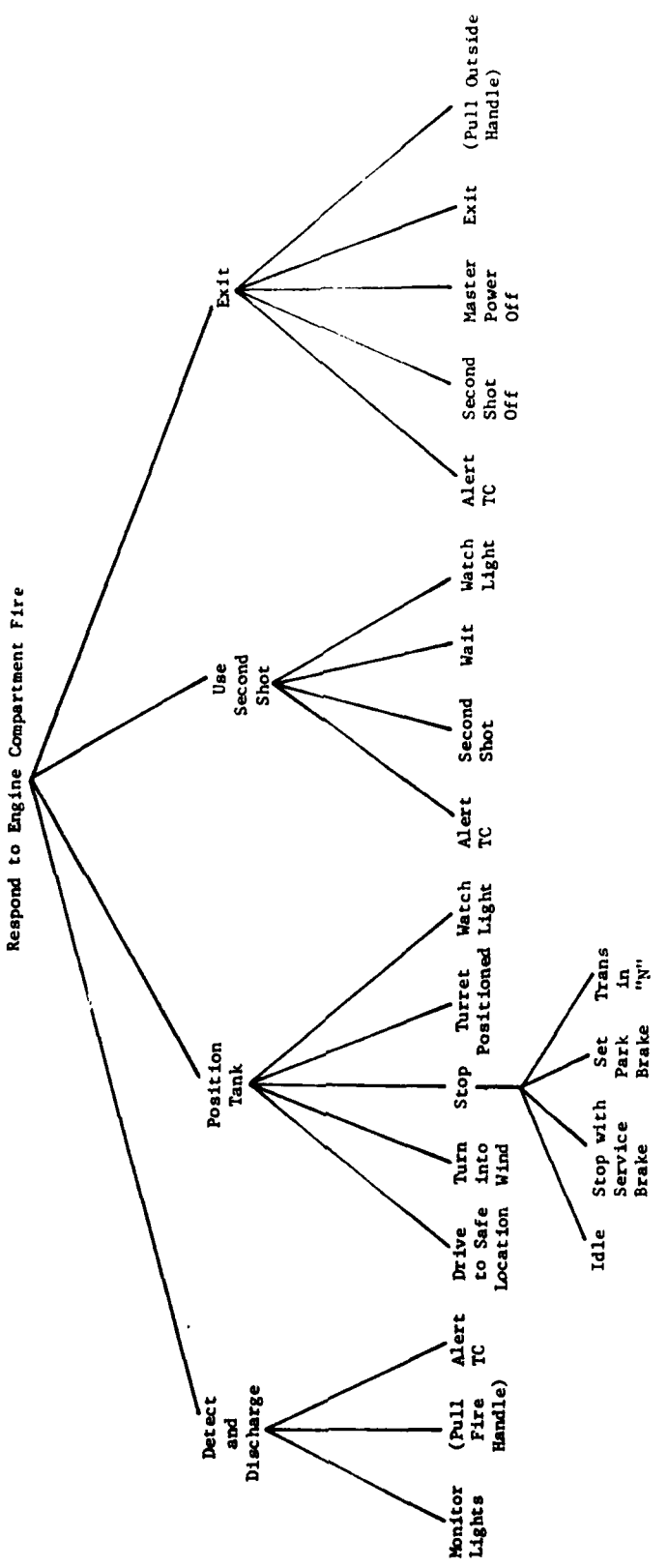


Figure 6. Structure for responding to an engine compartment fire in an M1 tank.

Army training from the results of the effort. Given the argument stated in the Introduction that the Army's standard training approach, POT, is not built on incorrect learning principles, but rather on an incomplete set of principles, POT was taken as the starting point for this research. Thus, POT served as the standard method of instruction against which alternative training strategies could be evaluated, and it provided the basic instructional format to which memory organizing information was added.

Performance-Oriented Training

Undoubtedly, POT is implemented throughout the Army in countless subtle varieties. It is possible, perhaps probable, that some seasoned instructors already augment standard POT with memory organization mnemonics of one kind or another. On the other hand, POT may just as often be presented in a straightforward, unembellished fashion. The intention of this research was not to test how POT is normally implemented, but rather to test a particular approach for adding organization information developed in a predetermined and specifiable manner against the basic POT requirements for instructional design. Such a comparison made possible recommendations about whether or not augmenting POT with memory structure information should become a standard procedure.

It is important, therefore, that the POT procedures employed in this study were clearly delineated and verifiable according to FM 21-6. Accordingly, the following POT procedures guided the development of the training programs for each task:

1. Instructional objectives are established for each task, and these objectives will be grounded in an actual job.

2. A brief introduction is presented to the student about the task. This includes:

    a. A statement about the training objective.

    b. An orientation to the task that tells the student why he must learn the task.

    c. A statement about safety, as required.

    d. A brief description of how training on the task will proceed (demonstration, practice, feedback, test)

3. The instructor demonstrates the task steps as they should be performed.

4. The student practices the steps.

5. The instructor provides feedback to the student about his performance of task steps, and corrects or reinforces the student as appropriate.

6. Practice on the task will continues until the student can perform the task without error.

Experimental Memory Organization-Based Experimental Training Programs

Two experimental training programs were built on the basic POT design. The difference between POT training and the two experimental programs was the addition of memory organization information to the experimental programs. The expectation was that students would be able to perform the task more accurately after having received the memory organization information. The difference between the two experimental approaches was in the timing of the presentation of the memory organization information. One strategy presented information concerning the memory organization of the task prior to POT-style presentation and practice of the steps. Since a structure was provided prior to the detailed material, this approach was called the "top-down" approach, analogous to the terminology of J. Mandler (1979). The second alternative to POT, which is also based on the use of memory organization, first allowed students to have POT style experience with the elemental steps of the procedure being taught and then presented them with a memory structure to organize the storage of those steps in memory. This strategy was called "bottom-up." These labels should act as a mnemonic bridge between the task and the elemental steps.

Although the task of learning memory organization information may appear to be an extra burden during training, it is an effort that appears likely to pay dividends in task recall (Segal, 1969; Shuell, 1969). Various diagrams and graphics, along with verbal presentations were used to convey this organizing information during the training program. Emphasis was placed on the cluster labels.

The top-down and bottom-up training programs both introduced the labeled clusters of task steps. The top-down, or structure first, method was a straightforward application of the proposition that a memory structure which is similar to a previously learned task structure can guide the acquisition and subsequent recall of new, detailed material (Ausbel, Novak, & Hanesien, 1978). Students were presented the set of interrelated verbal labels which organize the task prior to being presented the elemental steps of the task. The steps were then presented one cluster at a time, to reinforce the organizing structure. After all clusters were presented, students practiced the entire procedure. The top-down training strategy is outlined in Table 4.

For the bottom-up approach, the set of organizing labels were presented after the task steps had been presented and practiced by the students. The rationale was that, for students who may not be used to employing strategies other than rote rehearsal, the clustering and labeling of steps may be too novel and too abstract. By presenting the steps first, these students would have a better idea of what the labels mean and therefore how to use them in organizing their memory of the task. This approach corresponds to the instructional sequence advocated by Gagne (1965) in which elemental, concrete information is presented before more general, abstract information. Thus, the bottom-up method began like the POT approach. After students had completed the task two times through, the memory structure was provided by the presentation of the cluster labels. Because students were familiar with the steps, the clusters were presented by starting with the steps, indicating how they could be grouped together as clusters of related steps. After the entire structure had been presented students then practiced the task. Table 5 outlines the bottom-up training strategy.

Table 4

Outline of Top-down Training Strategy

1. Name task.

2. Present orientation statement.

   -brief description of what the task is about, e.g., who does it, why, what is being done, etc.

3. Present outline training procedure.

   -tell students that they will be told how to remember the steps,
   -show them a demonstration of these steps,
   -give them practice,

4. Introduce nomenclature.

   -only relevant parts,

   -use structure relationships as appropriate (e.g., by location similar to existing schema).

5. Present top level of memory organizing.

6. Tell briefly to remember by using cluster labels.

7. Present subclusters for first clusters.

8. Present and demonstrate steps of the subcluster.

9 Give statement signaling the end of subcluster (may be omitted if steps are simple and very limited in number.)

...Repeat 8 & 9 for each subcluster within first cluster.

10. Give statement signaling end of cluster by reviewing names of subclusters.

11. Review top of structure.

...Repeat 7 to 11 for each cluster. For clusters without subclusters, omit 7 & 9; for 8 present all steps and for 10 review steps.

12. Review total structure.

13. Talk student through task one time, highlight cluster names.

14. Tell student to practice using cluster names.

15. Aid and reinforce student's practice.

Table 5

Outline of Bottom-up Strategy[a]

1. Name task.

2. Present orientation statement.

   -brief description of what the task is about, e.g., who does it, why, what is being done, etc.

3. Present outline training procedure.

   -show them a demonstration,
   -give them practice,
   -give additional information to help them remember,*
   -give additional practice.*

4. Introduce nomenclature.

   -only relevant parts.

5. Give demonstration.

   -step by step,
   -steps numbered.

6. Review steps (verbal only).

7. Talk student through task one time.

8. Let student practice the task two times.

9.* Introduce structure presentation.

   -remember task by using clusters.

10.* Show how steps are combined into subcluster...repeat 10 for each subcluster in first cluster.

11.* Show how subclusters are combined into a cluster (or omit 10 and form steps into cluster if cluster has no subclusters.)

...Repeat 10 and 11 for each cluster.

12.* Show how clusters form total organization of the task.

13.* Give instruction for additional practice (say out loud cluster names).

14. Aid and reinforce student's practice.

[a]Unstructured POT training strategy was constructed by omitting the bottom-up training strategy steps marked with an "*".

Training programs were prepared for each of the tasks described in the previous section of the report using each of the three training strategies. A diagram was designed for each task to show its memory organization. Diagrams included brief verbal phrases for each step together with the cluster label. For each cluster, a line drawing of the components or operation involved in the cluster steps was shown to help bridge the gap between the verbal labels and actual equipment component. For the M2 and engine compartment fire tasks which involve branching, clusters were enclosed in boxes. Arrows between the boxes depicted the alternative paths that could be followed in completing the tasks. The complete diagrams for each task appear in Figures 7, 8, 9 and 10. Slides were prepared from these diagrams which showed the entire structure, with or without the steps included, and of each cluster separately. For the M2 and engine fire tasks, slides were prepared which focused on the relationship between clusters at the branching points. Slide/tape presentations were then prepared which presented the task structures slides and all verbal commentary except for the practice dialogue. (No slides were presented in POT programs.) Instructions were prepared for an instructor to demonstrate the task (following the verbal instructions being presented by the taped commentary), and then talk the student through the task using a standardized protocol. Instructions were also prepared for instructors to provide feedback and assistance while students practiced the task. Tape recorded scripts, talk through protocols, and replicas of the slides used in training are presented in the Appendixes.

Instead of students practicing until they were able to perform the task, as in common is typical POT instruction, training (presentation and practice) was set at a fixed time period, equal across training strategies. This was done for two reasons related, not to the instructional techniques per se, but to the interpretability of the results of the comparative evaluation of the techniques. First, because of the added information presentation time for the two experimental strategies was longer than for the POT program. Second training time is a valuable resource. Therefore, if (a) all students were trained to a performance criterion, and (b) trained with POT reached the criterion in a shorter overall time period, and if (c) structure students subsequently recalled the task better in delay testing, then one could argue that the difference in delayed performance could have been an artifact of total training time, and that if POT students could have practiced during the time experimental students were receiving the memory structure information, delayed performance differences would have been mitigated. Therefore training time was fixed.

For the M240, M2, and Radio tasks, training was conducted using the actual equipment. For the engine compartment fire task, a driver's compartment mock-up was used.

Summary

An effort was made to improve training techniques in order to increase retention of procedural tasks common to armor crewmen. Based on an overview of principles of cognitive, information processing psychology concerning the structuring of information in memory and on research using various memory organization mnemonics, a general training strategy was described. The strategy began with a systematic structure analysis of tasks to be trained.

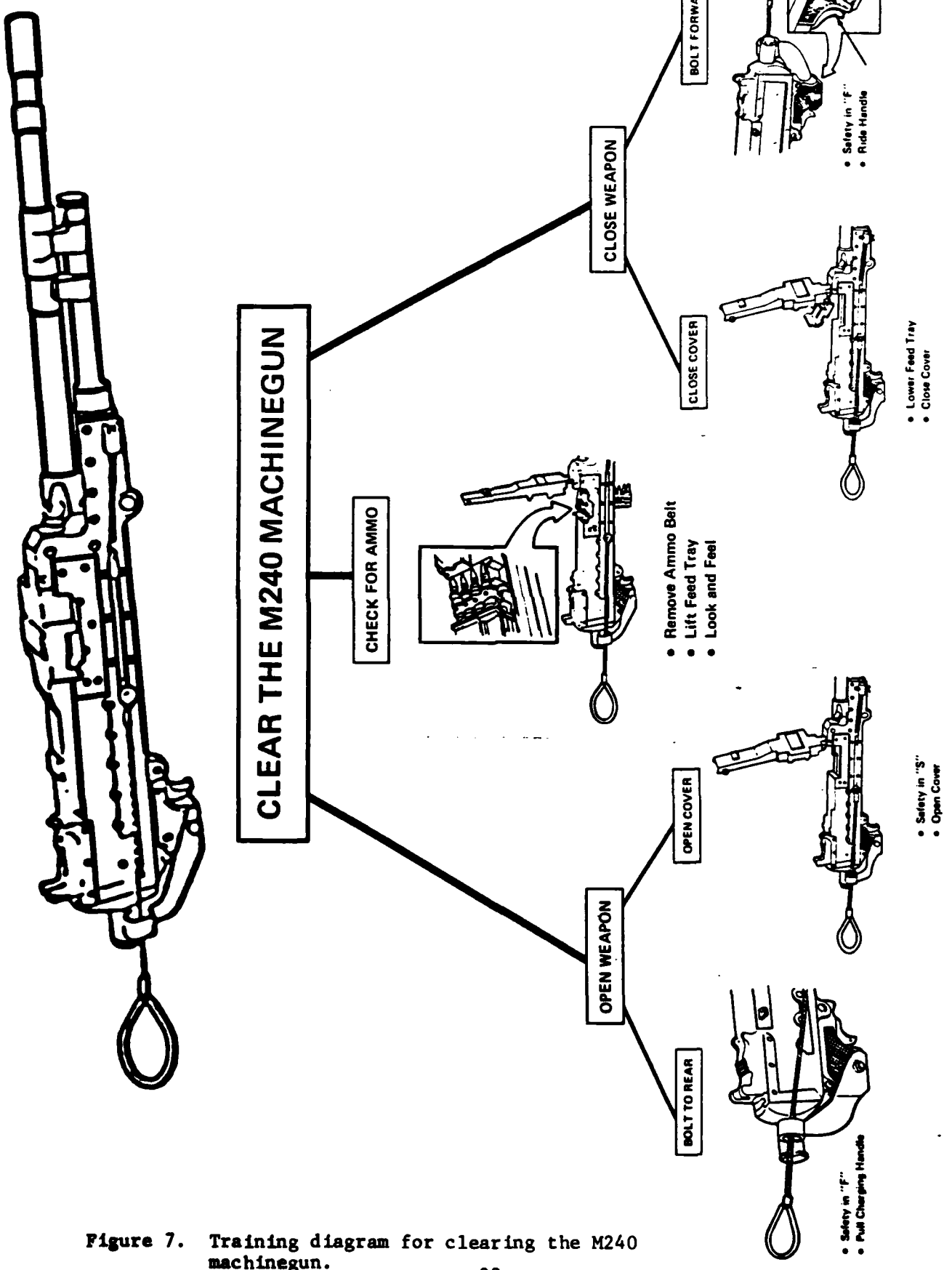
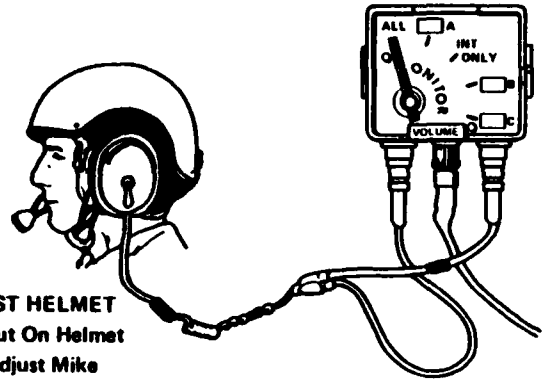


Figure 7. Training diagram for clearing the M240 machinegun.

OPERATE THE AN/VRC - 64 RADIO

PREPARE CREWMAN'S STATION



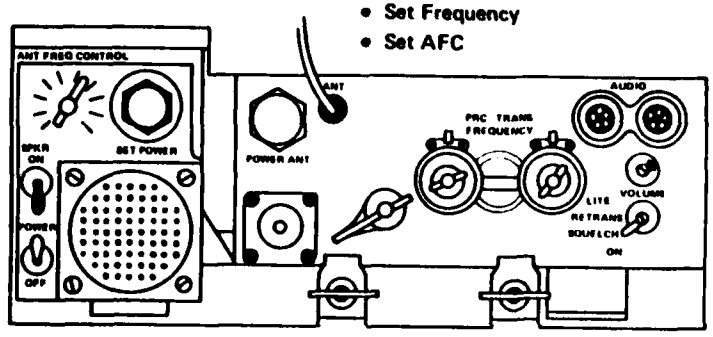
ADJUST HELMET
- Put On Helmet
- Adjust Mike
- Switch To Center

ADJUST CONTROL BOX
- Set Monitor
- Adjust Volume

CONNECT CABLES
- Connect Quick Disconnect
- Connect Audio Cables

SET RADIO TRANSMITTER

SET FREQUENCY
- Set Band
- Set Frequency
- Set AFC



SET SWITCHES
- Speaker Off
- Power On

ADJUST R-T CONTROLS
- Adjust Volume
- Set Function

SET AUDIO FREQUENCY AMPLIFIER

- Set Radio Transmitter
- Set INT Accent
- Set Main Power
- Set Power Circuit Breaker

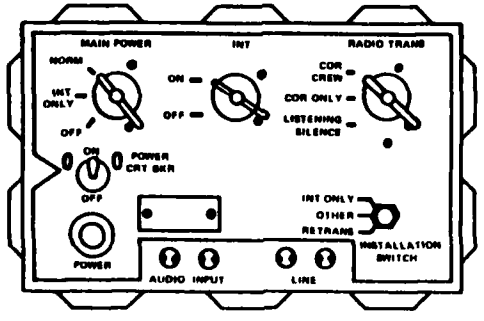


Figure 8. Training diagram for operate the AN/VRC-64 radio.

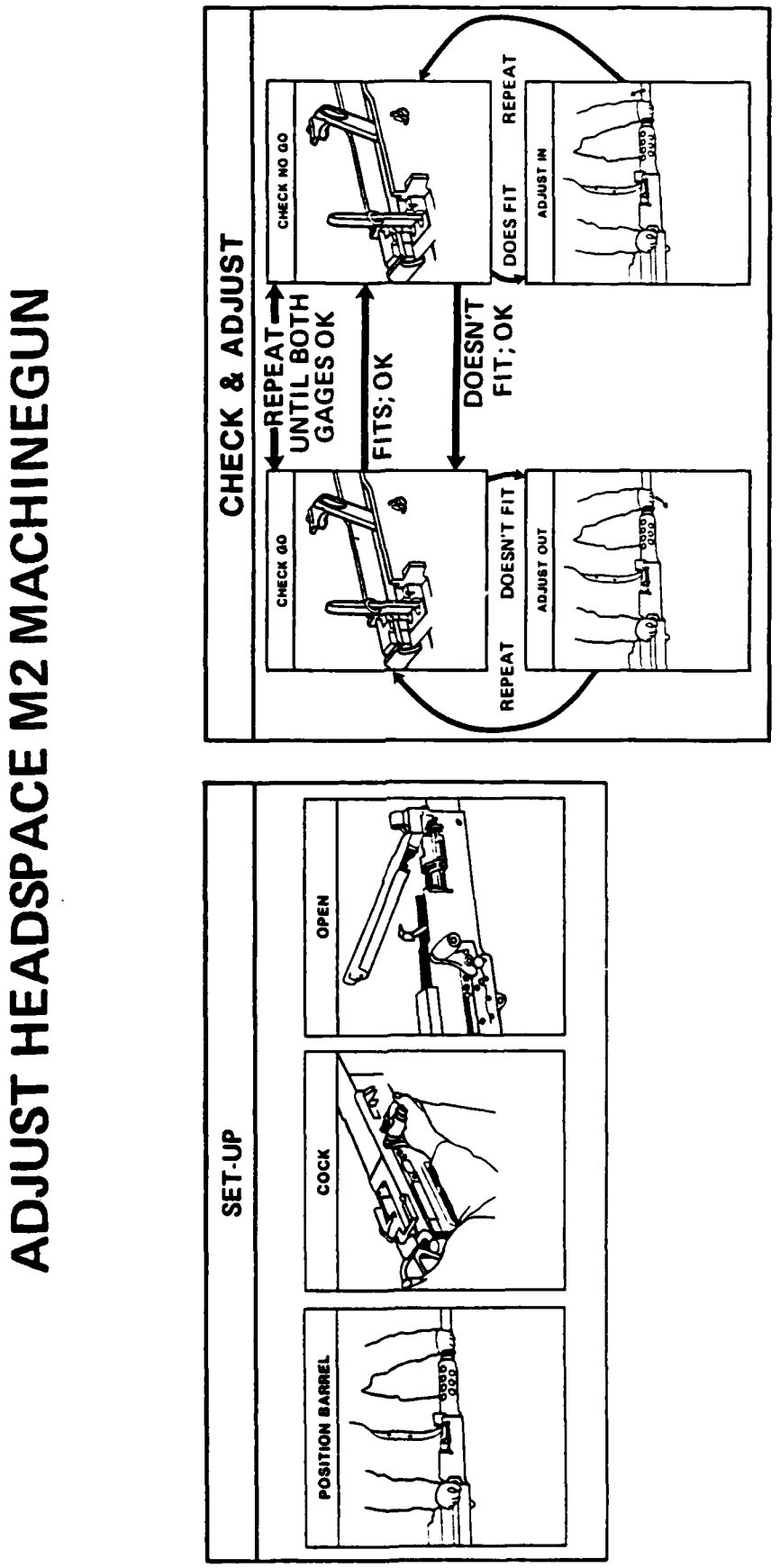


Figure 9. Training diagram for adjust the headspace on an M2 machinegun.

ENGINE COMPARTMENT FIRE M1 TANK

DETECT & DISCHARGE

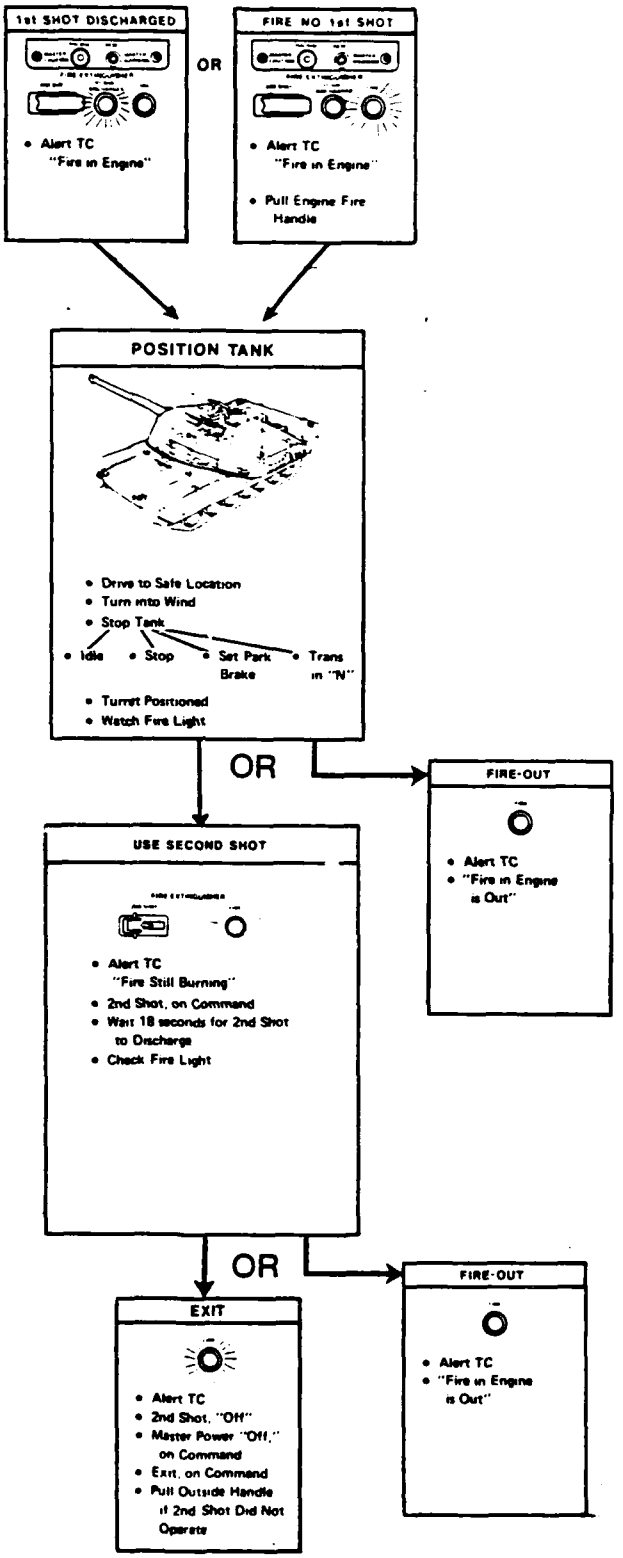


Figure 10. Training diagram for responding to an engine compartment fire in an M1 tank.

Training was then designed to give students the organizing structure to aid their recall of the task. Two alternative strategies for presenting the structure were developed: one in which the structure guided the presentation from the beginning of training, and one in which students were first allowed to have hands-on exposure to the task before being given the structure information. Training programs using these two training strategies, along with programs using the Army's standard performance-oriented training strategy were developed for four tasks performed by M1 (Abrams) tank crew members.

REFERENCES

Abelson, R.P. Psychological status of the script concept. American Psychologist, 1981, 36, 715-729.

Ausbel, D.P., Novak, J.D., & Hanesien, H. Educational psychology: A cognitive view. New York: Holt, Rinehart and Winston, 1978.

Battig, W.F., & Bellezza, F.S. Organization and levels of processing. In C.R. Puff (Ed.) Memory organization and structure. New York: Academic Press, 1979.

Cox, J.A. & Boren, L.M. A study of backward chaining. Journal of Educational Psychology, 1965, 56,

Department of the Army, Field Manual 21-6. How to prepare and conduct military training.

Diewert, G.L., & Stelmach, G.E., Perceptual organization in Motor Learning. In G.E. Stelmach (Ed.), Information in motor control and learning. New York: Academic Press, 1978.

Ehrlich, S. Semantic memory: A free-elements system. In C.R. Puff (Ed.) Memory organization and structure. New York: Academic Press, 1979.

Estes, W.K. Structural aspects of associative models for memory. In C.N. Cofer (Ed.) The structure of human memory. San Francisco: W.H. Freeman and Company, 1976.

Friendly, M. Methods for finding graphic representations of associative memory structures. In C.R. Puff (Ed.) Memory organization and structure. New York: Academic Press, 1979.

Gagne, R.M. The conditions of learning (Rev. ed.). New York: Holt, Rinehart and Winston, 1965.

Gilmartin, K.J., Newell, A., & Simon, H.A. A program modeling short-term memory under strategy control. In C.N. Cofer (Ed.) The structure of human memory. San Francisco: W.H. Freeman and Company, 1976.

Glaser, R. Instructional psychology: Past, present and future. American Psychologist, 1982, 37, 292-305.

Griffith, D. The keyword method of vocabulary acquisition: An experimental evaluation (TR-439). ARI Technical Report 439, January 1980.

Griffith, D., & Actkinson, T.R. Mnemonic enhancement and general technical ability ARI Technical Paper 336, September 1978.

Guilford, J.P. Psychometric methods. New York: McGraw-Hill, 1954.

Harris, J.H., Campbell, C.H., Kraemer, R.E., & Bessemer, D.W. Development of training objectives for XM1 UCOFT. ARI Research Product 81-6, January 1980.

Hoffman, R.G., Drucker, E.H., Morrison, J.E., & Goldberg, S.L. Memory organization-based methods of instruction: A comparison with performance-oriented training. Technical report, in preparation.

Johnson, S.C. Hierarchical clustering schemas. Psychometrika, 1967, 32, 241-254.

Mandler, G. Organization, memory and mental structures. In C.R. Puff (Ed.) Memory organization and structure. New York: Academic Press, 1979.

Mandler, J.M. Categorical and schematic organization in memory. In C.R. Puff (Ed.) Memory organization and structure. New York: Academic Press, 1979.

Miller, G.A., Galanter, E., & Pribram, K.H. Plans and the structure of behavior. New York: Henry Holt and Company, 1960.

Morrison, J.E. Retention of armor procedures: A structural analysis. ARI Technical Report, in preparation.

Morrison, J.E., & Goldberg, S.L. A cognitive analysis of armor procedural task training. ARI Technical Report, in preparation.

Pellegrino, J.W., & Ingram, A.L. Processes, products, and measures of memory organization. In C.R. Puff (Ed.) Memory organization and structure. New York: Academic Press, 1979.

Puff, R.C. Memory organization research and theory: The state of the art. In C.R. Puff (Ed.) Memory organization and structure. New York: Academic Press, 1979.

Reitman, J.S., & Rueter, H.H. Organization revealed by recall orders and confirmed by pauses. Cognitive Psychology, 1980, 12, 554-581.

Schvaneveldt, R.W., Goldsmith, T.E., Durso, F.T., Maxwell, K., & Acosta, H.M. Structures of memory for critical flight information. AFHRL Technical Paper 81-46, June 1982.

Segal, E.M. Hierarchical structure in free recall. Journal of Experimental Psychology, 1969, 80, 59-63.

Shuell, T.J. Clustering and organization in free recall. Psychological Bulletin, 1969, 72, 353-374.

Singer, R.N., Ridsdale, S., & Korienek, G.G. The influence of learning strategies in the acquisition, retention, and transfer of a procedural task. Florida State University Movement Science and Physical Education Department, Technical Report 408, August 1979.

Smith, E.E., & Goodman, L. Understanding instructions: The role of explantory material. Cambridge, MA: Bolt, Beranek, and Newman, Technical Report 5088, July 1982.

Tulving, E. Subjective organization in free recall of "unrelated words." Psychological Review, 1962, 69, 344-354.

Weinstein, C.E., Rood, M.M., Roper, C., Underwood, V.L., & Wicker, F.W. Field test of a revised form of the cognitive learning strategies training program with army enlisted personnel. University of Texas at Austin, Department of Psychology, Technical Report 462, August 1980.

Weinstein, C.E., Underwood, V.L., Wicker, F.W., & Cubberly, W.E. Cognitive learning strategies: Verbal and imaginal elaboration. In H.F. O'Neil & C.D. Spielberger (Eds.) Cognitive and affective learning strategies. New York: Academic Press, 1979.

Yore, B.J., Drucker, E.H., & O'Brien, R.E. Mission-based analysis of armor training requirement, Volume VII: Training objectives for the XM1 loader. ARI Research Product, in preparation.

APPENDIX A

Clear the M240 Training Program

Clear the M240 Machinegun
Unstructured POT

Instructor/Demonstration	Narrator	Visual (Slides)
Introductions, as needed. Record student's name and related information on record form.		
Turn on tape.	The task you are going to learn now is to Clear the M240 Machinegun.	
(Machinegun should be on a table laying on its side with cover and feed tray open. Dummy ammo on table.)	This machinegun is one of the weapons on the M1 tank. All crewmen on an M1 tank must be able to operate this weapon. This includes both firing it and clearing it. After the machinegun has been fired, whether on a range or in battle, it is necessary for safety to clear the weapon, that is, to make sure a round is not left in the chamber. If a round is still there, it must be removed. Making sure the chamber is empty is called clearing the weapon. You must learn how to clear the M240 machinegun so that it does not accidently discharge and injure (or kill) someone. Here is how we will proceed. First, we will name the parts of the M240. Then, we will	

demonstrate, step by step, how to clear the M240. You will then practice doing the steps. An instructor will help you as you practice. You will continue practicing the steps for the rest of the period of instruction.

We will begin by naming the parts of the M240 that you will be working with. These parts are the safety switch, trigger, charging handle, receiver, chamber, bolt, feed tray and cover. Ammo on a belt enters the machinegun through the feed tray.

Point to each.

Close feed tray and cover.
Pick up ammo belt.

We will now demonstrate the eleven steps needed to clear the M240. Watch the demonstrator as he tells you about the steps being performed.

Demonstrate each step.

The first thing you must do is place the safety to "F".

Second, pull the charging handle all the way to the rear until you hear it catch.

Next, place the safety to "S". This is important so you won't smash your finger later on.

Fourth, push in the latch and open the cover.

Fifth, check the feed tray for any ammo. If there is an ammo belt on the feed tray, simply pick it up and remove it.

The sixth step is to raise the feed tray.

Then, seventh, carefully look and feel for ammo in the receiver or chamber. There ordinarily should be no ammo in the receiver or chamber.

Now, eighth, close the feed tray.

Then, ninth, close the cover.

Tenth, place the safety to "F".

Last, hold back on the charging handle, press the trigger and ride the handle to the forward position.

That completes the steps for clearing the M240. Now you will practice the steps. When you practice try to remember that you must

Point to the parts as stated.

1. Put the safety on "F".
2. Pull the charging handle to the rear.
3. Put the safety on "S".
4. Open the cover.
5. Check for an ammo belt.
6. Lift the feed tray.
7. Look and feel for any ammo.
8. Lower the feed tray.
9. Close the cover.
10. Put the safety on "F".
11. Pull the trigger and ride the charging handle forward.

The instructor will first talk you through the steps, and then you will practice. Practice so that you can perform all the steps needed to Clear the M240.

The best way to learn this task so that you can remember how to do it is to practice the steps.

Clear the M240 Machinegun
Bottom-up Presentation

Instructor/Demonstration	Narrator	Visual (Slides)
Introductions, as needed. Record student's name and related information on record form.		
Turn on tape.	The task you are going to learn now is to Clear the M240 Machinegun.	
(Machinegun should be on a table laying on its side with cover and feed tray open. Dummy ammo on table.) Point to each.	This machinegun is one of the weapons on the M1 tank. All crewmen on an M1 tank must be able to operate this weapon. This includes both firing it and clearing it.	
	After the machinegun has been fired, whether on a range or in battle, it is necessary for safety to clear the weapon, that is, to make sure a round is not left in the chamber. If a round is still there, it must be removed. Making sure the chamber is empty is called clearing the weapon. You must learn how to clear the M240 machinegun so that it does not accidently discharge and injure (or kill) someone.	
	Here is how we will proceed. First, we will name the parts of the M240. Then, we will	

demonstrate, step by step, how to clear the M240. You will then practice doing the steps. An instructor will help you as you practice. After you have practiced for a while, and learned how to do each of the steps, we will give you some additional information which will help you remember the task.

We will begin by naming the parts of the M240 that you will be working with. These parts are the safety switch, trigger, charging handle, receiver, chamber, bolt, feed tray and cover. Ammo on a belt enters the machinegun through the feed tray.

Close feed tray and cover.
Pick up ammo belt.

We will now demonstrate the eleven steps needed to clear the M240. Watch the demonstrator as I tell you about the steps being performed.

Demonstrate each step.

The first thing you must do is place the safety to "F".

Second, pull the charging handle all the way to the rear until you hear it catch.

Next, place the safety to "S". This is important so you won't smash your finger later on.

Fourth, push in the latch and open the cover.

Fifth, check the feed tray for any ammo. If there is an ammo belt on the feed tray, simply pick it up and remove it.

The sixth step is to raise the feed tray.

Then, seventh, carefully look and feel for ammo in the receiver or chamber. There ordinarily should be no ammo in the receiver or chamber.

Now, eighth, close the feed tray.

Then, ninth, close the cover.

Tenth, place the safety to "F".

Last, hold back on the charging handle, press the trigger and ride the handle to the forward position.

That completes the steps for clearing the M240. Now you will practice the steps. When you practice try to remember that you must

Point to the parts as stated.

1. Put the safety on "F".
2. Pull the charging handle to the rear.
3. Put the safety on "S".
4. Open the cover.
5. Check for an ammo belt.
6. Lift the feed tray.
7. Look and feel for any ammo.
8. Lower the feed tray.
9. Close the cover.

10. Put the safety on "F".
11. Pull the trigger and ride the charging handle forward.

The instructor will first talk you through the steps, and then you will practice.

(PRACTICE PERIOD)

Start tape.

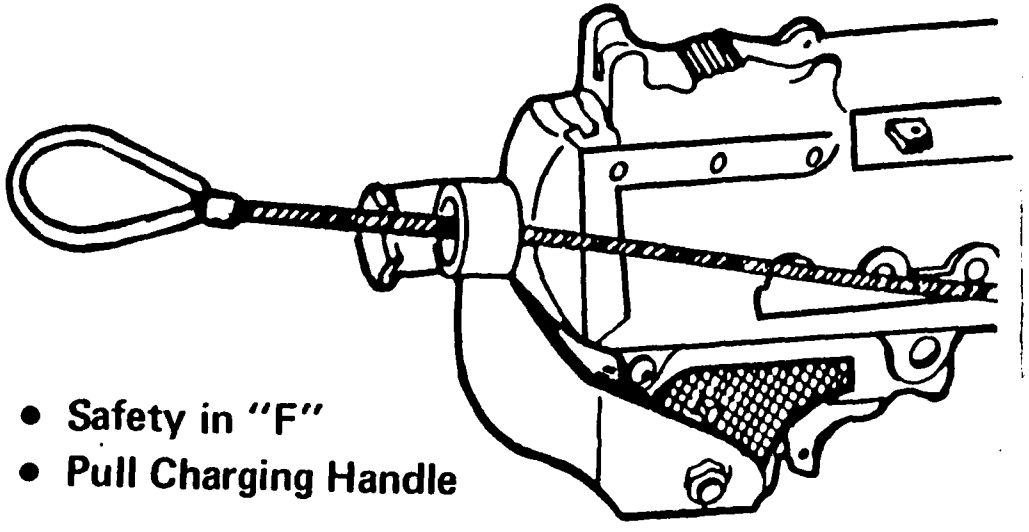
You have now practiced the steps needed to clear the M240. We are now going to review the steps and put them together in a way that should help you remember them.

Because you have already received extensive instruction and practice on the M16 rifle, we will point out the similarities and the differences between clearing the M16 and clearing the M240. This will help you remember the steps needed to clear the M240.

The first two steps in clearing the M240 were first to make sure the safety switch was in "F" and second to pull the charging handle all the way to the rear. When you have done these two steps, you will have moved the bolt to the rear of the weapon. The bolt will stay in the rear position when you release the handle. That is just like clearing the M16, only easier because the bolt stays back automatically without you having to trip a bolt catch like you do on the M16. Again, on the M240, to move the bolt back to the rear, put the

1) Bolt to rear portion of structure.

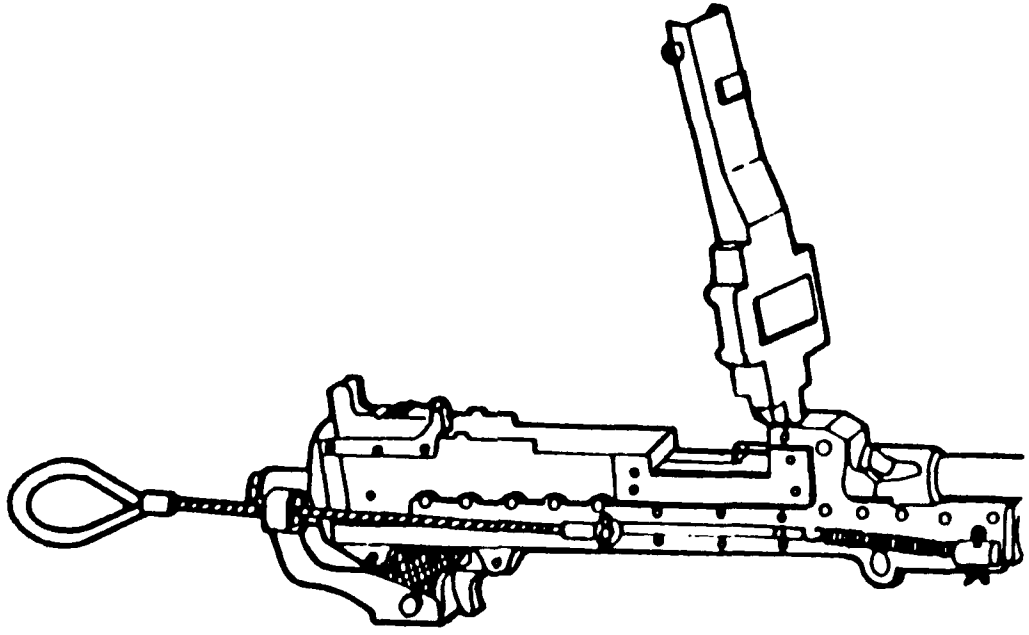
BOLT TO REAR



- Safety in "F"
- Pull Charging Handle

	safety on "F" and pull the charging handle all the way back.	
Continuing using chart.	The next two steps in clearing the M240 were to put the safety on "S" and then to open the cover. Opening the cover is the first new step to remember because the M16 has no cover.	2) Open cover portion of chart.
Point to top and then middle layer of structure.	When you have moved the bolt to the rear and opened the cover, you will have opened up the weapon in order to check it for ammo. So the first thing you must remember when clearing the M240 is that you must open it up, by first moving the bolt to the rear, just like the M16, and then by opening the cover.	3) Open weapon portion of chart.
	Once you have opened the weapon, you check for an ammo belt, lift the lift tray and check for ammo in the receiver and chamber. In an M16 all you needed to do was to look in the receiver and chamber. Since ammo enters the M240 on a belt through the feed tray, you must check the feed tray as well as the receiver and chamber. You also have to lift up the feed tray in order to look and feel in the receiver and chamber.	4) Check ammo portion of chart.
	So far we have found that just like the M16 there are two major steps for clearing the M240: opening up the weapon and checking for ammo.	5) Blank.

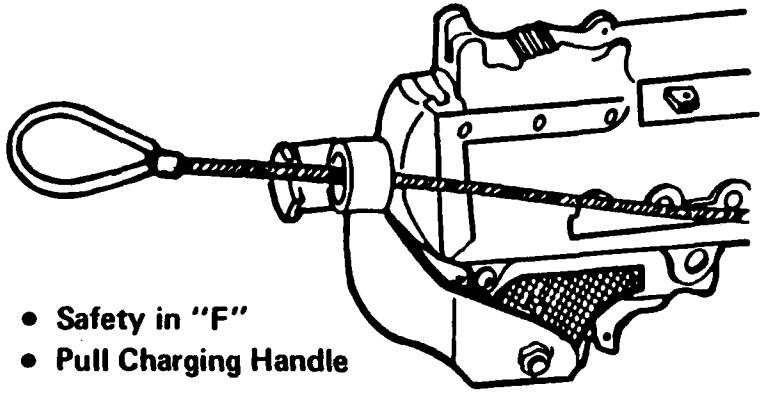
OPEN COVER



- Safety in "S"
- Open Cover

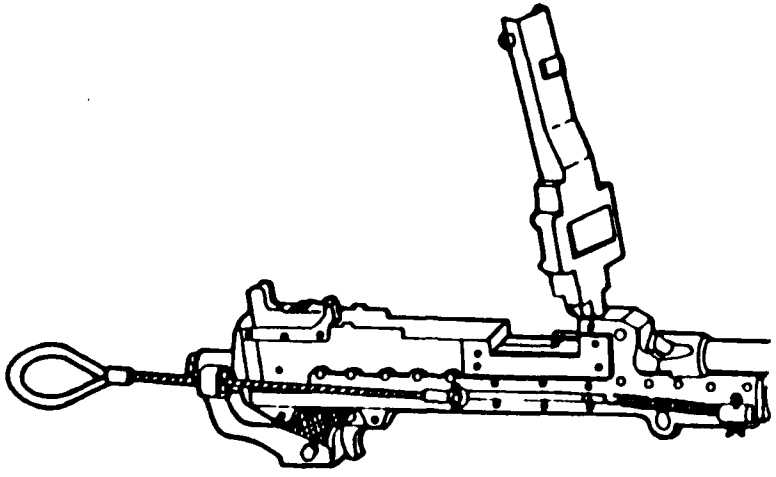
OPEN WEAPON

BOLT TO REAR



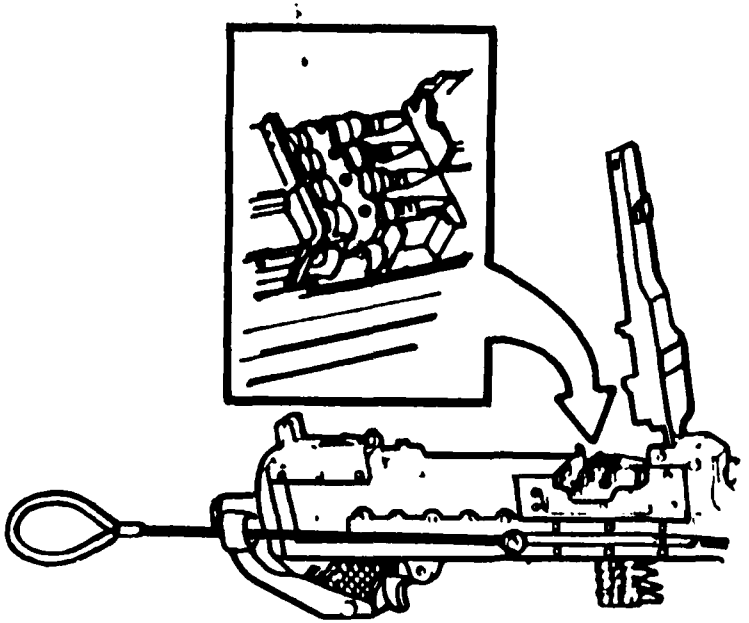
- Safety in "F"
- Pull Charging Handle

OPEN COVER



- Safety in "S"
- Open Cover

CHECK FOR AMMO



- Remove Ammo Belt
- Lift Feed Tray
- Look and Feel

The next steps are to lower the feed tray and to close the cover. This closes up the outer portion of the weapon.

6) Close cover portion of chart.

The last two steps are to put the safety on "F". Then pull the trigger while riding the handle forward. This will cause the bolt to be returned to the forward position. Again, this is similar to the M16 in that the last steps in clearing the M16 are to close the weapon by returning the bolt to the forward position. By closing the cover and returning the bolt to the forward position, you have closed the weapon.

7) Bolt forward portion of chart.

8) Close weapon portion of chart.

Let's review:

Clearing the M240 involves three basic steps:

9) Total chart.

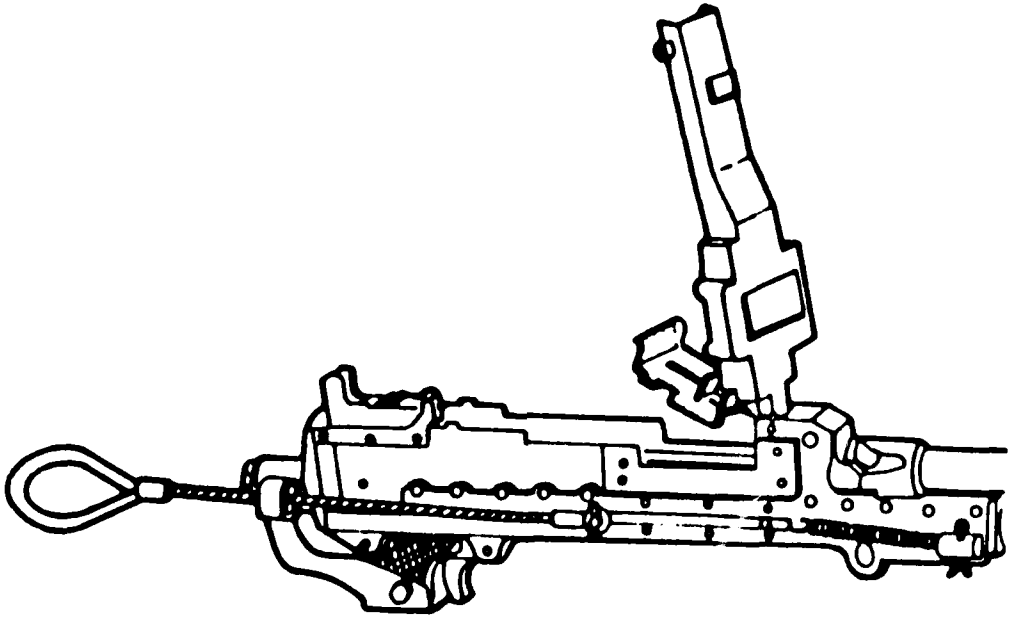
.open the weapon
.check for ammo
.close the weapon

To open the weapon, remember to move the bolt to the rear and open the cover.

Check for ammo on the feed tray and in the receiver and chamber.

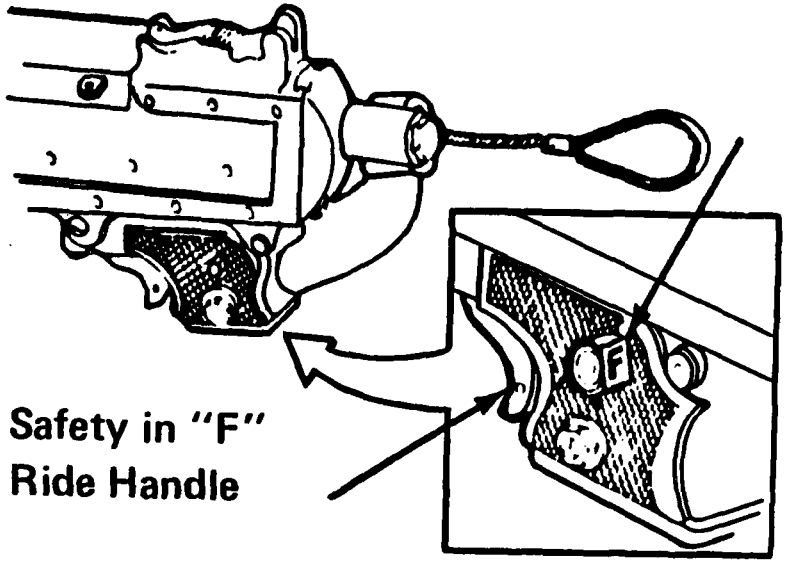
Finally, close the weapon by closing the cover and returning the bolt to the forward position.

CLOSE COVER



- Lower Feed Tray
- Close Cover

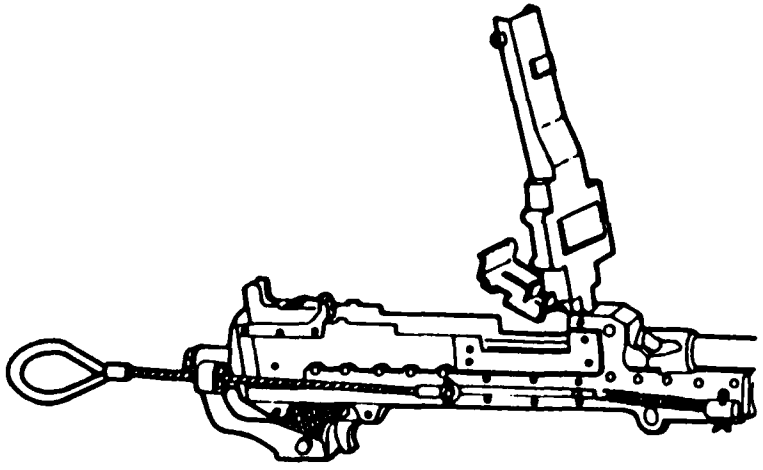
BOLT FORWARD



- Safety in "F"
- Ride Handle

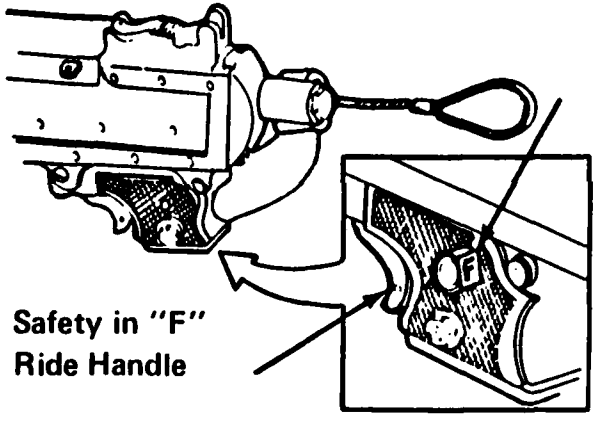
CLOSE WEAPON

CLOSE COVER

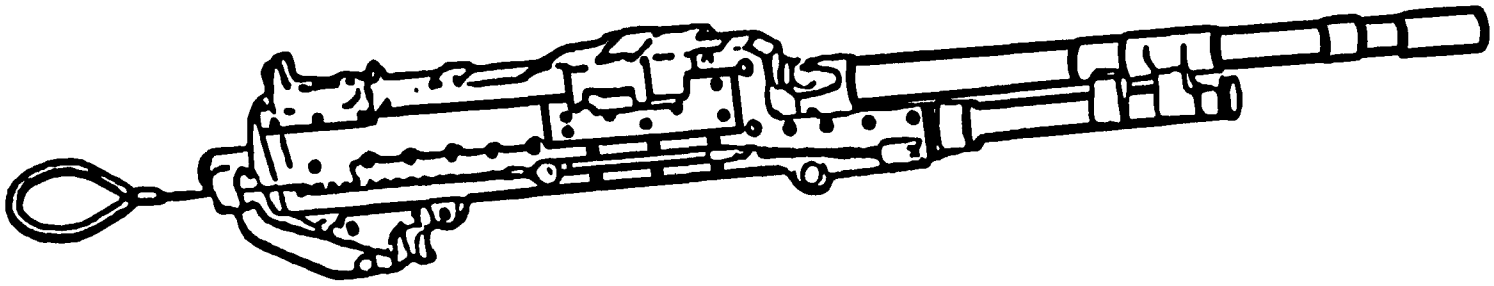


- Lower Feed Tray
- Close Cover

BOLT FORWARD

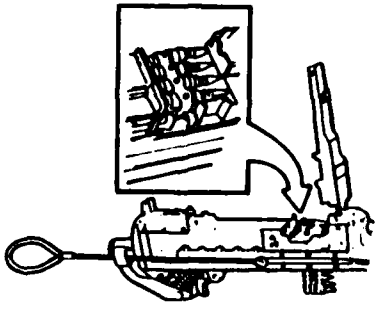


- Safety in "F"
- Ride Handle



CLEAR THE M240 MACHINEGUN

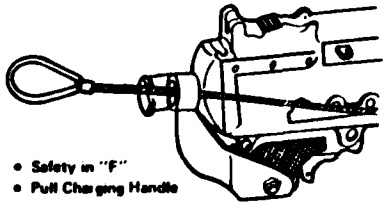
CHECK FOR AMMO



- Remove Ammo Belt
- Lift Feed Tray
- Look and Feel

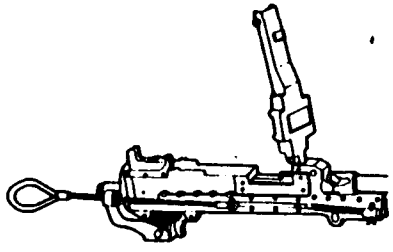
OPEN WEAPON

BOLT TO REAR



- Safety in "F"
- Pull Charging Handle

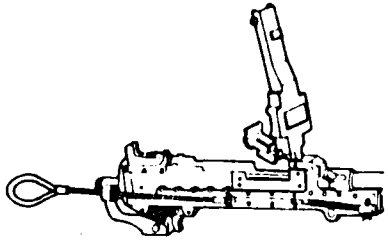
OPEN COVER



- Safety in "S"
- Open Cover

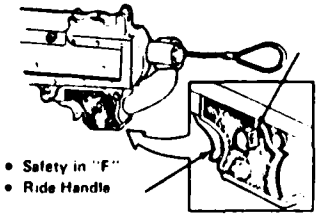
CLOSE WEAPON

CLOSE COVER



- Lower Feed Tray
- Close Cover

BOLT FORWARD



- Safety in "F"
- Ride Handle

Now, you will continue practicing clearing the M240. This time, say out loud which group of steps you are about to do, using the outline that has just been described. Practice so that you can perform all of the steps needed to clear the M240.

Clear the M240 Machinegun
Top-down Presentation

Instructor/Demonstration	Narrator	Visual (Slides)
Introductions, as needed. Record student's name and related information on record form.		
Turn on tape.	The task you are going to learn now is to Clear the M240 Machinegun.	
(Machinegun should be on a table laying on its side with cover and feed tray open. Dummy ammo on table.)	This machinegun is one of the weapons on the M1 tank. All crewmen on an M1 tank must be able to operate this weapon. This includes both firing it and clearing it.	
	After the machinegun has been fired, whether on a range or in battle, it is necessary for safety to clear the weapon, that is, to make sure a round is not left in the chamber. If a round is still there, it must be removed. Making sure the chamber is empty is called clearing the weapon. You must learn how to clear the M240 machinegun so that it does not accidently discharge and injure (or kill) someone.	
	Here is how we will proceed. First, we will name the parts of the M240. Then because you have	

already received extensive instruction and practice with the M16 rifle, we will tell you about some of the similarities between the M16 and M240. You will discover that you already know a lot about clearing the M240 because it is similar to clearing the M16. Pointing out the similarities and the differences between clearing the M16 and clearing the M240 will help you remember the steps needed to clear the M240. We will also demonstrate how to clear the M240 and then let you practice. An instructor will help you as you practice. You will continue to practice the steps for the rest of the period of instruction.

We will begin by naming the parts of M240 that you will be working with, and by pointing out the similarity of these parts to the M16 rifle. Although the parts look different from the M16 rifle, the M240 has a safety switch, a trigger and a charging handle. The M240 safety switch has only two positions: safe and fire, rather than three positions like the M16. Inside of the M240 is the receiver, the chamber and the bolt. The M240 does not have a magazine like the M16 does. Instead it has a feed tray which feeds ammo which is clipped

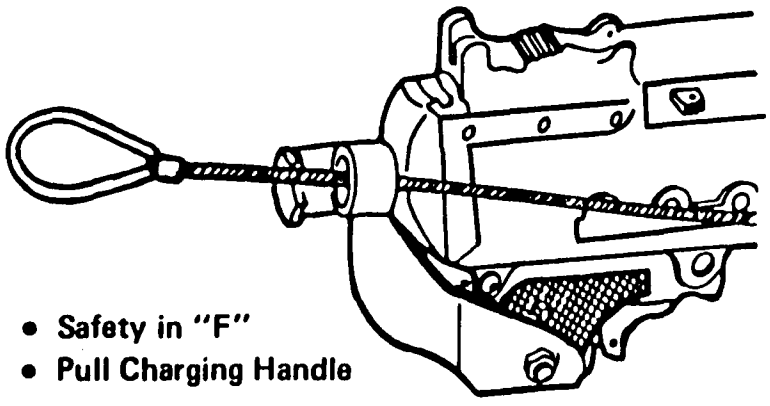
Point to each on the M240.

Point to feed tray and close it.

Pick up ammo belt. Close cover and set M240 up right.	together in an ammo belt. Finally, there is a cover on the M240. Clearing the M240 is like clearing the M16 because there are three basic things that have to be done: First you must open the weapon. Second, you check the receiver and chamber for ammo, and third you close the weapon. These are the basic steps that you need to remember: open the weapon, check for ammo and close the weapon. Obviously, there are differences between the M240 and the M16 in the way they are made and in the way they operate. For example, the M240 has no magazine but does have a feed tray and cover. So to open the M240 you have to pull the bolt to the rear (like the M16). In addition you have to open the cover.	1) Show open weapon portion for structure.
Now demonstrate.	To move the bolt to the rear, place the safety to "F", and pull back on the charging handle. You will hear the bolt automatically catch, so when you release the handle the bolt will stay to the rear.	2) Bolt to rear.
Continue demonstrating.	Before opening the cover, place the safety to "S". With the weapon on "S", the bolt can not fly forward and smash your finger.	3) Open Cover.

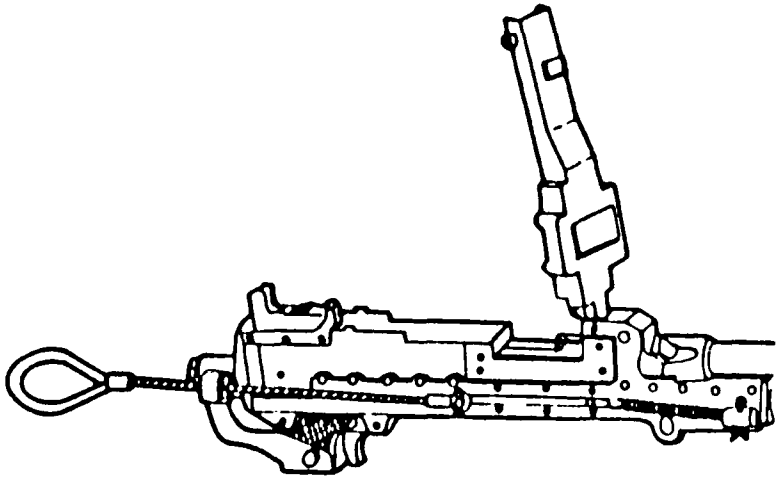
OPEN WEAPON

BOLT TO REAR



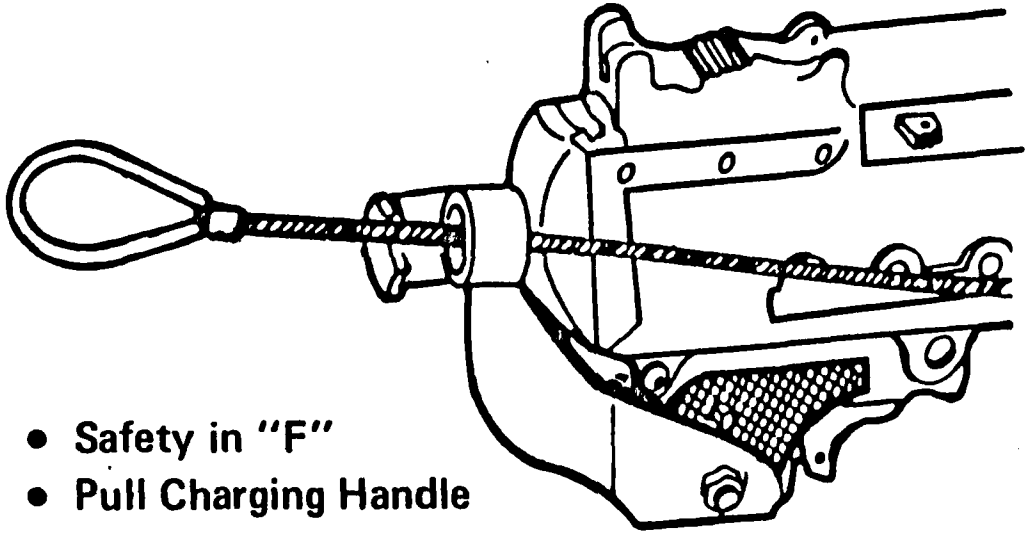
- Safety in "F"
- Pull Charging Handle

OPEN COVER



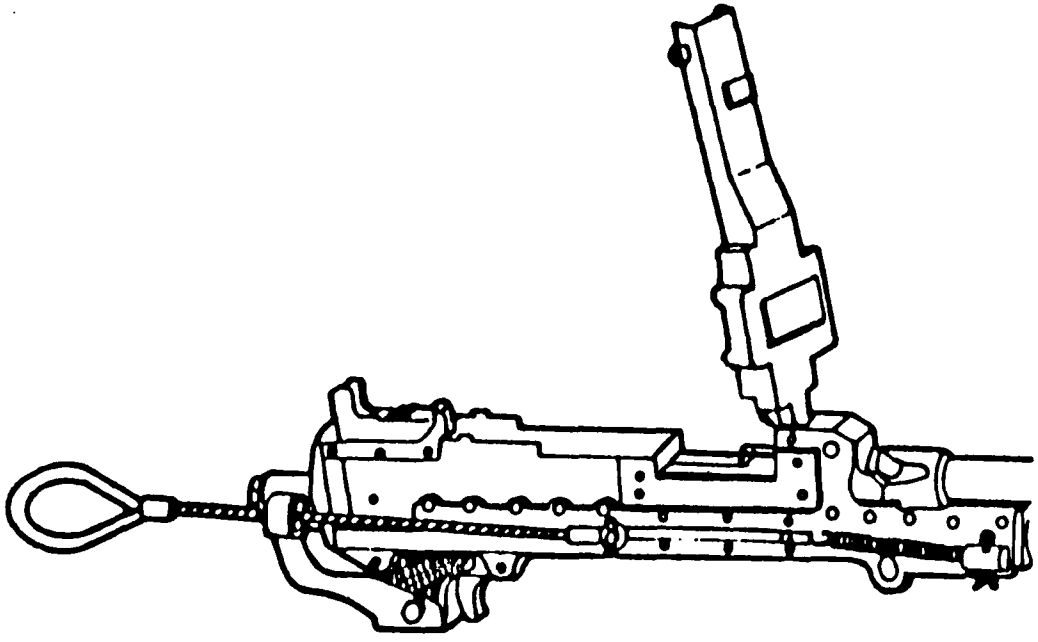
- Safety in "S"
- Open Cover

BOLT TO REAR



- Safety in "F"
- Pull Charging Handle

OPEN COVER



- Safety in "S"
- Open Cover

Now open the cover by squeezing the latches and lifting the cover. This completes opening the M240.

So, the first thing to remember in clearing the M240 is to open the weapon. To open the weapon move the bolt to the rear and open the cover. Put the safety in "F" before pulling back on the charging handle, and then put in on "S" before opening the cover.

Once you have opened the weapon, you next check for ammo. In an M16 all you needed to do was look in the receiver and chamber. Since ammo enters the M240 on a belt through the feed tray, the first step in checking for ammo in the M240 is to check the feed tray. If there is an ammo belt on the feed tray, simply pick it up and remove it. Now you lift the feed tray in order to see into the receiver and chamber.

Carefully look and feel for ammo in the receiver or chamber. There ordinarily should be no ammo in the receiver or chamber.

So there are three steps to remember to check for ammo:

.check for ammo belt.
.lift the feed tray, then
.look and feel in receiver and chamber.

4) Blank

5) Check for ammo portion of the structure chart.

The last step in clearing a weapon is to close it by returning the bolt forward. On the M16, you'll remember that all you needed to do was press the bolt catch. On the M240, however, you first have to close the cover. Just lower the feed tray and close the cover. Make sure the cover is latched.

6) Close weapon portion of the M240.

Demonstrate.

7) Close cover.

Since the M240 has no bolt catch, the bolt may be moved forward by first putting the safety on "F". Then, hold back on the charging handle, press the trigger, and ride the handle to the forward position. When the bolt is in the forward position, the weapon is closed.

8) Bolt forward.

This completes the steps for clearing the M240. The weapon has been opened, checked for ammo and then closed.

Now you will practice the steps. When you practice try to remember that clearing the M240 involves three basic steps:

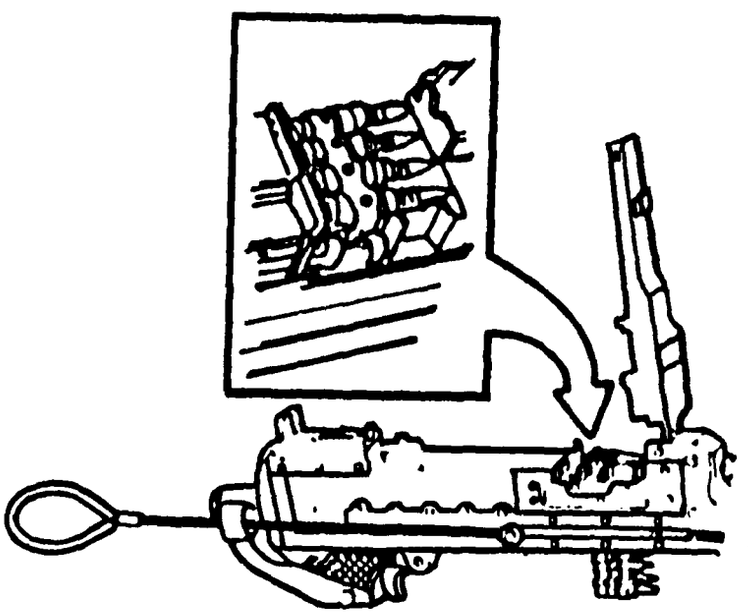
9) Show chart of total structure.

.open the weapon
.check for ammo
.close the weapon

Point to weapon.

In order to open the weapon, you have to remember to move the bolt to the rear and then open the cover. To move the bolt to the rear, you put the safety on "F" and pull back on the charging

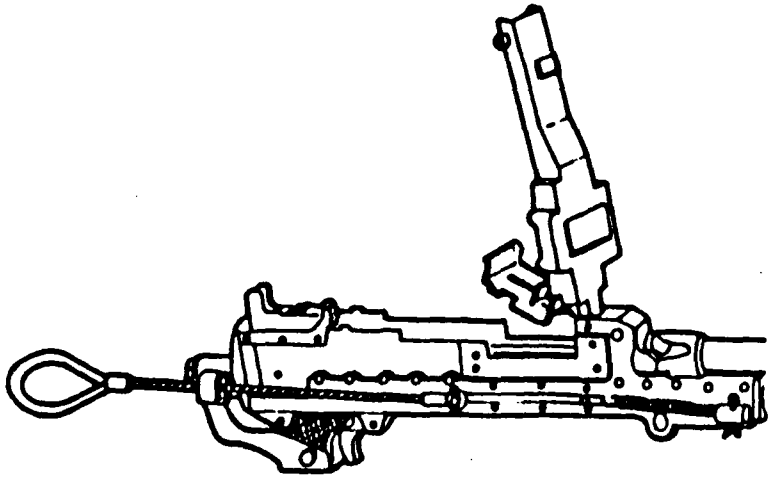
CHECK FOR AMMO



- Remove Ammo Belt
- Lift Feed Tray
- Look and Feel

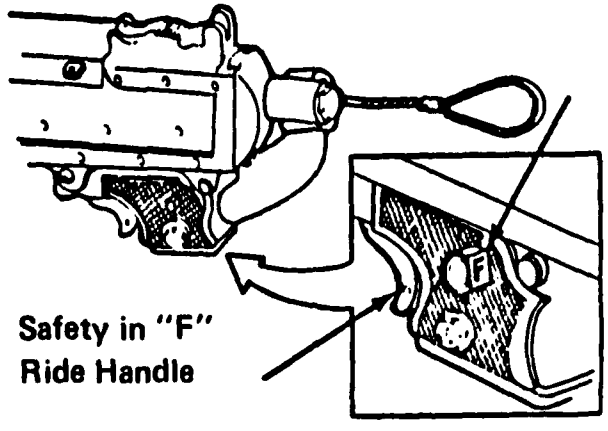
CLOSE WEAPON

CLOSE COVER



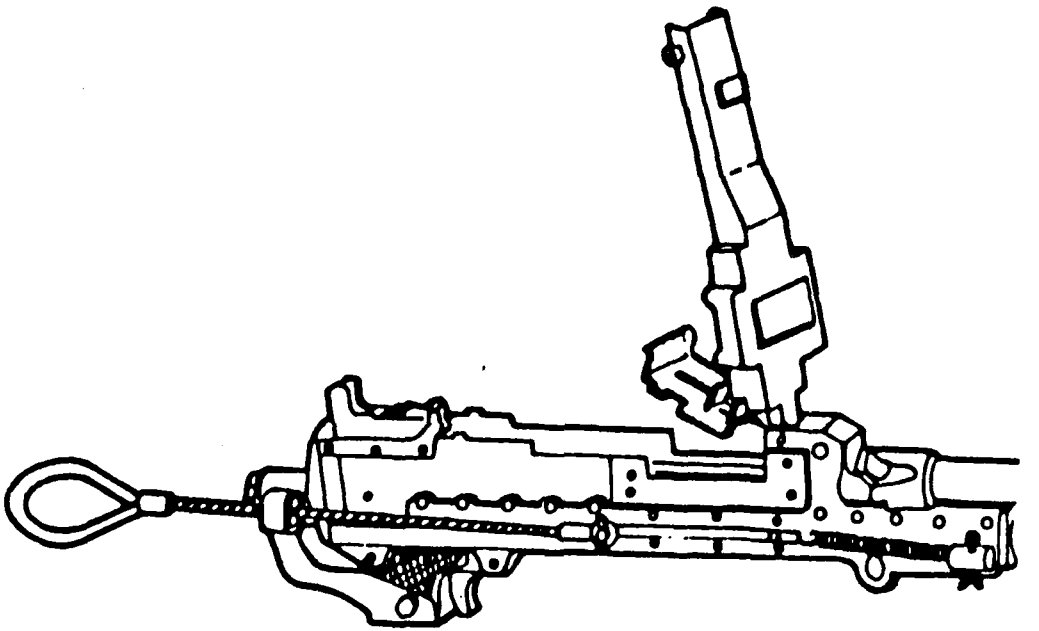
- Lower Feed Tray
- Close Cover

BOLT FORWARD



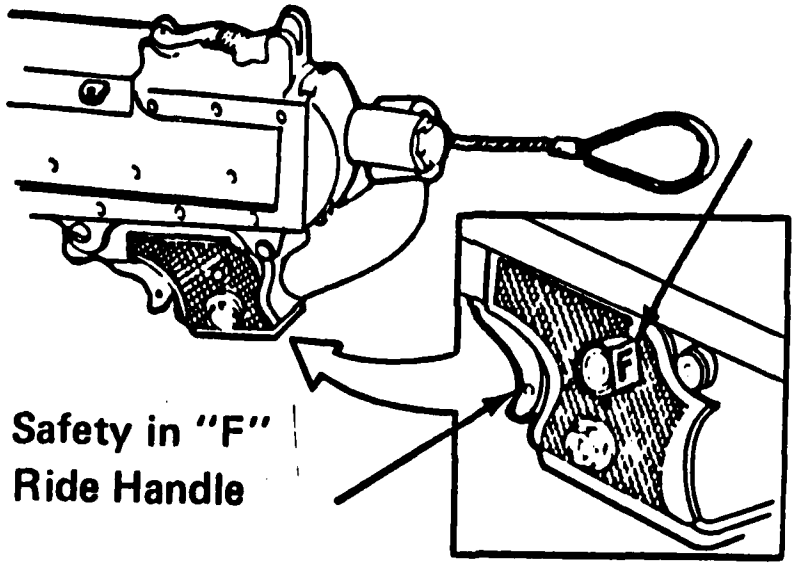
- Safety in "F"
- Ride Handle

CLOSE COVER

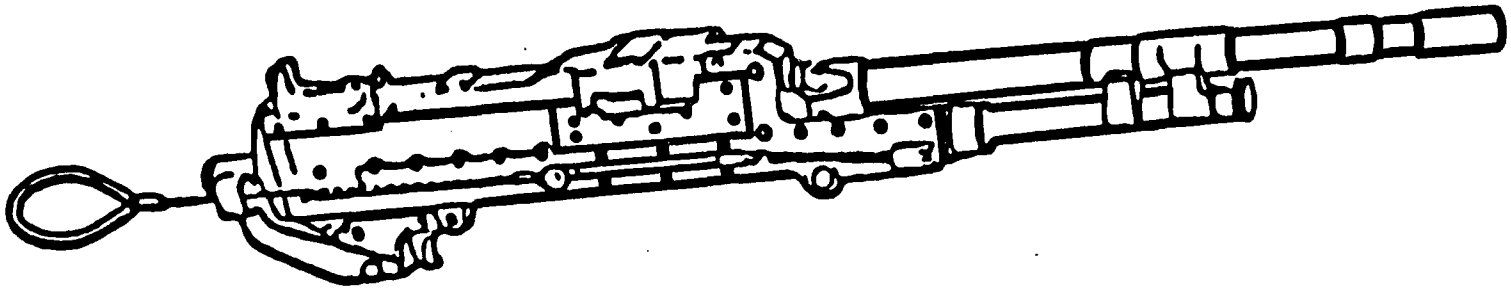


- Lower Feed Tray
- Close Cover

BOLT FORWARD

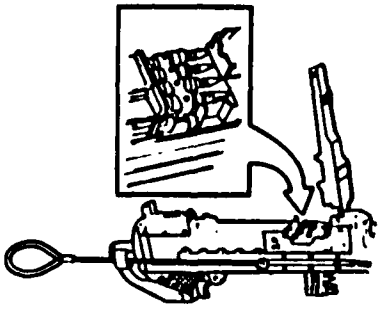


- Safety in "F"
- Ride Handle



CLEAR THE M240 MACHINEGUN

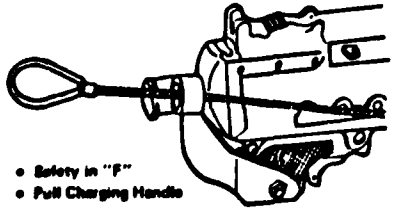
CHECK FOR AMMO



- Remove Ammo Belt
- Lift Feed Tray
- Look and Feel

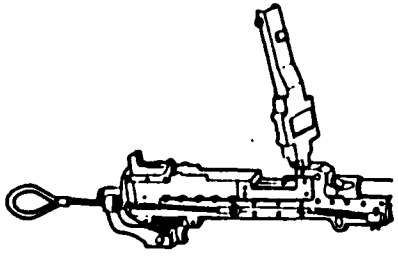
OPEN WEAPON

BOLT TO REAR



- Safety in "F"
- Pull Charging Handle

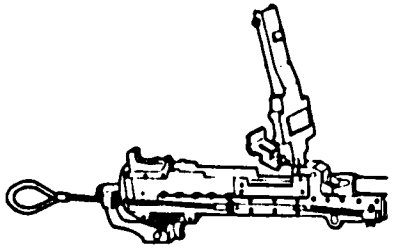
OPEN COVER



- Safety in "S"
- Open Cover

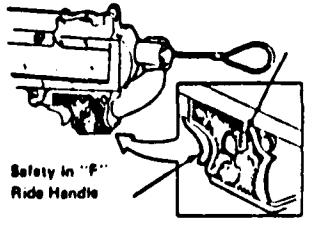
CLOSE WEAPON

CLOSE COVER



- Lower Feed Tray
- Close Cover

BOLT FORWARD



- Safety in "F"
- Ride Handle

handle. To open the cover, put the safety on "S" and open the cover.

To check for ammo, first look for ammo on the feed tray, then open the feed tray and look and feel for ammo in the receiver and chamber.

Finally, to close the weapon you should remember to close the cover and release the bolt to the forward position. To close the cover, just let the feed tray down, and snap the cover down. To let the bolt go forward, put the safety on "F", then ride the handle forward as you pull the trigger.

The instructor will first talk you through the steps. Then you will practice. When you practice, say out loud which group of steps you are about to do, using the outline that has just been described. Practice so that you can perform all of the steps needed to clear the M240.

APPENDIX B

Adjust the M2 Machinegun Headspace Training Program

Set the Headspace on the M2 Machinegun
Unstructured POT presentation

Instructor/Demonstrator	Narrator	Visual
Introductions, as needed. Record student's name and related information on record form.		
Turn on tape recorder. M2 should be on table with the cover open, the barrel out of adjustment (too far out) and not cocked.	The task you are now going to learn is to set the headspace on an M2 machinegun. As you can see the M2 is a heavy machinegun. It is one of the Army's largest machineguns, and fires .50 caliber ammunition. It is also one of the oldest weapons still being used by the Army. It has been used since before World War II. Currently, one of its uses is as the tank commander's weapon mounted on Army's newest tank, the M1. There are two critical adjustments which must be made on the M2 in order for it to fire properly. You are going to learn one of those adjustments. It's called setting the headspace. Here is how we will proceed. First, we will name the parts to the M2. Then we will demonstrate one step at a time how to set the headspace. You will then practice setting the headspace. An instructor will help you as you practice.	

	You will continue to practice the steps for the rest of the period of instruction.
	We will begin by naming the component parts of the M2 that you will be working with.
Point to each as stated.	This is the barrel. The machine-gun has a cover on top. Inside is the bolt assembly, and the extractor. The "headspace" that we will adjust is this area. The firing
Make sure soldier can see. Tilt M2 so he can see.	pin can be seen in this space when the M2 is not cocked. The M2 is cocked with the charging handle.
Close the cover.	The trigger and bolt release are on the end of the weapon. Finally, there is the headspace gage used to measure the headspace.
Demonstrate each task.	We will now demonstrate the steps. Watch the instructor as I tell you the steps being performed.
	The first step is to push back on the charging handle until you can see the locking lug in the center of the small hole on the right side of the weapon.
	Second, screw the barrel in all the way. Listen for the clicking sound.
	Third, screw the barrel back out two clicks.
	Fourth, release the charging handle.

Fifth, cock the weapon.

You cock the M2 by pulling the charging handle all the way to the rear. You can't just pull back on the charging handle and expect to get it cocked. Instead you have to brace yourself hard against the back of the M2 with your left hand, and grasp the handle with your right hand, palm up. Then, push with your left arm and jerk the handle hard with your right arm. Watch the demonstrator.

The next step is to hold the charging handle tightly, press the bolt release, and then, let the handle move forward slowly.

The seventh step is to raise the cover.

Eighth, raise the extractor.

Now, retract the charging handle so the bolt assembly moves back about 1/16 inch.

Now use the headspace gage. It has a GO gage on one end and a NO GO gage on the other. First, try to insert the GO gage. Use gentle pressure; don't force the gage.

If the GO gage does not fit, continue with the next step. What to do when the GO gage fits will be described later.

Again, if the GO end does not fit, the next step is to retract the charging handle so the locking lug shows in the side hole.

Turn the barrel toward you one click, and then release the charging handle.

Next, retract the charging handle so the bolt moves back 1/16 inch, and try to insert the GO gage again. If it still does not fit, retract the charging handle again so the locking lug shows, turn the barrel toward you one more click, release the charging handle. Next, retract the charging handle so the bolt moves back 1/16 inch, and try to insert the GO gage again. Repeat these steps until the GO gage fits the space. If you turn the barrel out five clicks (not counting the two clicks at the beginning of the procedure) and the GO gage still does not fit, the weapon is defective and must be turned in to the armorer for maintenance.

Continue until adjusted.

(Pause on tape.)

When the go gage fits into the space, try to insert the NO GO gage. If the NO GO gage does not fit, the procedure is completed.

Take barrel out several clicks and restart the tape.

If the NO GO gage does fit into the space, follow these steps:

Retract the charging handle so the locking lug shows in the side hole.

Turn the barrel away from you one click, release the charging handle, and retract the charging handle so the bolt moves back 1/16 inch. Then try to insert the NO GO end again.

Repeat these steps if necessary until the NO GO gage does not fit the space.

(Pause.)

If you turn the barrel any time after inserting the NO GO gage, you must try to insert the GO gage again. If it still fits, the headspace is properly set. If it no longer fits, you must retract the charging handle so the locking lug shows in the side hold, turn the barrel toward you one click, release the charging handle, and retract the charging handle so that the bolt moves back 1/16 inch and insert the GO gage. Repeat these steps until the GO gage fits the space.

Remember, any time you turn the barrel, you must make certain that the GO gage fits and the NO GO gage does not. When you have shown this, then the headspace is set.

If the NO GO gage happens to fit the space and you have not moved the barrel since you set it at two clicks out, then the weapon is defective and must be turned in to the armorer of maintenance.

When the NO GO gage does not fit the space and the GO gage does, the headspace is properly set.

That completes the steps for setting the headspace on the M2 machinegun. Now you will practice the steps. When you practice remember that you must:

1. Retract the charging handle.
2. Screw the barrel in all the way.
3. Screw the barrel toward you two clicks.
4. Release the charging handle.
5. Cock the M2.
6. Release the bolt.
7. Raise the cover.
8. Raise the extractor.
9. Retract the handle slightly.
10. Try to insert the GO gage.
    If it does not fit,
    . retract the charging handle.
    . Screw the barrel toward you one more click.
    . Release the charging handle.
    . Retract the charging handle slightly.
    . Try again to insert the GO gage.
    . Repeat until GO gage fits.
11. Try to insert the NO GO gage. If it does not fit, task is finished. If it does fit,
    . Retract the charging handle.

- Screw the barrel away from you one click.
- Release the charging handle.
- Retract the charging handle slightly.
- Try again to insert NO GO gage.
- Repeat until NO GO gage will not fit.

12. Repeat these procedures until the GO fits, but the NO GO gage does not fit. The gun is defective if the NO GO gage will fit after the barrel is turned out two clicks or if the GO does not fit after the barrel is turned out five more clicks.

The instructor will first talk you through the steps, and then you will practice. Practice so that you can perform all the steps needed to set the headspace on the M2 machinegun.

The best way to learn this task so that you can remember how to do it is to practice the steps.

Set the Headspace on the M2 Machinegun
Bottom-up presentation

Instructor/Demonstrator	Narrator	Visual
Introductions, as needed. Record student's name and related information on record form.		
Turn on tape recorder. M2 should be on table with the cover open, the barrel out of adjustment (too far out) and not cocked.	The task you are now going to learn is to set the headspace on an M2 machinegun. As you can see the M2 is a heavy machinegun. It is one of the Army's largest machineguns, and fires .50 caliber ammunition. It is also one of the oldest weapons still being used by the Army. It has been used since before World War II. Currently, one of its uses is as the tank commander's weapon mounted on Army's newest tank, the M1. There are two critical adjustments which must be made on the M2 in order for it to fire properly. You are going to learn one of those adjustments. It's called setting the headspace. Here is how we will proceed. First, we will name the parts to the M2. Then, we will demonstrate one step at a time how to set the headspace. You will then practice setting the headspace. An instructor will help you as you practice.	

After you have practiced for a while and learned how to to each of the steps, we will give you some additional information which will help you remember the task.

We will begin by naming the component parts of the M2 that you will be working with.

Point to each as stated.

This is the barrel. The machine-gun has a cover on top. Inside is the bolt assembly, and the extractor. The "headspace" that we will adjust is this area. The firing

Make sure soldier can see.
Tilt M2 so he can see.

pin can be seen in this space when the M2 is not cocked. The M2 is cocked with the charging handle.

Close the cover.

The trigger and bolt release are on the end of the weapon. Finally, there is the headspace gage used to measure the headspace.

Demonstrate each task.

We will now demonstrate the steps. Watch the instructor as I tell you the steps being performed.

The first step is to push back on the charging handle until you can see the locking lug in the center of the small hole on the right side of the weapon.

Second, screw the barrel in all the way. Listen for the clicking sound.

Third, screw the barrel back out two clicks.

Fourth, release the charging handle.

Fifth, cock the weapon.

You cock the M2 by pulling the charging handle all the way to the rear. You can't just pull back on the charging handle and expect to get it cocked. Instead you have to brace yourself hard against the back of the M2 with your left hand, and grasp the handle with your right hand, palm up. Then, push with your left arm and jerk the handle hard with your right arm. Watch the demonstrator.

The next step is to hold the charging handle tightly, press the bolt release, and then, let the handle move forward slowly.

The seventh step is to raise the cover.

Eighth, raise the extractor.

Now, retract the charging handle so the bolt assembly moves back about 1/16 inch.

Then try to insert the GO gage of the headspace gage. Use gentle pressure; don't force the gage. If the GO gage does not fit, continue with the next step. What to do when the GO gage fits will be described later.

Again, if the GO gage does not fit, the next step is to retract the charging handle so the locking lug shows in the side hole.

Turn the barrel toward you one click, and then release the charging handle.

Next, retract the charging handle so the bolt moves back 1/16 inch, and try to insert the GO gage again. If it still does not fit, retract the charging handle again so the locking lug shows, turn the barrel toward you one more click, release the charging handle, retract the charging handle so the bolt moves back 1/16 inch, and try to insert the GO gage again. Repeat these steps until the GO gage fits the space.

(Pause on tape.)

If you turn the barrel out five clicks (not counting the two clicks at the beginning of the procedure) and the GO gage still does not fit, the weapon is defective and must be turned in to the armorer for maintenance.

Continue until adjusted.

When the go gage fits into the space, retract the charging handle 1/16", and try to insert the NO GO gage. If the NO GO gage does not fit, the procedure is completed.

Take barrel out several clicks and restart the tape.

If the NO GO gage does fit into the space, follow these steps:

Retract the charging handle so the locking lug shows in the side hole.

Turn the barrel away from you one click, release the charging handle. Retract the charging handle so the bolt moves back 1/16 inch. Then try to insert the NO GO gage again.

Repeat these steps if necessary until the NO GO gage does not fit the space.

(Puase)

If you turn the barrel any time after inserting the NO GO gage, you must try to insert the GO gage again. If it still fits, the headspace is properly set. If it no longer fits, you must retract the charging handle so the locking lug shows in the side hold, turn the barrel toward you one click, release the charging handle, retract the charging handle so that the bolt moves back 1/16 inch, and insert the GO gage. Repeat these steps until the GO gage fits the space.

Remember, any time you turn the barrel, you must make certain that the GO gage fits and the NO GO gage does not. When you have shown this, then the headspace is set.

If the NO GO gage happens to fit the space and you have not moved the barrel since you set it at two clicks out, then the weapon is defective and must be turned in to the armorer of maintenance.

When the NO GO gage does not fit the space and the GO gage does, the headspace is properly set.

That completes the steps for setting the headspace on the M2 machinegun. Now you will practice the steps. When you practice remember that you must:

1. Retract the charging handle.
2. Screw the barrel in all the way.
3. Screw the barrel toward you two clicks.
4. Release the charging handle.
5. Cock the M2.
6. Release the bolt.
7. Raise the cover.
8. Raise the extractor.
9. Retract the handle slightly.
10. Try to insert the GO gage.
    If it does not fit,
    - retract the charging handle.
    - Screw the barrel toward you one more click.
    - Release the charging handle.
    - Retract the charging handle slightly.
    - Try again to insert the GO gage.
    - Repeat until GO gage fits.
11. Try to insert the NO GO gage. If it does not fit, task is finished. If it does fit,
    - Retract the charging handle.

. Screw the barrel away from you one click.
. Release the charging handle.
. Retract the charging handle slightly.
. Try again to insert NO GO gage.
. Repeat until NO GO gage will not fit.

12. Repeat these procedures until the GO fits, but the NO GO gage does not fit. The gun is defective if the NO GO gage will fit after the barrel is turned out two clicks or if the GO gage does not fit after barrel is turned out five more clicks.

The instructor will first talk you through the steps, and then you will practice.

(PRACTICE PERIOD)

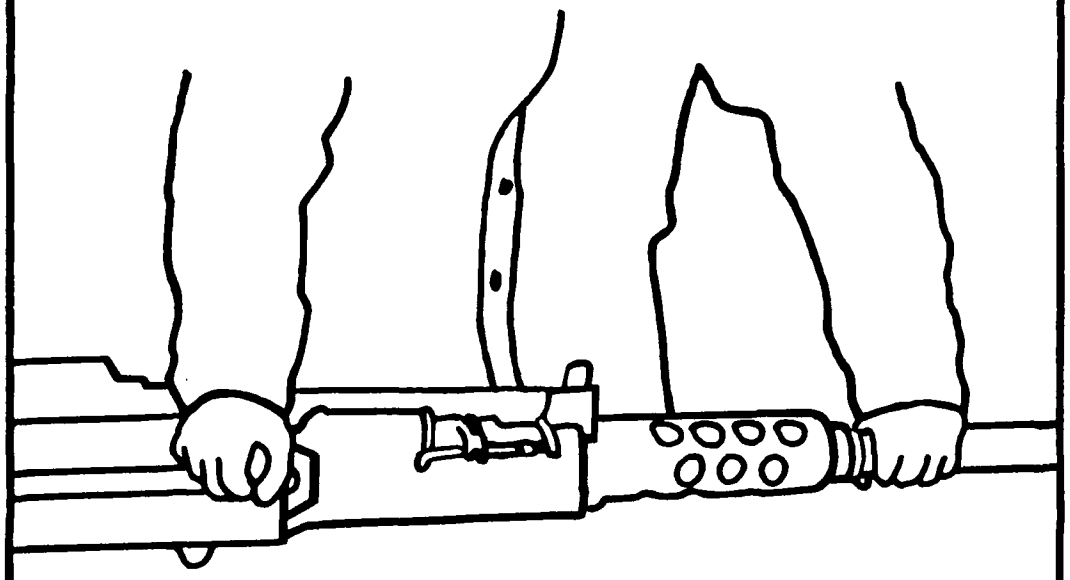
Restart tape.

Now that you have practiced setting the headspace on the M2 machinegun, we are going to review the steps and present to you a way that will help you remember them.

Let's review the first four steps. The first step is to retract the handle; this unlocks the barrel. Then you screw the barrel all the way in, screw it out two clicks, and then release the handle to lock the barrel in place. These four steps all together position the barrel in as far as allowed for safe operation of the weapon. That is, with the barrel in this position, two clicks out, you are not

1) Position barrel.

POSITION BARREL



- Retract Handle
- Screw Barrel In
- Screw Barrel Out
  (2 clicks)
- Release Handle

allowed to adjust the headspace by screwing the barrel in any further. Also, by setting the barrel at exactly two clicks out, you can count each outward adjustment you make, so you won't go beyond the maximum position out. That is, when the barrel is positioned at the beginning of the procedure at exactly two clicks out, you are not allowed to screw it in any further nor are you allowed to screw it out more than five clicks. So, when you are going to set the headspace on an M2 machinegun, you begin the steps by positioning the barrel two clicks out.

The next two steps are to cock the weapon by pulling the charging handle to the rear and then returning it to the forward position. That is, you must remember that after you position the barrel you then cock the M2.

2) Cock.

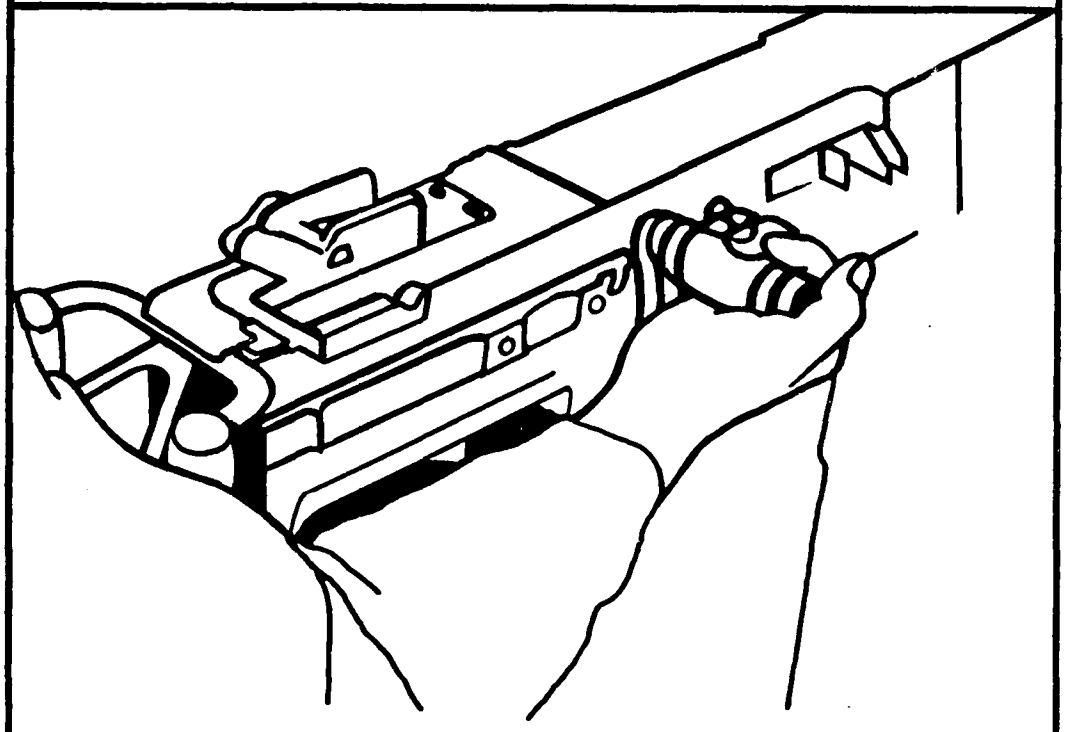
After you position the the barrel and cock the weapon, the next steps are to raise the cover and the extractor. This opens the weapon so that you can check the headspace.

3) Open.

So, the first three things you do to adjust the headspace are to position the barrel, cock the weapon and open it up. These three parts of the procedure can be thought of together as getting the M2 ready to make the necessary checks and adjustments. That is,

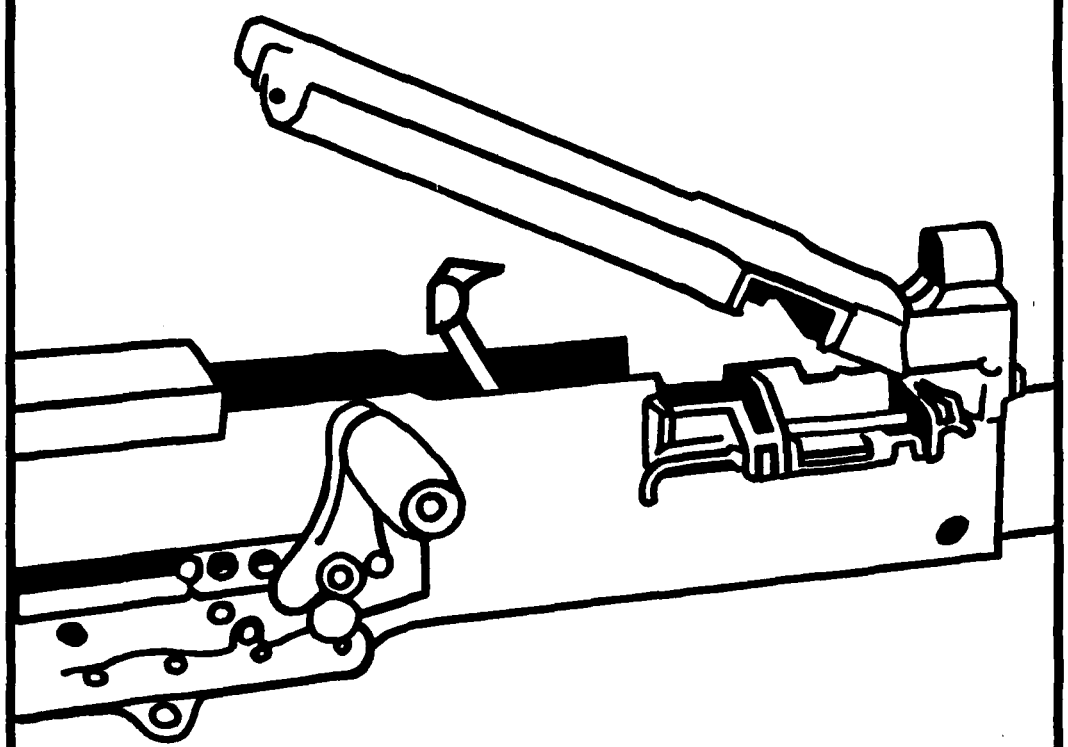
4) Set-up.

COCK



- Cock
- Return

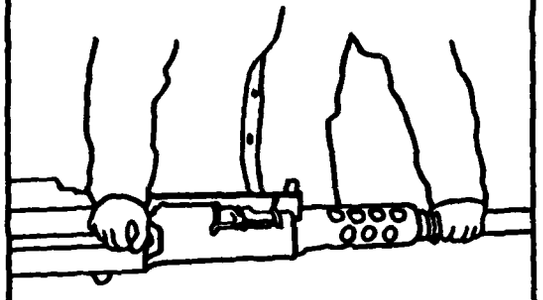
OPEN



- Raise Cover
- Raise Extractor

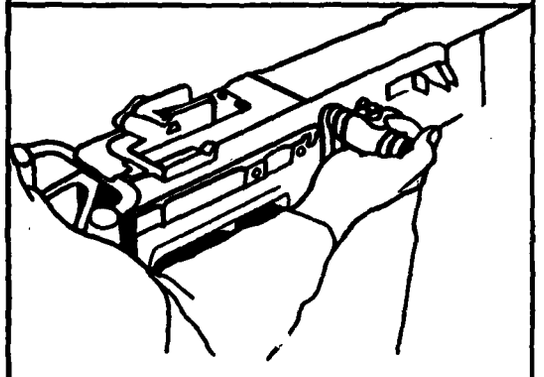
SET-UP

POSITION BARREL



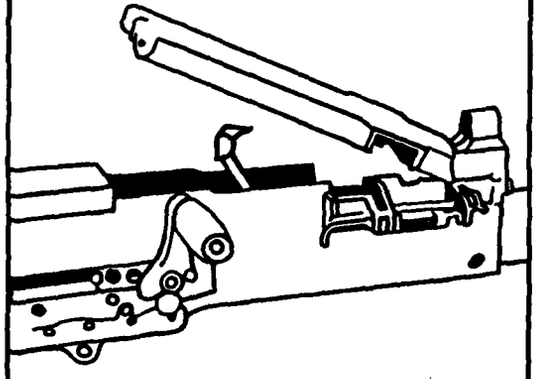
- Retract Handle
- Screw Barrel In
- Screw Barrel Out
  (2 clicks)
- Release Handle

COCK



- Cock
- Return

OPEN



- Raise Cover
- Raise Extractor

you should remember that the first thing you do when adjusting the headspace is to set-up the machine-gun.

To set up the M2, remember to position the barrel, cock the weapon and then open it.

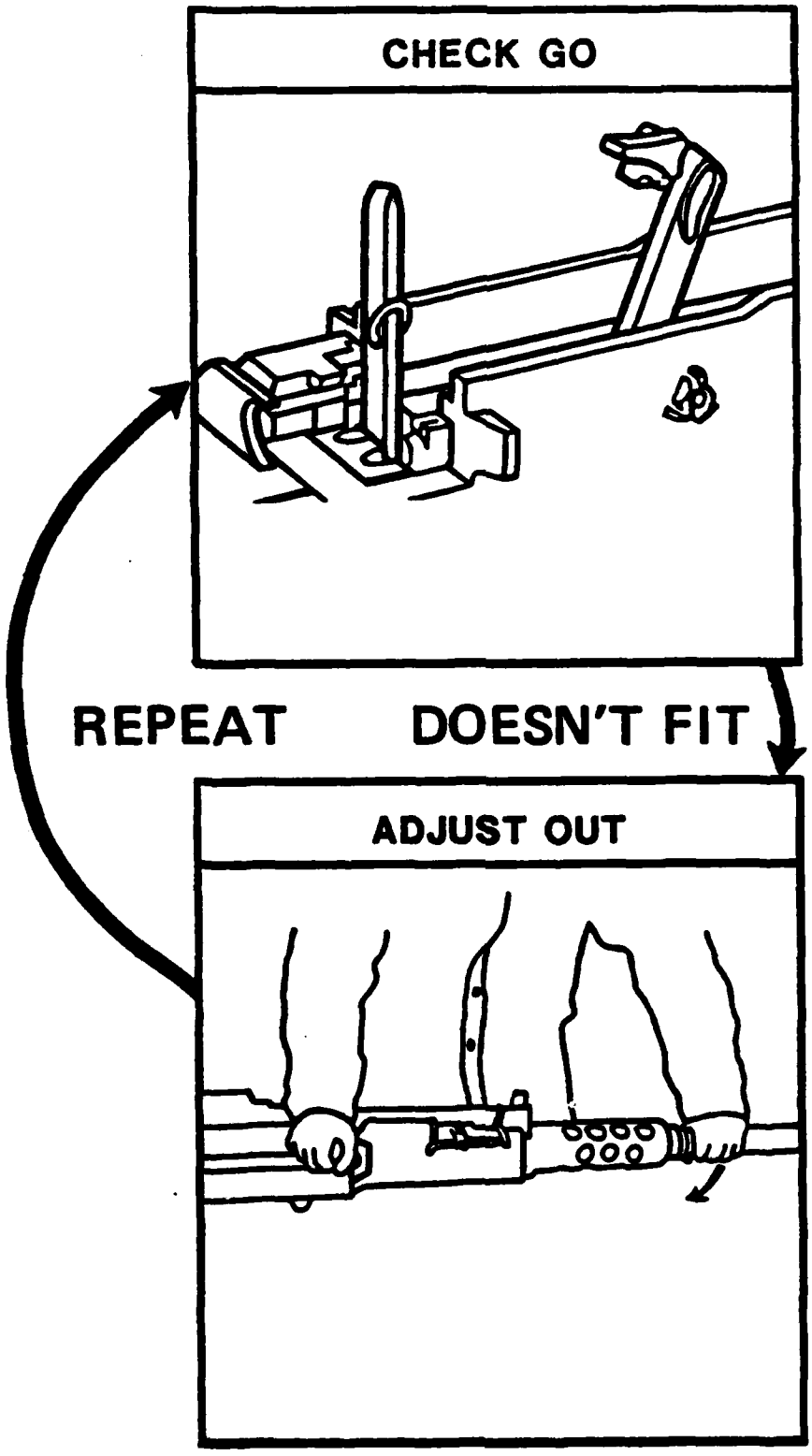
After you have set-up the weapon, you have completed the first eight steps of the procedure. Now we'll look at the next steps. The next two steps are to retract the handle slightly and try to insert the GO gage. That is, after the weapon is set-up, next you check the GO gage by retacting the handle slightly and trying to insert the GO gage.

5) Check GO.

What you do after that depends on whether or not the GO gage fits into the space. If it doesn't fit, you retract the handle to unlock the barrel, screw the barrel out one click and release the handle. These three steps together adjust the barrel out by one click, so if the GO gage does not fit, all you have to remember is to adjust the barrel out. You won't forget to unlock it, because the barrel won't move if you don't.

After you have adjusted the barrel, you then recheck the GO gage.

What you need to remember is that you keep on checking and adjusting using the GO gage until the barrel


CHECK GO
REPEAT
DOESN'T FIT
ADJUST OUT

is out far enough for the GO gage to fit the space.

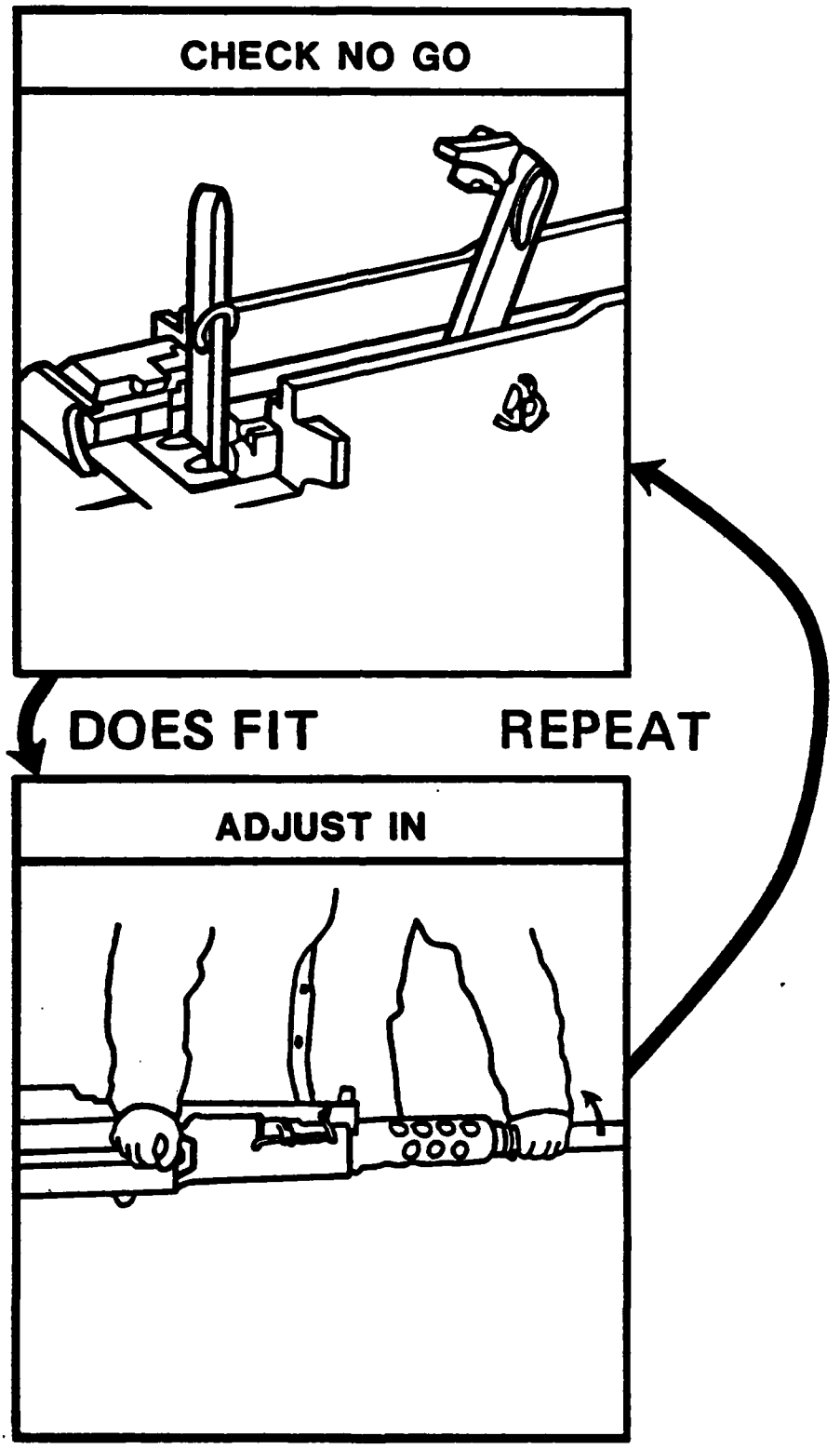
After the barrel is positioned so the GO gage fits, the next two steps are to retract the handle and try the NO GO gage. That is, you check the space with the NO GO gage to make sure the barrel is not too far out. If you have been careful and adjusted the barrel out only one click at a time until the GO gage first fits, the NO GO gage will usually not fit. If the NO GO gage fits into the space, then the barrel is too far out. If that happens, you have to unlock the barrel with the charging handle, screw the barrel one click and release the handle. These three steps together adjust the barrel in one click. So remember, if the NO GO gage fits, adjust the barrel <u>in</u>. Then you recheck with the NO <u>GO</u> gage, and you may have to adjust the barrel again if the NO GO still doesn't fit.

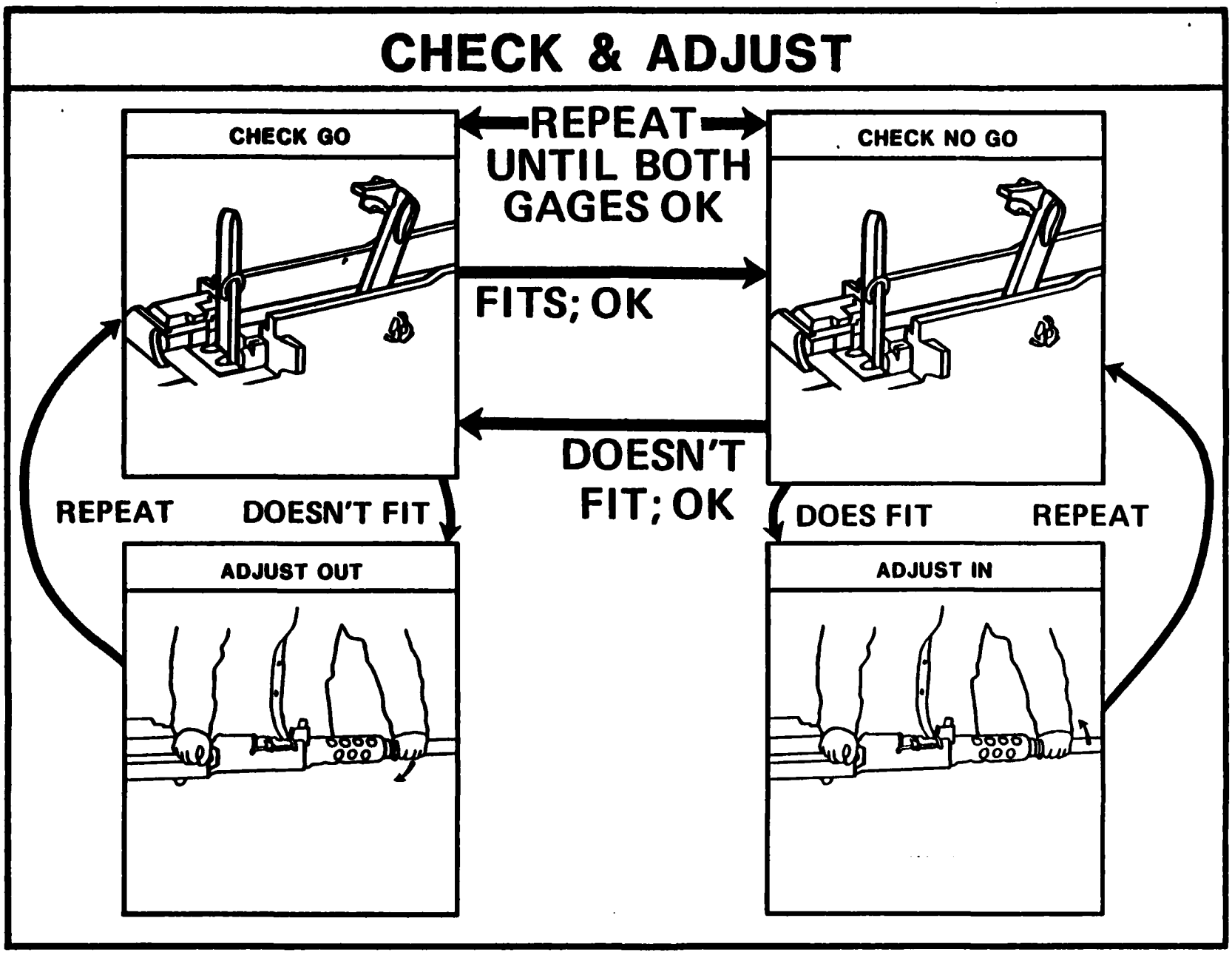
6) Check NO GO.

If you have to adjust the barrel in so that the NO GO gage will not fit the space, then go back and recheck the GO gage.

7) Check and adjust.

The headspace is correct when the barrel is set in a position so that the GO gage fits and NO GO gage does not. That's the most important thing to remember. You keep on checking and adjusting and rechecking the headspace using the


CHECK NO GO
DOES FIT
REPEAT
ADJUST IN


CHECK & ADJUST
CHECK GO
REPEAT
UNTIL BOTH
GAGES OK
CHECK NO GO
FITS; OK
DOESN'T
FIT; OK
REPEAT
DOESN'T FIT
DOES FIT
REPEAT
ADJUST OUT
ADJUST IN

two gages, the GO gage first and then the NO GO gage, until the GO gage fits and the NO GO gage does not.

Let's look at the procedure one more time.

8) Total chart.

You should remember that there are two phases to adjusting the headspace:

First, set up the M2 in preparation for checking.

Second, make the checks and adjustments.

To set up the machinegun, there are three things you must remember:

First, position the barrel,
Second, cock the machinegun, then
Third, open it up.

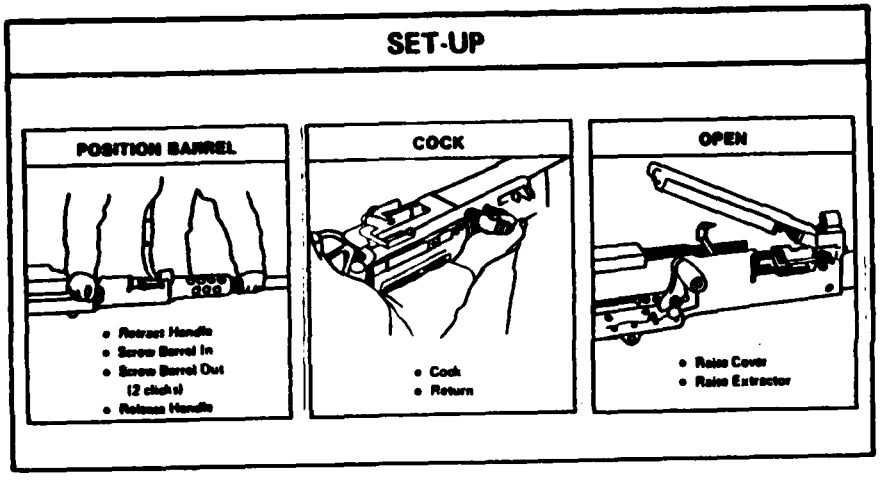
To make your checks and adjustments, you:

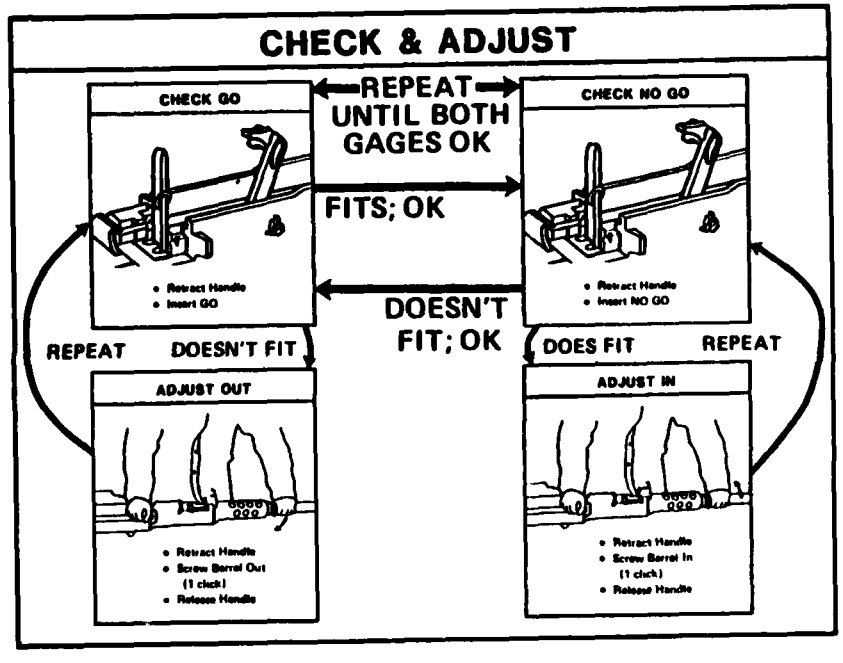
First, check and adjust using the GO gage. If the GO gage does not fit, screw the barrel out. Repeat checking and adjusting until the barrel is out far enough for the GO gage to fit.

Next, check with the NO GO gage. if it does fit, screw the barrel in and recheck.

The headspace is correctly set when the GO gage fits the space and the

ADJUST HEADSPACE M2 MACHINEGUN





NO GO gage does not. Also, remember the barrel must be at least two clicks out but no more than five clicks past the first two clicks.

Now, you will continue practicing adjusting the headspace on the M2 machinegun. This time, say out loud which group of steps you are about to do, using the outline that has just been described. Practice so that you can perform all of the steps needed to set the headspace on the M2 machinegun.

Set the Headspace on the M2 Machinegun
Top-down presentation

Instructor/Demonstrator	Narrator	Visual
Introductions, as needed. Record student's name and related information on record form.		
Turn on tape recorder. M2 should be on table with the cover open, the barrel out of adjustment (too far out) and not cocked.	The task you are now going to learn is to set the headspace on an M2 machinegun. As you can see the M2 is a heavy machinegun. It is one of the Army's largest machineguns, and fires .50 caliber ammunition. It is also one of the oldest weapons still being used by the Army. It has been used since before in World War II. Currently, one of its uses is as the tank commander's weapon mounted on Army's newest tank, the M1. There are two critical adjustments which must be made on the M2 in order for it to fire properly. You are going to learn one of those adjustments. It's called setting the headspace. The M2 has a barrel which can be removed and replaced by unscrewing the old barrel and screwing in a replacement. The replacement barrel is not screwed in tight, however. Rather, it must be screwed in just the right amount. This is called	

having the proper headspace. You will learn to set the headspace so that the barrel is screwed in the right amount.

Here is how we will proceed. First, we will name the parts of of the M2. Then we will tell you, in general the actions you need to take in order to set the headspace on the M2 machinegun. We will then describe the individual steps and tell you how to remember them. We will also demonstrate each of these steps.

You will then practice setting the headspace by doing each of the steps. You will continue to practice the steps for the rest of the period of instruction.

Let's begin by naming the parts of the M2 machinegun that you will be working with. Many of these parts are similar to the parts of the M16 rifle you have already learned to disassemble, assemble and operate during your basic combat training.

Point to each as stated.

This is the barrel. The machinegun has a cover on top. Inside is the bolt assembly and extractor.

The "headspace" that we will adjust is this area. The firing pin can be seen in this space when the M2 is not cocked. The M2 is cocked with the charging handle. The trigger and a bolt release are on

Make sure soldier can see. Tilt M2 so he can see.

the end of the weapon. Finally, there is the headspace gage used to measure the headspace.

There are essentially two parts to the procedure for setting the headspace on an M2. The first part of the procedure is to set up the weapon so that the headspace can be checked and adjusted. The second part is to check and adjust the headspace. For the headspace to be set properly, first you must have the weapon set-up for checking and second you must make the headspace checks and adjustments in the proper way.

So, the first thing you should do when told to set the headspace on an M2 is to think to yourself: Set-up, then check and adjust, because that is what it takes to set the headspace. There are anywhere from twelve to eighteen or more steps, depending on the amount of adjustment needed. But you won't need to remember them all at once. Begin by thinking to yourself, first I must set-up the machinegun to make the checks, and then I must check and adjust the M2. After you have thought about the two parts of the procedure for setting the headspace on an M2, focus in on the first part of the procedure. That is, think about how to set up the machinegun. After that is completed, focus on how to make your checks and adjustments.

We will demonstrate setting the headspace on the M2 by first showing you the set-up part of the procedure and then showing you the checks and adjustments part of the procedure.

Before we begin the demonstration tell the instructor what the two major parts of the procedure are.

Prompt, if necessary.

(Pause on tape.)

Okay. We will now look at the set up part of the procedure. To get the M2 ready for checking the headspace, you must perform three set-up tasks. These are:

1) Set-up structure.

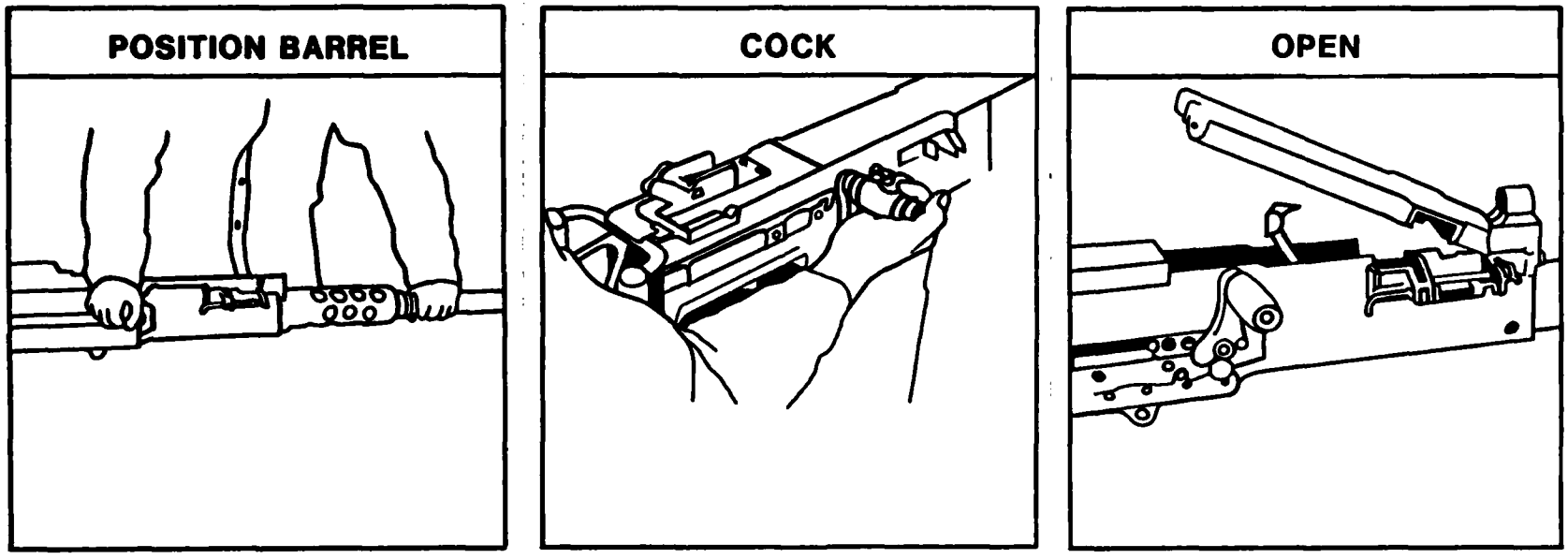
1) position the barrel,
2) cock the weapon, and
3) open the weapon.

These three set-up tasks must be completed before you can begin to check and adjust the headspace. We will now demonstrate the steps needed to position the barrel, cock the machinegun and open it up.

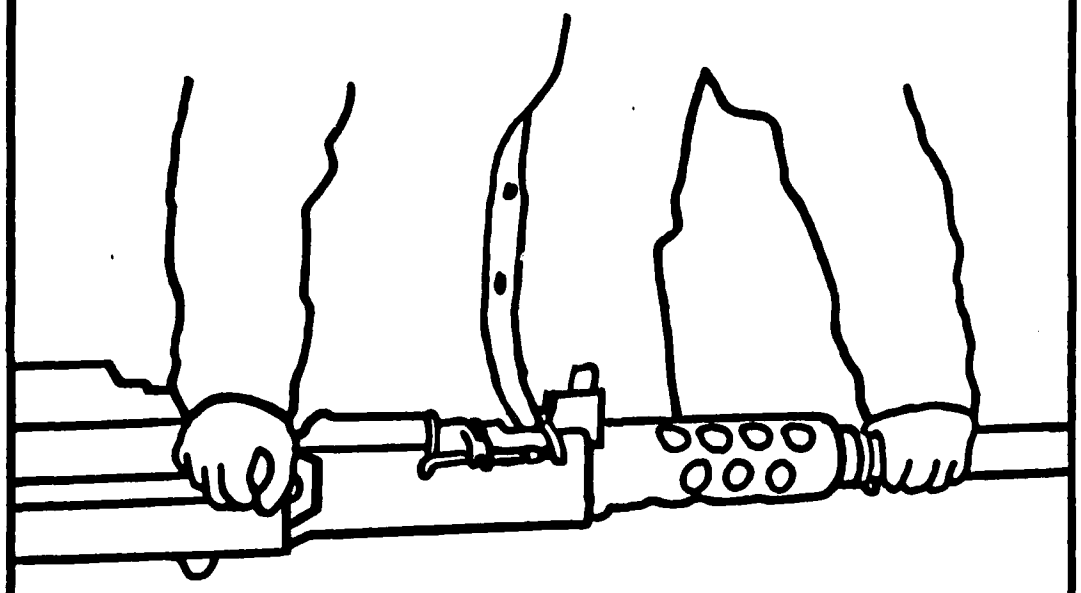
Remember, the barrel of an M2 is installed by screwing it in, but for it to work properly the position of the barrel must be set. The first task, positioning the barrel, puts the barrel in as far as allowed for safe operation of the weapon. To screw the barrel in or out, you must first unlock it by pushing back on the charging handle until you can see the locking lug

2) Position barrel.

SET-UP

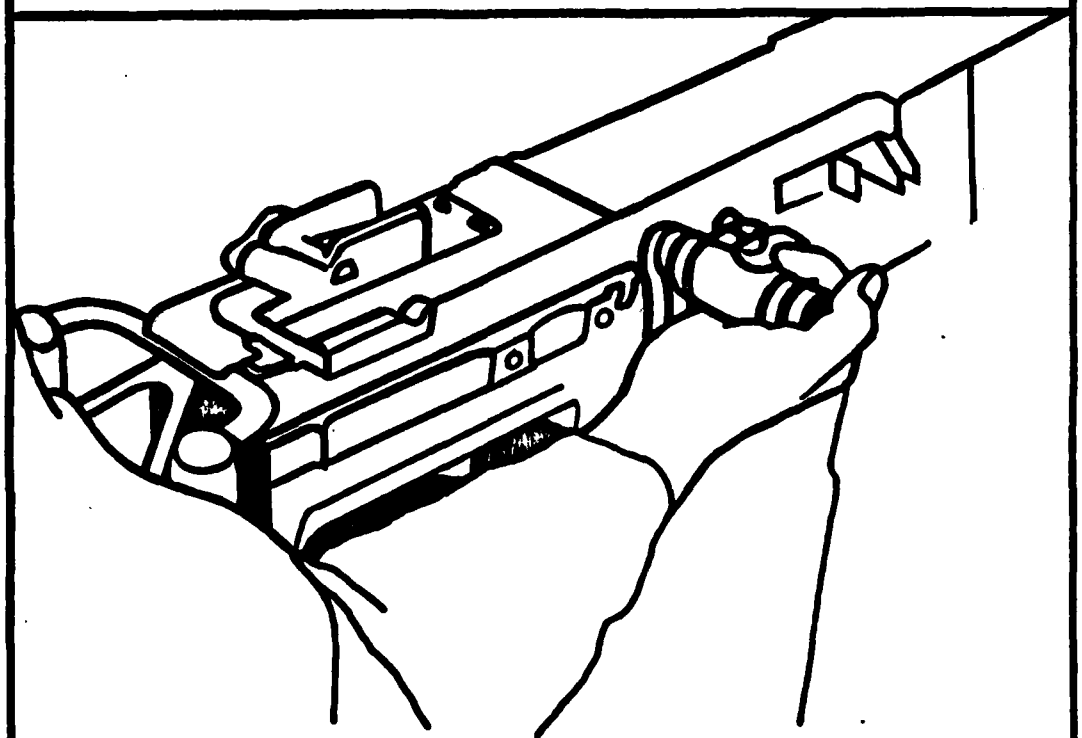


POSITION BARREL



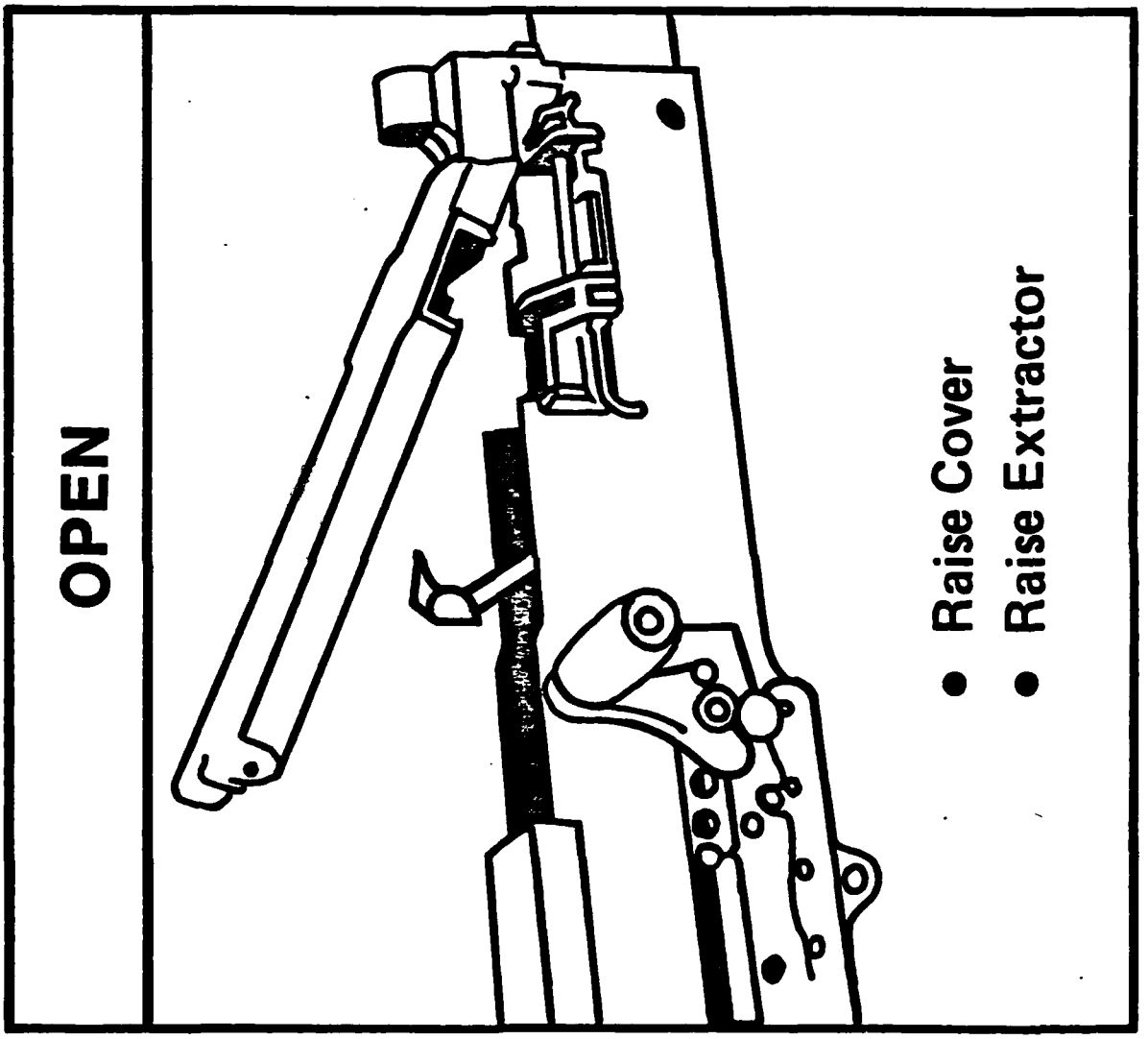
- Retract Handle
- Screw Barrel In
- Screw Barrel Out
  (2 clicks)
- Release Handle

COCK



- Cock
- Return

Point to hole on weapon, the retract handle.	in the center of the small hole on the right side of the weapon. When you can see the locking lug, the barrel can be turned. To get the barrel into the correct starting position for making the headspace	
Demonstrate along with tape.	adjustment, first screw the barrel in all the way. Listen for the clicking sound. Then, turn the barrel out two clicks. Release the handle to lock the barrel in place. That completes the set up task of positioning the barrel.	
Point out firing pin.	Next, the weapon must be cocked.	3) Cock.
Point to handle.	You cock the M2 by pulling the charging handle all the way to the rear. You can't just pull back on the charging handle and expect to get it cocked. Instead you have to brace yourself hard against the back of the M2 with your left hand, and grasp the handle with your right hand, palm up. Then, push the machinegun with your left arm and at the same time jerk the handle hard with your right arm. Watch the demonstrator.	
	This particular type of M2 machine-gun has a bolt catch which holds the bolt to the rear after it is cocked. The bolt must be forward to check the headspace. The bolt is returned forward by holding the	


OPEN
• Raise Cover
• Raise Extractor

charging handle tightly, pressing the bolt release and then letting the handle move forward slowly.

Now the barrel is in the correct initial position and the weapon is cocked. The next task in setting up the M2 is to open it up. Simply twist the latch and raise the cover; then rasie the extractor.

Demonstrate.

4) Open diagram.

Now that the barrel is positioned, and the weapon is cocked and opened, the set-up procedure is completed. These are the three things you need to remember to set up the M2 for checking and adjusting the headspace:

5) Set-up structure with with steps.

.Position the Barrel
.Cock the weapon
.Open the weapon

After the M2 is set-up, the checks and adjustments can be made. To check and adjust the headspace, there are two basic actions:

6) Blank.

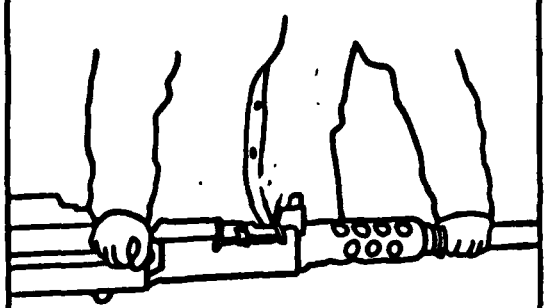
.check the headspace with the headspace gage, and
.adjust the headspace by screwing the barrel in or out.

These two actions are repeated as necessary until the headspace is set correctly.

Let's look at the headspace gage. On one end of the gage the words "NO GO" are stamped. On the other

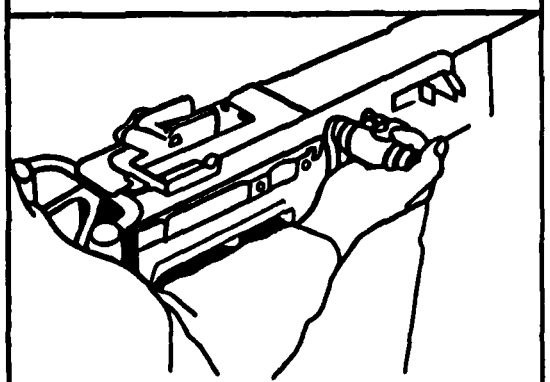
SET-UP

POSITION BARREL



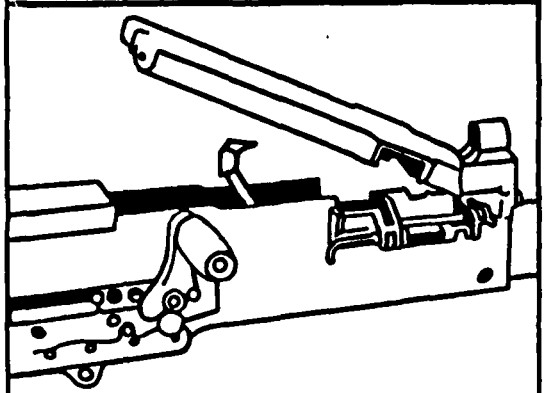
- Retract Handle
- Screw Barrel In
- Screw Barrel Out (2 clicks)
- Release Handle

COCK



- Cock
- Return

OPEN



- Raise Cover
- Raise Extractor

end, the word "GO" is stamped. The NO GO gage is larger than the GO gage. As the names suggest, the headspace is properly set when the GO gage will go into the space, but the NO GO gage will not. If the GO gage does not fit, the headspace is too small and the barrel must be screwed out.

7) Check GO.

If the NO GO gage fits, the headspace is too large and the barrel must be screwed in. So to check the headspace, attempt to insert the GO and NO GO gages of the headspace gage. The headspace is correct when the GO gage fits and NO GO gage does not fit into the headspace. The barrel must be screwed <u>out</u> if the GO end does not fit. The barrel must be screwed <u>in</u> if the NO GO gage does fit into the headspace.

8) Check NO GO.

9) Check & Adjust.

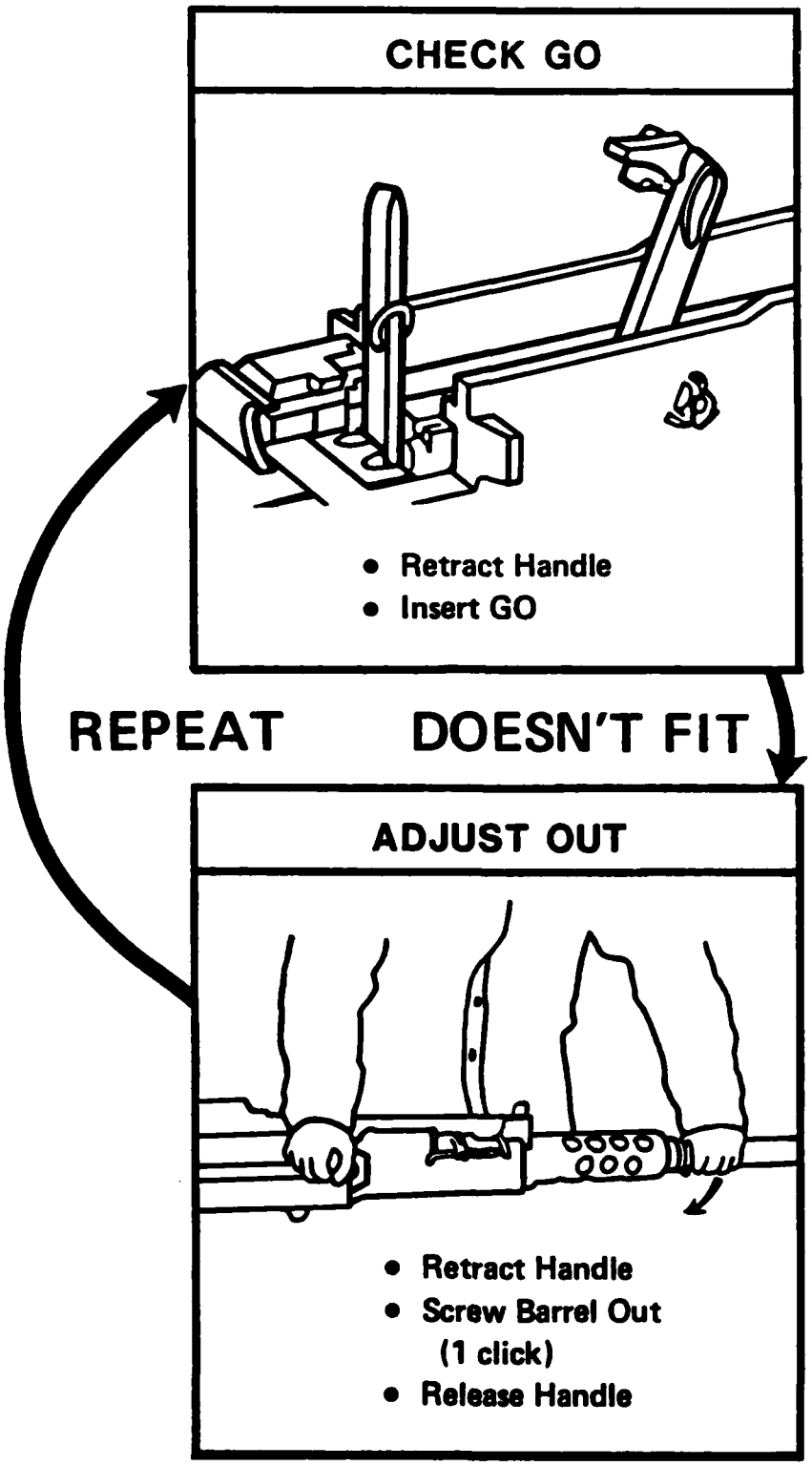
Now demonstrate.

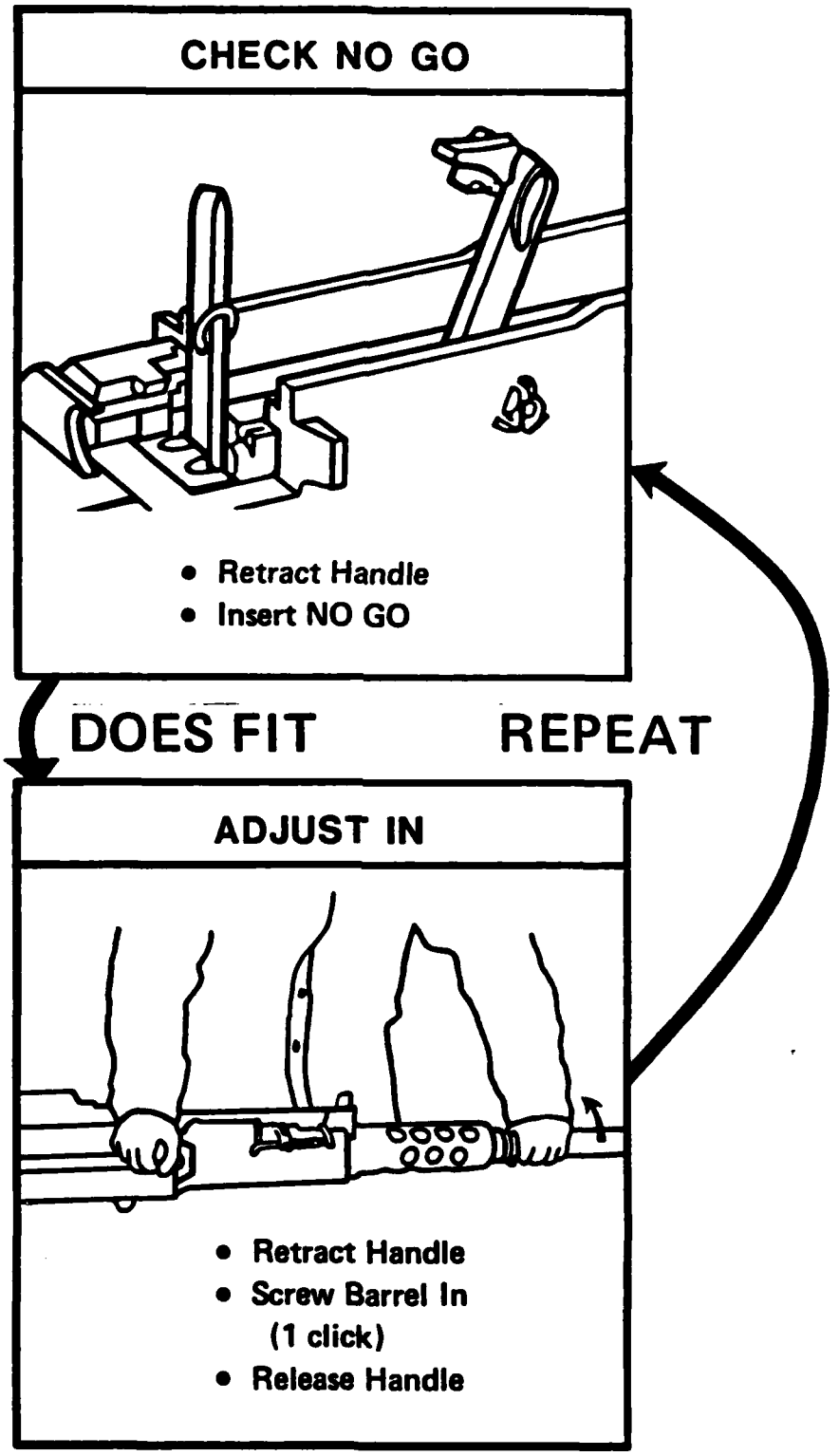
Begin checking with the GO gage. To insert the headspace gage, you first retract the charging handle just slightly, about 1/16 of an inch. Then try to insert the GO gage. Use gentle pressure; don't force the gage.

10) Check GO, with steps.

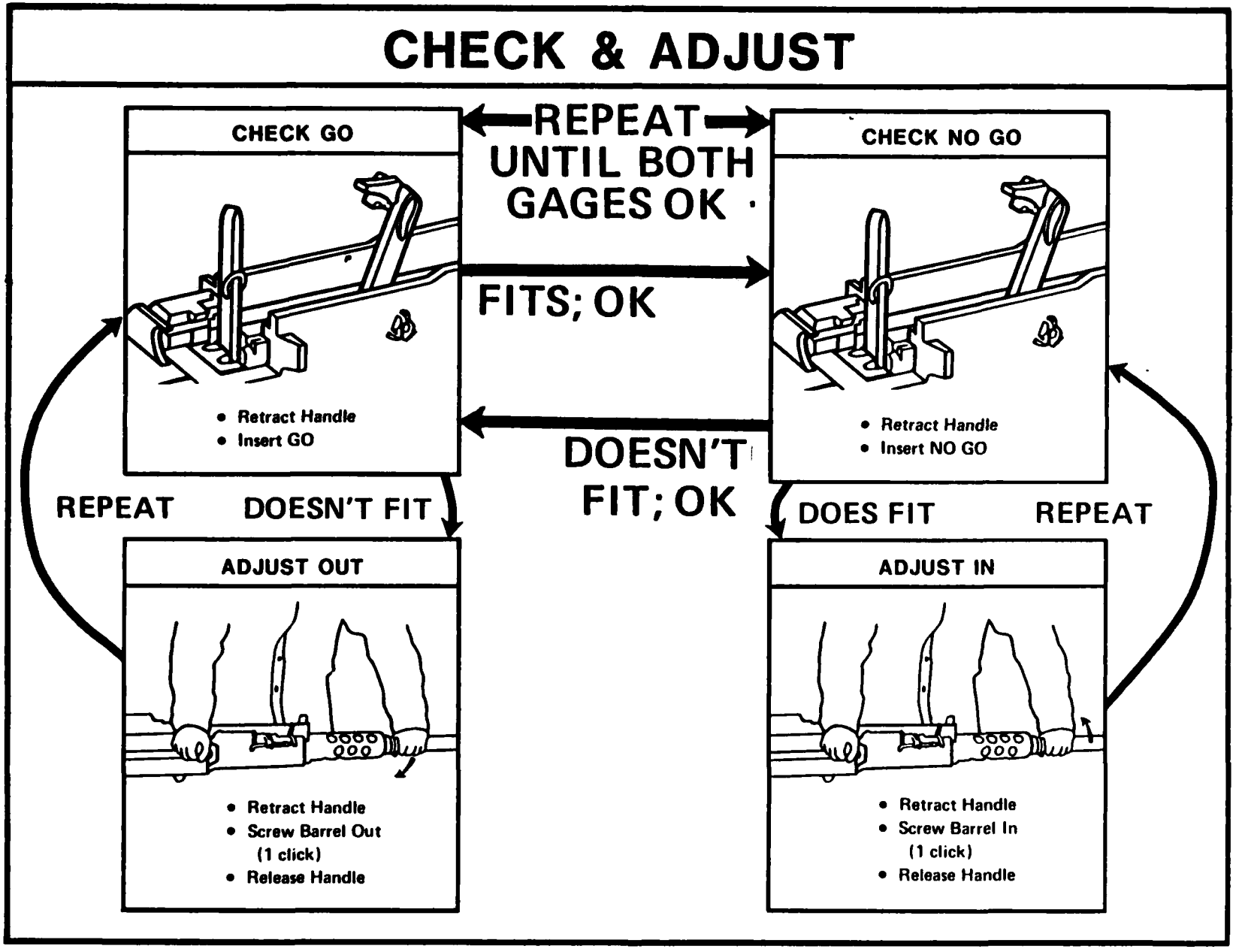
With the barrel in the initial starting position, the GO gage usually will not fit.

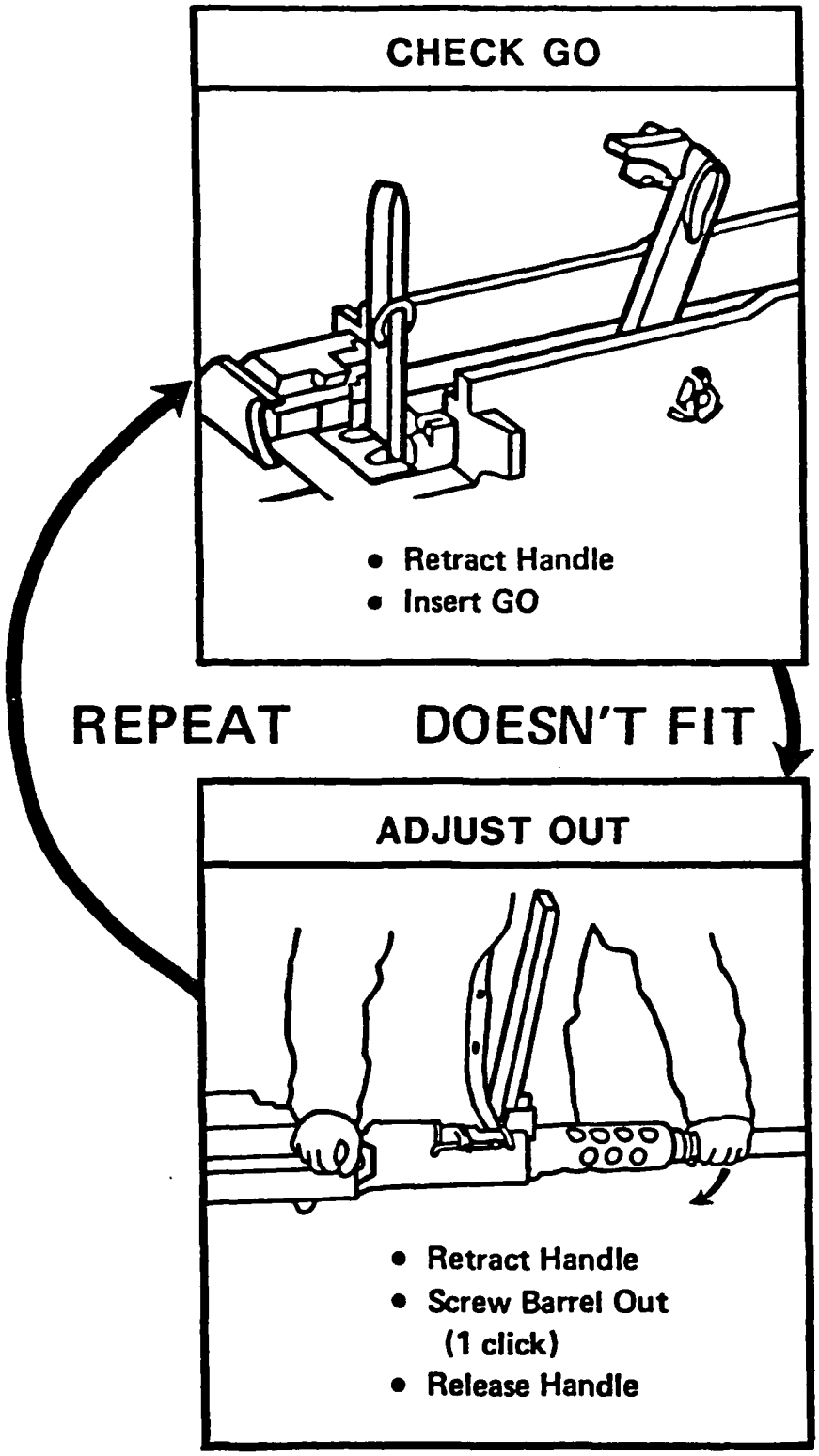
If the GO gage does not fit, you must screw the barrel out. To screw the barrel out, first retract the charging handle to unlock the barrel. Then twist it out just one


CHECK GO
• Retract Handle
• Insert GO
REPEAT
DOESN'T FIT
ADJUST OUT
• Retract Handle
• Screw Barrel Out
(1 click)
• Release Handle


CHECK NO GO
• Retract Handle
• Insert NO GO
DOES FIT
REPEAT
ADJUST IN
• Retract Handle
• Screw Barrel In
(1 click)
• Release Handle

CHECK & ADJUST




CHECK GO
• Retract Handle
• Insert GO
REPEAT
DOESN'T FIT
ADJUST OUT
• Retract Handle
• Screw Barrel Out
(1 click)
• Release Handle

click and release the handle. Then, check the headspace again. Retract the handle slightly. Then try the GO gage. If the GO gage still doesn't fit, retract the charging handle and twist the barrel out one more click.

Repeat the process of checking and adjusting until the GO gage does fit the space.

Continue until headspace is correct.

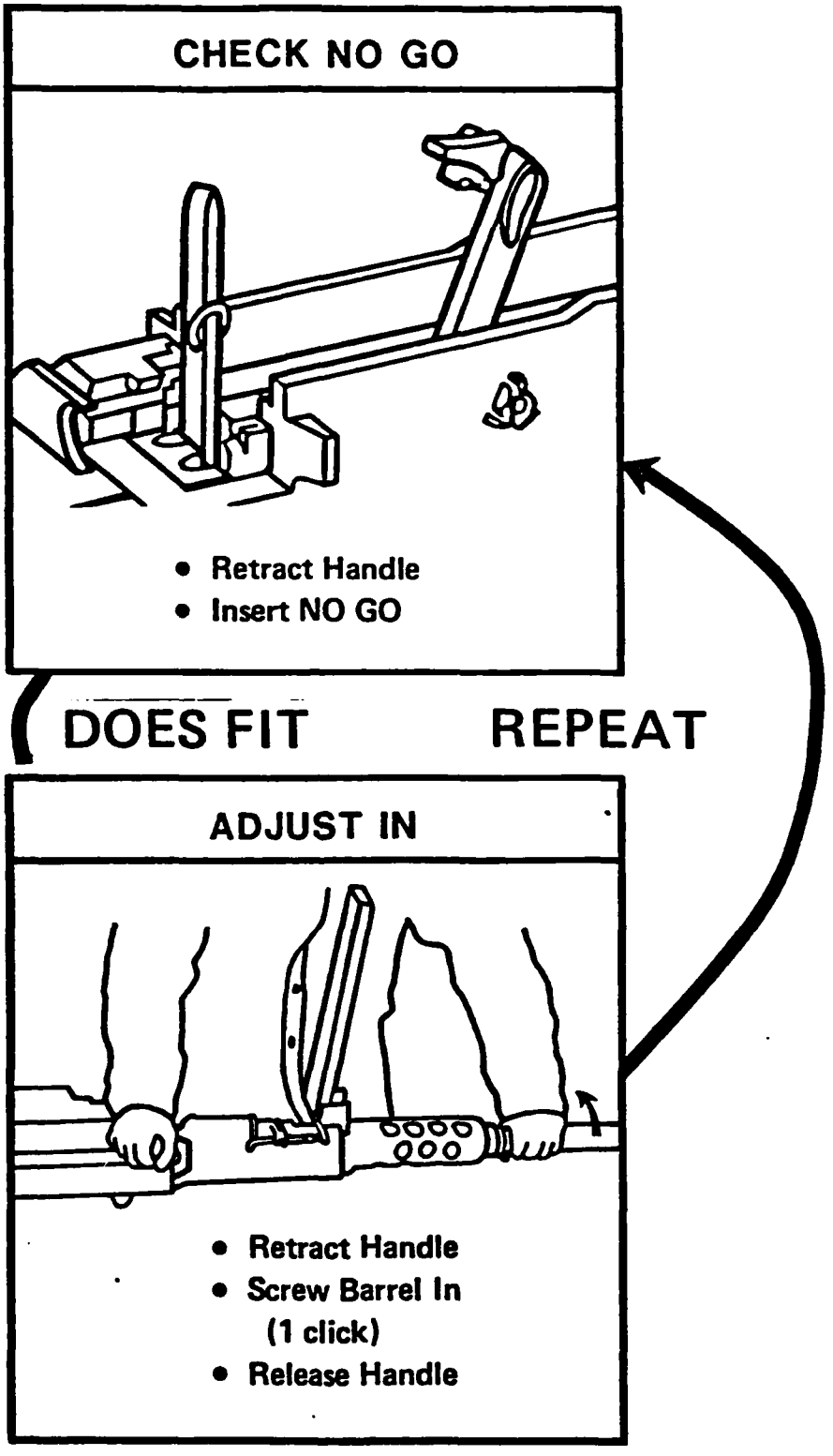
(Pause on tape.)

If you have to turn the barrel out more than five clicks for the GO gage to fit (not counting the two clicks it was moved out when setting up the weapon), the weapon is defective and must be turned in to the armorer for maintenance.

Restart tape. Screw barrel out several additional clicks.

When the GO gage fits, try to insert the NO GO gage. If it does not fit, then the headspace is set correctly. If it does fit, and you have not moved the barrel from the initial starting position of two clicks, the weapon is defective and must be turned in to the armorer for maintenance. If the NO GO gage fits anytime after you have adjusted the barrel out, then you have screwed the barrel out too far. You must screw it back in far enough so that the NO GO gage no longer fits, but the GO gage does fit. Just retract the handle, screw the barrel in one click, and release the handle. Then recheck, using

11) Check NO GO, with steps.


CHECK NO GO
• Retract Handle
• Insert NO GO
DOES FIT
REPEAT
ADJUST IN
• Retract Handle
• Screw Barrel In
(1 click)
• Release Handle

the NO GO gage. When the NO GO gage does not fit, then you will need to recheck with the GO gage.

Readjust headspace.

(Pause on tape.)

Restart tape.

The procedure is completed when the GO gage of the gage fits into the space and the NO GO gage does not fit.

That completes the set of steps needed to properly set the headspace on the M2 machinegun. The M2 was first set up for checking and adjusting the headspace. After it was properly set up, the headspace was checked and adjusted.

Now you will practice the steps. When you practice, try to remember that you must:

First, set-up the machinegun, and Second, make the checks and adjust ments.

To set up the machinegun, there are three things you must remember to do:

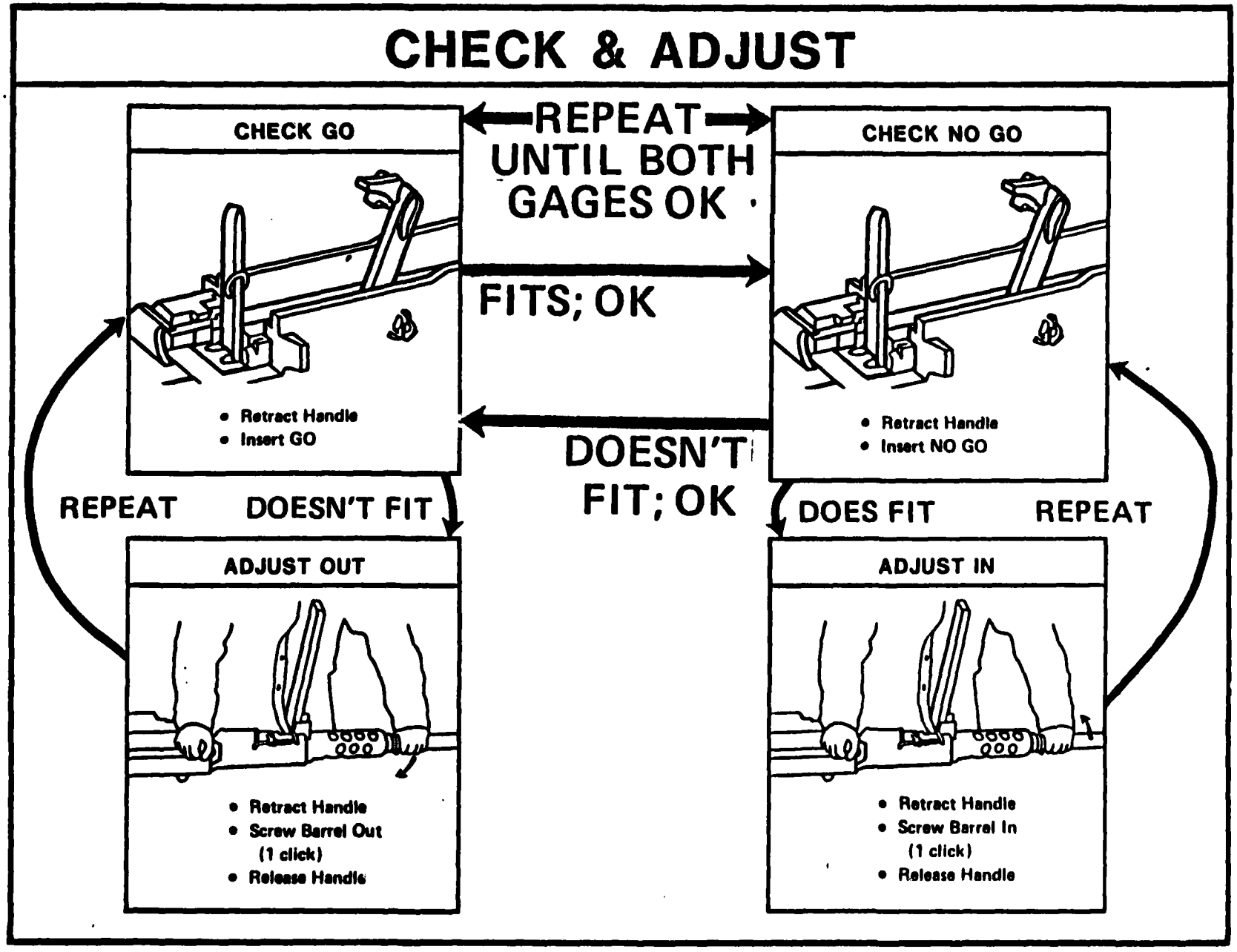
first, position the barrel,
second, cock the machinegun, and
third, open it up.

To make your checks and adjustments, you:

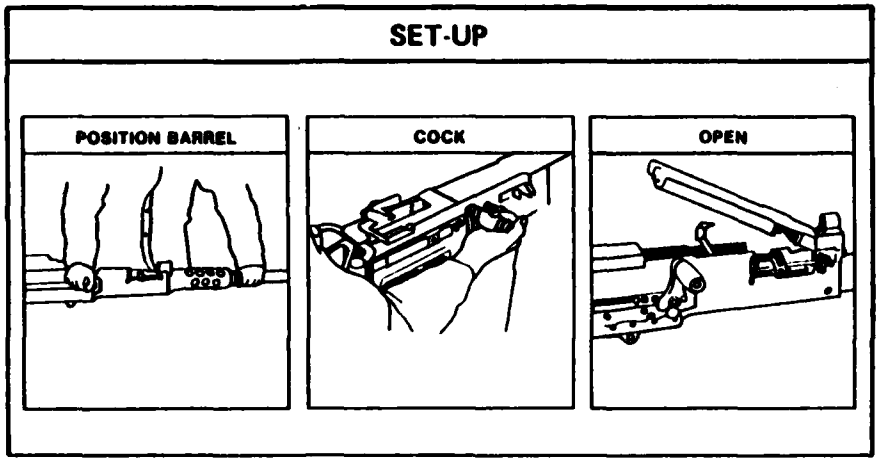
First, check using the GO gage. If the GO gage does not fit, screw the barrel out one click. Repeat

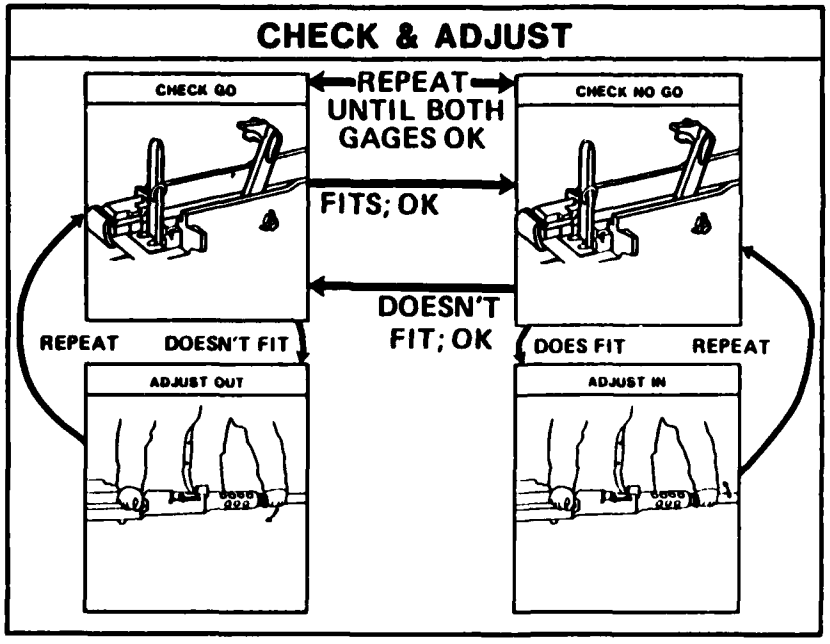
12) Total check and adjust structure.

13) Total diagram.


CHECK & ADJUST
CHECK GO
REPEAT
UNTIL BOTH
GAGES OK
CHECK NO GO
FITS; OK
• Retract Handle
• Insert GO
• Retract Handle
• Insert NO GO
DOESN'T
FIT; OK
REPEAT
DOESN'T FIT
DOES FIT
REPEAT
ADJUST OUT
ADJUST IN
• Retract Handle
• Screw Barrel Out
(1 click)
• Release Handle
• Retract Handle
• Screw Barrel In
(1 click)
• Release Handle

ADJUST HEADSPACE M2 MACHINEGUN





checking and adjusting until the GO gage fits.

Next, try the NO GO gage. If it does fit, screw the barrel in, then recheck.

The headspace is correctly set when the GO gage fits the space and the NO GO gage does not.

The weapon is defective if either:

1) the GO end will not fit and the barrel has been screwed out 5 clicks past the initial set-up position.

2) the NO GO fits when the barrel is in the initial starting position of two clicks out.

The instructor will first talk you through the steps. Then you will practice. Say out loud which group of steps you are about to do using the outline that has just been described. Practice so that you can perform all the steps needed to set the headspace on the M2 machinegun.

APPENDIX C

Operate the AN/VRC-64 Radio Training Program

Operate the Radio AN/VRC-64
Unstructured POT Presentation

Instructor	Narrator	Visual
Introductions, as needed, Record student's name and related information.		
Seat soldier by radio.		
Turn on tape and projector.		
	You are now going to learn how to prepare the Radio Set AN/VRC 64 for operation.	
	The AN/VRC 64 radio set is used in M60 series and M1 tanks. The radio set lets you talk to other tank crew members over an intercom system. It lets you send and receive messages over the radio to locations up to about 5 miles away. When you are assigned to a unit, you will be expected to talk to the other crewmen in a tank and to send and receive messages over this radio set. Before you are able to do this, however, you must learn how to set it up. That is the purpose of the present instruction. Here is how we will proceed. First, we will name the parts to the radio. Then we will demonstrate, one step at a time, how to set up the radio. You will then practice setting it up by doing the steps. An instructor will help you as you practice.	

	You will continue practicing for the rest of the period of instruction.
	Let's begin by naming the component parts of the radio set that are needed to perform the task.
Point to components .	There is the Combat Vehicle Crewman's helmet; this is usually called a CVC helmet; an audio cable; a crewman's control box; an audio frequency amplifier, usually just called an amplifier; and a radio transmitter.
	We will now demonstrate the eighteen steps needed to place the radio into operation. Watch the instructor as I tell you the steps being performed.
Put on helmet	First put on the CVC helmet. The microphone goes on the right.
Show how mike moves around and adjust.	Next, adjust the microphone on the helmet so that it is centered right in front of your mouth. It may be necessary to loosen the adjusting screw on the right side ear phone. This will let you slide the mike forward or back. If you do loosen the adjusting screw, be sure to retighten it when the mike is adjusted. Once the adjusting screw is tightened, you can still adjust the mike by simply pushing it center, right in front of your mouth.
Loosen adjusting screw and show how mike moves back and forth	
Adjust to correct position.	

Move switch to rear, and forward, then to center. Leave in center position.	Third, set the switch on the left side of your helmet so that it is in the center position.
Show quick disconnect.	The fourth step is to connect the quick disconnect on the end of the audio cable to the CVC cord.
Show notches.	There is a tab on the connector and a matching notch on the CVC cord.
Connect cords	Match these and push the cords together.
Show cords; point out longer cord.	The fifth step is to connect the two cords on the other end of the audio cable to the control box. Notice that one cord is longer than the other. The connector on the long cord must be connected to
Point to left side of control box	the left *side of the* crewman's control box -- Remember, long-left. The connector on the short cord must be connected to the right
Connect long end to left, following steps.	side of the control box. To connect them, turn the flat portion of the connector to the front (hold it with your thumb). Push the connector onto the correct side of the control box (remember, long-left) then twist it to the right. Pull down on it to make sure it is connected.
Connect short end to right.	Be sure to connect both the long and short connectors.

Adjust volume; point out tab.	The sixth step is to adjust the volume control to the mid range position by turning the knob until the tab is to the front.
Turn switch to ALL.	For the seventh step, turn the monitor switch on the control box to ALL.
Set each switch.	The eighth step is to turn the radio transmitter switch on the amplifier to the COMMANDER PLUS CREW position. Nine, turn the intercom accent switch to ON. Ten, turn the main power switch to NORM. Eleven, flip the power circuit breaker switch to ON.
Point to PWR ON and SPKR OFF, then squeeze them together.	Twelve, put the radio transmitter power switch to ON, and Thirteen, turn the speaker switch to OFF. Just squeeze the two switches together.
	Fourteenth, set the radio transmitter volume at the maximum level -- 10. Then set the radio transmitter function switch to SQUELCH.
Follow each step.	The sixteenth step is to set the BAND switch to the range of the frequency assigned to you. For example, if your frequency were 42.85, set the BAND switch to the 30 to 52 position.

Seventeenth, set the right and left frequency knobs. For a frequency of 42.85, set the left knob to 42 and the right knob to 85.

Last, set the Antenna Frequency Control to the range of your frequency. For 42.85, set the knob to the position between 42 and 47.5.

In a moment you will practice the steps. When you practice try to remember that you must:

Point to each item (area, switch, etc.) as the action is stated.

1. Put on the CVC helmet.
2. Adjust the mike.
3. Put the CVC switch to the center position.
4. Connect the quick disconnect.
5. Connect the audio cables.
6. Set the control box volume to mid-range.
7. Set the control box monitor to ALL.
8. Set the amplifier radio transmitter switch.
9. Set the "intercom accent" switch.
10. Set the "main power" switch.
11. Set the "power circuit breaker."
12. Turn the radio power on.
13. Turn the speaker off.
14. Adjust the radio volume.
15. Set the radio function control.
16. Set the band switch.
17. Adjust the radio frequency knobs.
18. Adjust the antenna frequency control.

The instructor will first talk you through the steps, and then you will practice. Practice so that you can perform all the steps needed to operate the AN/VRC 64 radio without looking at the list of steps.

The best way to learn this task so that you can remember how to do it is to practice the steps.

Operate the Radio AN/VRC-64
Bottom-up Presentation

Instructor	Narrator	Visual
Introductions, as needed, Record student's name and related information.		
Seat soldier by radio.		
Turn on tape and projector.		
	You are now going to learn how to prepare the Radio Set AN/VRC 64 for operation.	
	The AN/VRC 64 radio set is used in M60 series and M1 tanks. The radio set lets you talk to other tank crew members over an intercom system and it lets you send and receive messages over the radio to locations up to about 5 miles away. When you are assigned to a unit, you will be expected to talk to the other crewmen in a tank and to receive messages over this radio set. Before you are able to do this, however, you must learn how to set it up. That is the purpose of the present instruction. Here is how we will proceed. First, we will name the parts to the radio. Then we will demonstrate, one step at a time, how to set up the radio. You will then practice setting it up by doing the steps. An instructor will help you as you practice. After	

you have practiced for a while, and learned how to do each of the steps, we will give you some additional information which will help you remember the task.

Let's begin by naming the component parts of the radio set that are needed to perform the task.

There is the Combat Vehicle Crewman's helmet; this is usually called a CVC helmet; an audio cable; a crewman's control box; an audio frequency amplifier, usually just called an amplifier; and a radio transmitter.

We will now demonstrate the eighteen steps needed to place the radio in operation.

Watch the instructor as I tell you the steps being performed.

Put on helmet

First put on the CVC helmet. The microphone goes on the right.

Show how mike moves around and adjust.

Next, adjust the microphone on the helmet so that it is centered right in front of your mouth. It may be necessary to loosen the adjusting screw on the right ear phone. This will let you slide the mike forward or back. If you do loosen the adjusting screw, be sure to retighten it when the mike is adjusted. Once the adjusting screw is tightened, you can still adjust the mike by simply pushing it centered, right in front of your mouth.

Loosen the adjusting screw and show how mike moves back and forth.

Adjust to correct position.

Move switch to rear, and forward, then to center. Leave in center position.	Third, set the switch on the left side of your helmet so that it is in the center position.
Show quick disconnect.	The fourth step is to connect the quick disconnect on the end of the audio cable to the CVC cord.
Show notches.	There is a tab on the connector and a matching notch on the CVC
Connect cords	cord. Match these and push the cord together.
Show cords; point out longer cord.	The fifth step is to connect the two cords on the other end of the audio cable to the control box. Notice that one cord is longer than the other. The connector on the long cord must be connected
Point to the left side control box	to the left side of the crewman's control box -- Remember, long-left. The connector on the short cord must be connected to the right
Connect long end to left, following steps.	side of the control box. To connect them, turn the flat portion of the connector to the front (hold it with your thumb). Push the connector onto the correct side of the control box (remember, long-left) then twist it to the right. Pull down on it to make sure it is
Connect short end to right.	connected. Be sure to connect both the long and short connectors.
Adjust volume; point out tab.	The sixth step is to adjust the volume control to the mid range position by turning the knob until the tab is to the front.
Turn switch to ALL.	For the seventh step, turn the monitor switch on the control box to ALL.

Set each switch.	The eighth step is to turn the radio transmitter switch on the amplifier to the COMMANDER PLUS CREW position. Nine, turn the intercom accent switch to ON. Ten, turn the main power switch to NORM. Eleven, flip the power circuit breaker switch to ON.
Point to PWR ON and SPKR OFF, then squeeze them together.	Twelve, put the radio transmitter power switch to ON, and Thirteen, turn the speaker switch to OFF. Just squeeze the two switches together. Fourteenth, set the radio transmitter volume at the maximum level -- 10. Then set the radio transmitter function switch to SQUELCH.
Follow each step.	The sixteenth step is to set the BAND switch to the range of the frequency assigned to you. For example, if your frequency were 42.85, set the BAND switch to the 30 to 52 position. Seventeenth, set the right and left frequency knobs. For a frequency of 42.85, set the left knob to 42 and the right knob to 85. Last, set the Antenna Frequency Control to the range of your frequency. For 42.85, set the

knob to the position between 42 and 47.5.

In a moment you practice the steps. When you practice try to remember that you must:

Point to each item as action is stated.

1. Put on the CVC helmet.
2. Adjust the mike.
3. Put the CVC switch to the center position.
4. Connect the quick disconnect.
5. Connect the audio cables.
6. Set the control box volume to mid-range.
7. Set the control box monitor to ALL.
8. Set the amplifier radio transmitter switch.
9. Set the "intercom accent" switch.
10. Set the "main power" switch.
11. Set the "power circuit breaker."
12. Turn the radio power on.
13. Turn the speaker off.
14. Adjust the radio volume.
15. Set the radio function control.
16. Set the band switch.
17. Adjust the radio frequency knobs.
18. Adjust the antenna frequency control.

The instructor will first talk you through the steps, and then you will practice.

If you cannot remember the steps, look at the list of steps.

(PRACTICE PERIOD)

Now that you have practiced preparing the radio for operation, you may have found it difficult to remember all eighteen steps at once. Let's review the steps and you'll see that it's not necessary to remember them all at once.

Point out relationships on chart.

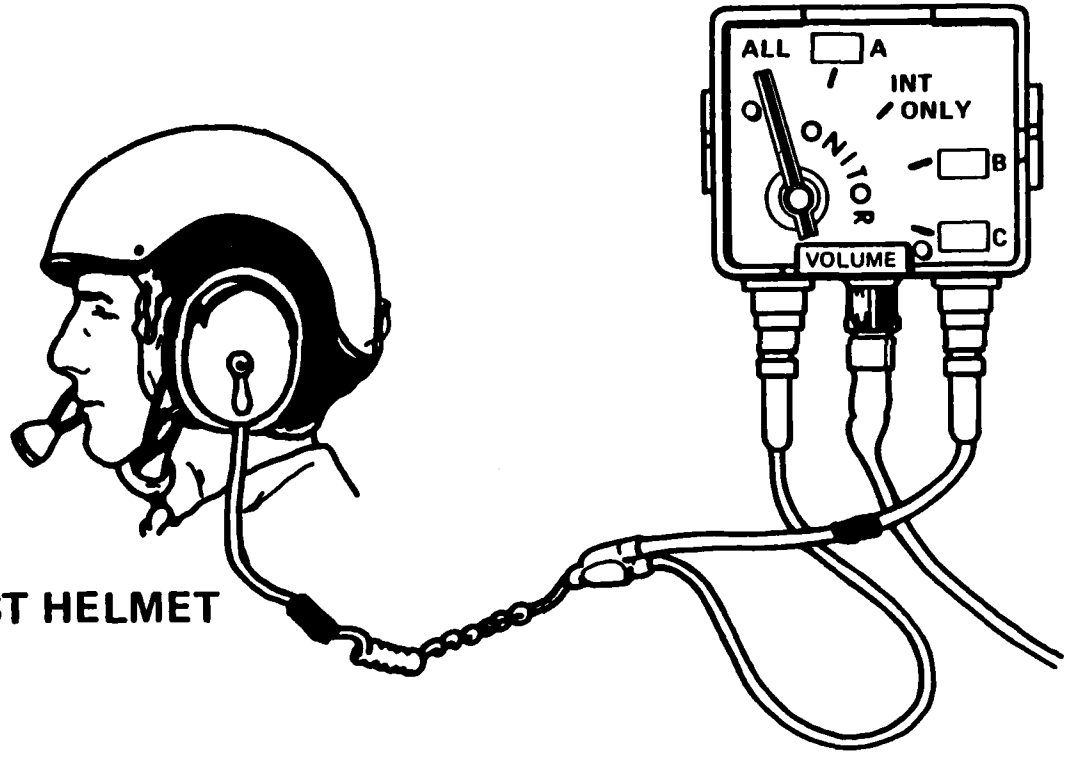
First, recall that the first three steps are to put on the CVC helmet, adjust the mike and put the switch to the center position. All three steps have to do with your CVC helmet. So any time you set up the radio for operation you know that you must put on and adjust your CVC helmet. That is, automatically adjust the mike and set the switch when you put on your CVC helmet.

1) Crew station structure chart

The next two steps are to connect the quick disconnect and the audio cables. That is, after you put on and adjusted your helmet all you need to remember is to connect it to the control box using the audio cable. After you have put on and adjusted your CVC helmet and connected it to the control box, the next steps are to set the control box monitor switch and adjust the control box volume control. That is, you adjust the control box.

We've now reduced the first seven steps to just three steps. If you remember to put on and adjust your

PREPARE CREWMAN'S STATION



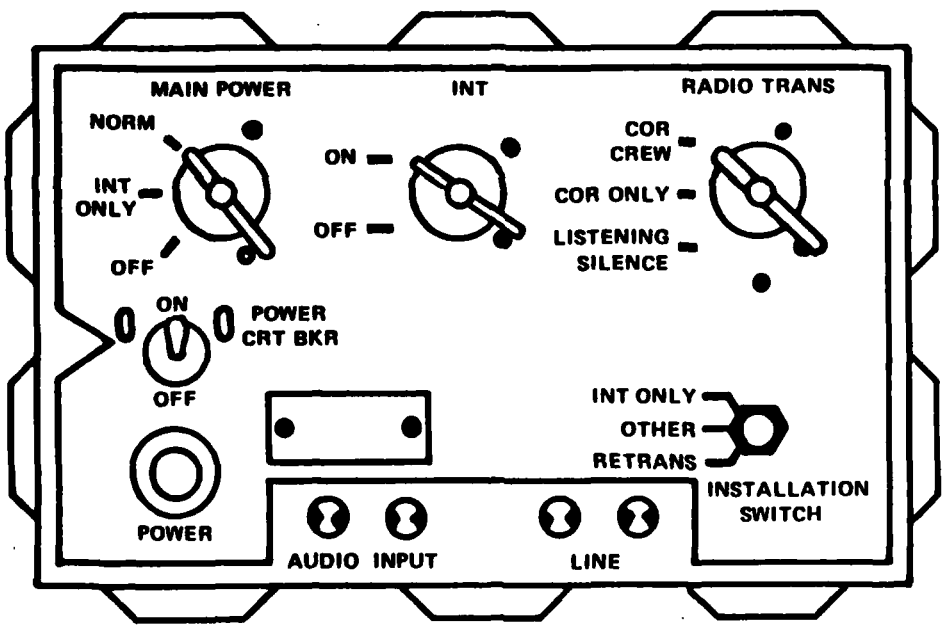
helmet, connect it to the control box with the audio cable and adjust the control box, you will have done the first seven steps. All of these steps are performed at the crewman's station. So the first thing you must remember when you're told to set the radio up for operation is that you must prepare the crewman's station for operation. Then, you must think to yourself: in order to prepare the crewman's station, I must put on and adjust my CVC helmet, connect it to the control box with the audio cable and adjust the control box.

Once the steps for preparing the crewman's station are completed, the next four steps all refer to controls on the amplifer. Recall that those four steps are to set the radio transmitter switch, set the intercom accent switch, turn on the main power switch, and turn on the circuit breaker switch. Each of these controls is on the amplifier and they are the only controls you can operate on the amplifier. So when you are to set the radio up for operation, you first remember to prepare the crewman's station, then you must remember to set the four controls on the amplifier.

2) Amplifier structure chart

After the crewman's station is prepared and the amplifier set, the next two steps are to set the power control and to set the

SET AUDIO FREQUENCY AMPLIFIER



Point to radio transmitter chart.

speaker control on the radio transmitter. These two steps are done at the same time by simply squeezing them together. The next two steps are to set volume control and to set the function controls on the radio transmitter. Since these two radio transmitter controls are located together, then it should be remembered to do them together. The remaining steps, which are to set the BAND switch, adjust the frequency knobs and adjust the antenna frequency control, all involve frequency adjustments. By setting all of these four controls, you have set the radio frequency. The power and speaker controls, the volume and function controls and the frequency control are all located on the radio transmitter.

3) Radio transmitter structure chart

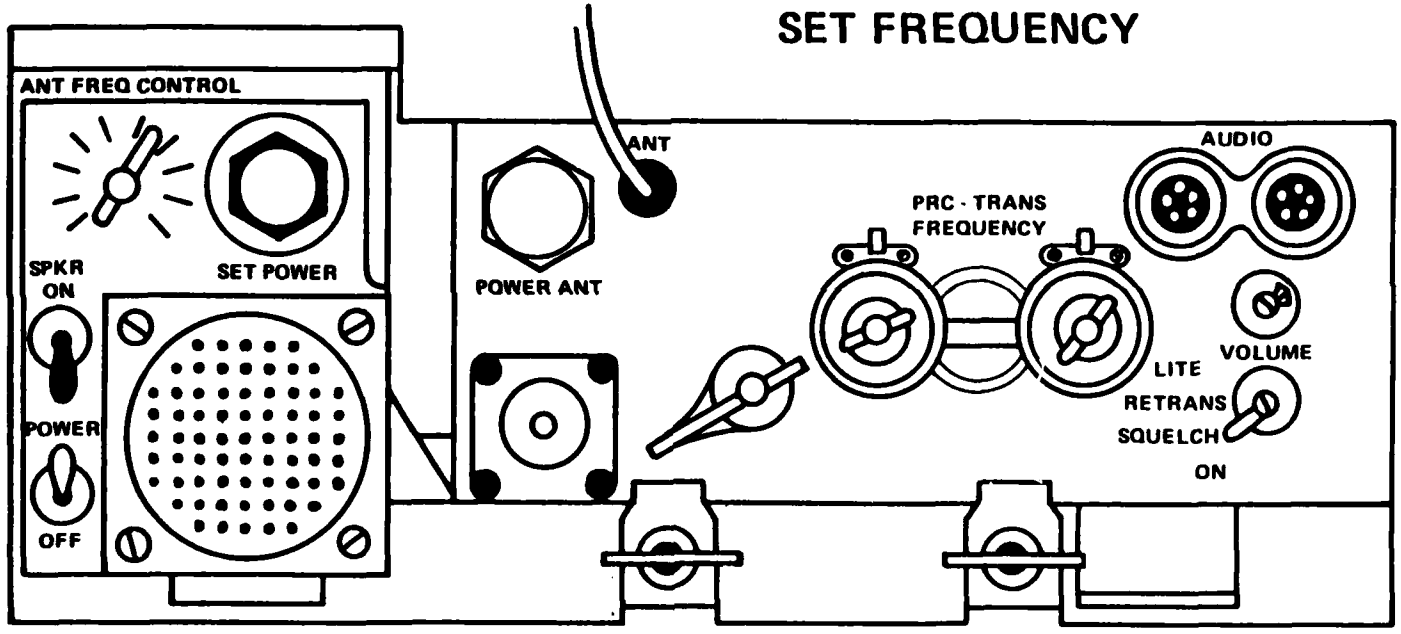
So what you need to remember to set up the radio for operation is first that there are three locations to set up: the crewman's station, the amplifier and the radio transmitter. Then, go to each location, one at a time, and do the steps for that location.

4) Operate radio structure chart

At the crewman's station you will remember to:

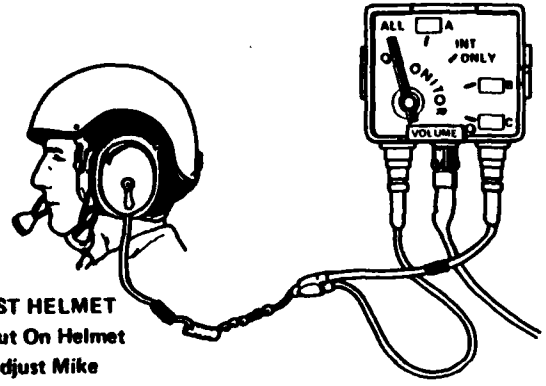
1. put on and adjust the helmet.
2. connect the audio cables.
3. adjust the control box.

SET RADIO TRANSMITTER



OPERATE THE AN/VRC - 64 RADIO

PREPARE CREWMAN'S STATION



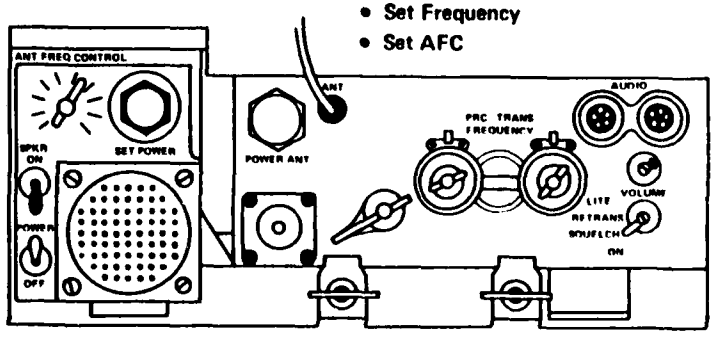
ADJUST HELMET
- Put On Helmet
- Adjust Mike
- Switch To Center

ADJUST CONTROL BOX
- Set Monitor
- Adjust Volume

CONNECT CABLES
- Connect Quick Disconnect
- Connect Audio Cables

SET RADIO TRANSMITTER

SET FREQUENCY
- Set Band
- Set Frequency
- Set AFC

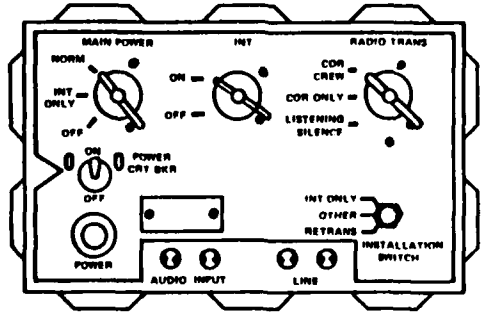


SET SWITCHES
- Speaker Off
- Power On

ADJUST R-T CONTROLS
- Adjust Volume
- Set Function

SET AUDIO FREQUENCY AMPLIFIER

- Set Radio Transmitter
- Set INT Accent
- Set Main Power
- Set Power Circuit Breaker



At the amplifier you set the four controls.

At the radio transmitter you:

1. squeeze the power and speaker controls.
2. adjust the volume and function controls.
3. set the frequency controls.

Now, you continue practicing setting up the radio for operation. This time, say out loud which groups of steps you are about to do, using the outline that has just been described. Practice so so that you can perform all of the steps needed to put the AN/VRC-64 radio into operation.

Operate the Radio AN/VRC-64
Top-down Presentation

Instructor	Narrator	Visual
Introductions, as needed, Record student's name and related information.		
Seat soldier by radio.		
Turn on tape and projector.		
	You are now going to learn how to prepare the Radio Set AN/VRC 64 for operation.	
	The AN/VRC 64 radio set is used in M60 series and M1 tanks. The radio set lets you talk to other tank crew members over an intercom system and it lets you send and receive messages over the radio to locations up to about 5 miles away. When you are assigned to a unit, you will be expected to talk to the other crewmen in a tank and to send and receive messages over this radio set. Before you are able to do this, however, you must learn how to set it up. That is the purpose of the present instruction. Here is how we will proceed. First, we will name the parts to the radio. Then we will tell you, in general, the basic things you need to do to set up the radio.	

We will then tell you what the individual steps are and tell you how to remember these steps. We will demonstrate how to do each step. You will then practice setting it up by doing the steps. An instructor will help you as you practice. You will continue practicing the steps for the rest of the period of instruction.

Let's begin by naming the component parts of the radio set that are needed to perform the task.

At each crewman's station there is the Combat Vehicle Crewman's helmet; this is usually called a CVC helmet, an audio cable and a crewman's control box.

Near the loader station there is an audio frequency amplifier, usually just called an amplifier, and there is a radio transmitter.

Before we demonstrate how to set up the radio for operation, it will help you to know that there are steps that must be done at three places:

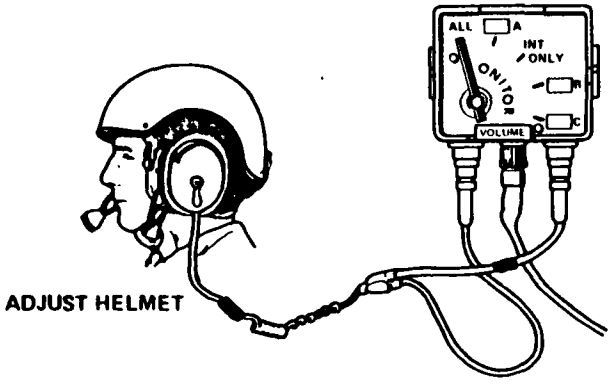
.the crewman's station
.the amplifier
.the radio transmitter

For the radio to work properly you must perform the necessary steps at each of these three locations.

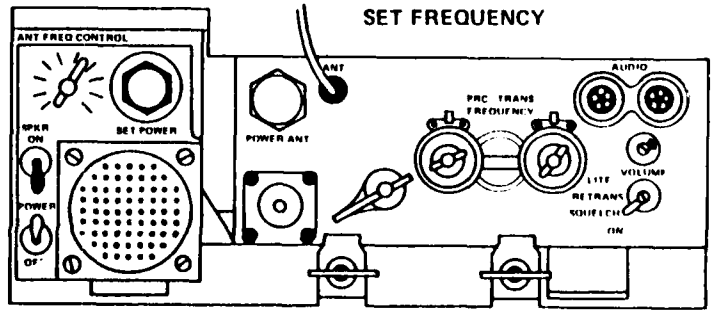
1) Operate radio structure chart, diagram #2.

OPERATE THE AN/VRC - 64 RADIO

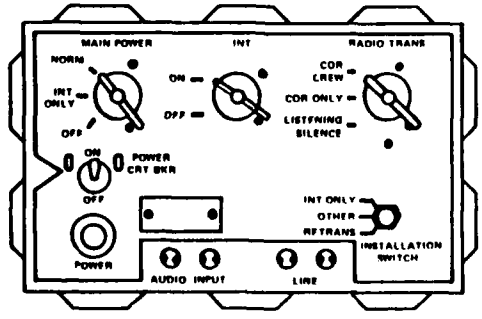
PREPARE CREWMAN'S STATION



SET RADIO TRANSMITTER



SET AUDIO FREQUENCY AMPLIFIER



So the first thing you should do when told to set up the radio, is to think to yourself, "crewman's station," "amplifier," "radio transmitter," because setting up the radio requires something at each of these locations. There are a total of eighteen separate steps needed to set up the radio. But don't try to remember them all at once. Begin by thinking to yourself that to set up the radio, there are steps at each of three locations. Then, go to each location, one at a time, and do the steps for that location. We will demonstrate setting up the radio by showing you the steps, one location at a time. So first, we will show you how to prepare the crewman's station, next we will demonstrate how to set the amplifier, and then finally we will demonstrate how to set and adjust the radio transmitter.

Before we begin the demonstration, tell the instructor what you should do when told to set up the radio.

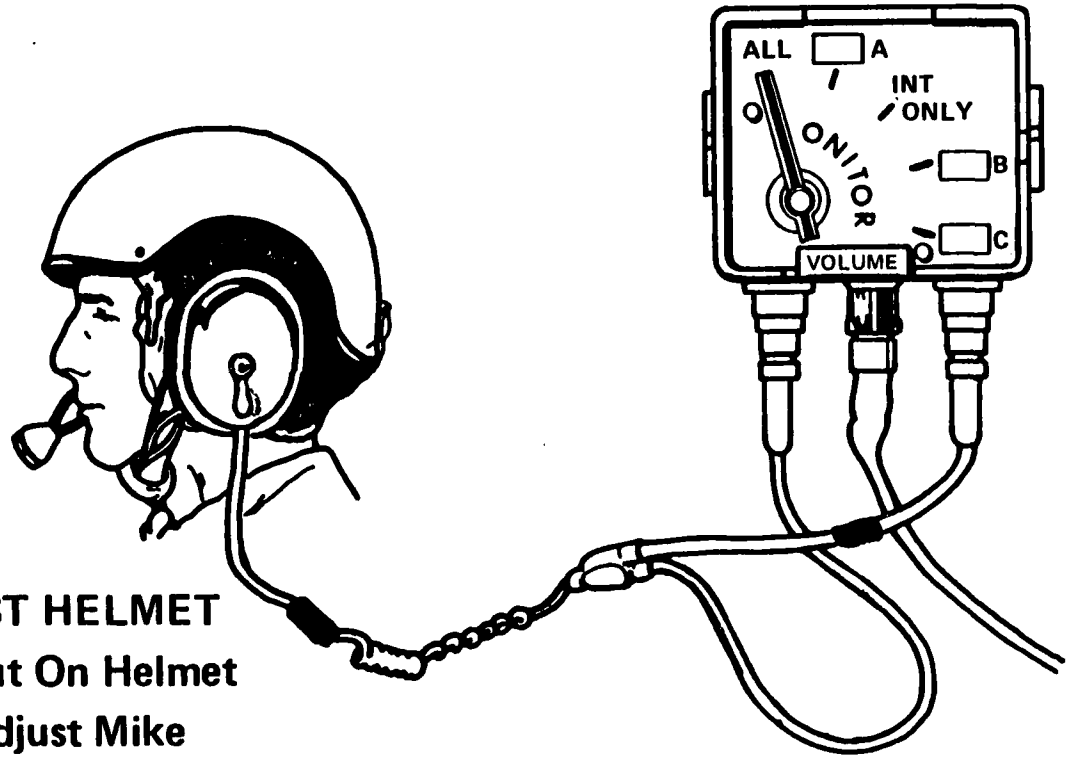
Prompt using chart, if necessary.

(pause on tape)

We will now begin demonstrating how to place the radio in operation by looking at the steps needed to prepare the crewman's station. Watch the instructor as I tell you the steps being performed.

2) Chart crewman's station structure.

PREPARE CREWMAN'S STATION



ADJUST CONTROL BOX

- Set Monitor
- Adjust Volume

ADJUST HELMET

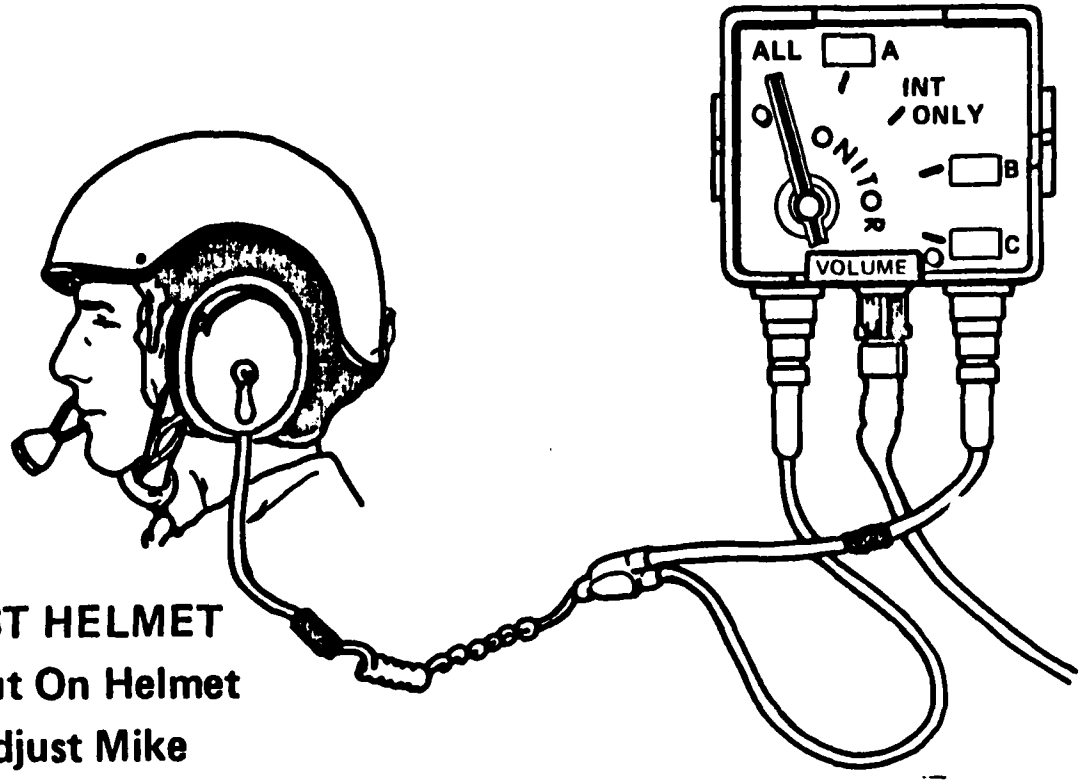
- Put On Helmet
- Adjust Mike
- Switch To Center

CONNECT CABLES

- Connect Quick Disconnect
- Connect Audio Cables

Point to each when stated.	The crewman's station has three components: the CVC helmet, the audio cable, and the control box. When you prepare the crewman's station, you have to do something with each of these three components. You have to put on and adjust the helmet. You have to use the audio cable to connect the helmet to the control box, and you have to adjust the control box.	
Put on helmet.	Let's look at the steps that are involved in putting on and adjusting the helmet. There are three steps that you must do. First, you put the helmet on. Notice that a a microphone is attached to it. Put the helmet on with the microphone to the right.	3) Crewman's Station, Chart #2.
Show how mike moves around and adjust.	The second step is to adjust the microphone so that it is centered right in front of your mouth.	
Loosen adjusting screw and show how mike moves back and forth.	It may be necessary to loosen the adjusting screw on the right side ear phone. This will let you slide the mike forward or back. If you do loosen the adjusting screw, be sure to retighten it when the mike is adjusted. Once the adjusting screw is tightened,	
Adjust to correct position.	you can still adjust the mike by simply pushing it centered, right in front of your mouth.	
Move switch to rear, and forward, then to center. Leave in center position.	The third step is to set the switch on the left side of your helmet so that it is in the center position.	

PREPARE CREWMAN'S STATION



ADJUST CONTROL BOX

- Set Monitor
- Adjust Volume

ADJUST HELMET

- Put On Helmet
- Adjust Mike
- Switch To Center

CONNECT CABLES

- Connect Quick Disconnect
- Connect Audio Cables

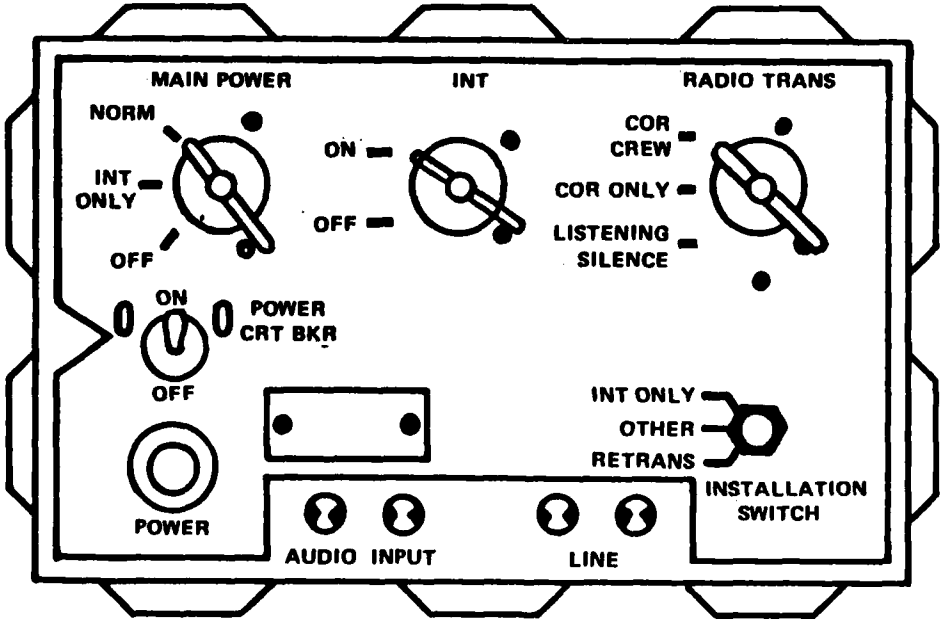
	When you have done all three steps, you will have put on and adjusted the helmet.
Hold up audio cord	The second component at the crewman's station is the audio cord. You must use it to connect the helmet to the control box. The audio cord has two connectors on one end but only one connection on the other.
Show each end	
Show end with quick disconnect.	The end of the audio cord with a single connector is called a quick disconnect. This connects to the CVC helmet. There is a tab on the connector and a matching notch on the CVC cord. Match these and push the cords together.
Show notches.	
Connect cords	
Show cords; point out longer cord.	Look at the other end of the audio cable. It has two connectors. Notice that one cord is longer than the other. The connector on the long cord must be connected to the left side of the crewman's control box -- Remember, long-left.
Point to left side of control box	
	The connector on the short cord then goes to the right side of the crewman's control box.
Connect long end to left.	To connect them turn the flat portion of the connector to the front (hold it with your thumb). Push the connector onto the correct side of the control box (remember, long-left). Then twist it to the right. Pull down on it to make sure it is connected. Be sure to

Connect short end to right.	connect both the long and short connectors to the control box.	
	Now the CVC helmet and control box are connected with the audio cord. That is, you used the audio cord to connect the helmet to the control box.	
Point to control box.	To finish preparing the crewman's station for operation, adjust the control box. There are two controls to set.	
Adjust volume.	First, adjust the volume control to the mid range position by turning the knob until the tab is to the front.	
Turn switch to ALL.	Then turn the monitor switch on the control box to ALL. These two steps complete the adjustment of the control box.	
Point to helmet, cord, and control box.	Now the crewman has put on and adjusted his helmet, used the audio cord to connect the helmet to the control box and adjusted the control box. Having completed these three things, the crewman's station is prepared for the operation of the radio.	
Prompt with chart if necessary	To repeat, in order to set up the radio, there are three locations you must remember. One of these locations is the crewman's station. We've just completed preparing the crewman's station for the operation. The other locations are the amplifier and radio transmitter.	4) Blank

Point to amplifier.	We will now demonstrate the steps that must be done at the second location -- the amplifier. At the amplifier you do four things:	5) Amplifier structure chart
Set each switch.	.First, turn the radio transmitter switch to the COMMANDER PLUS CREW position. .Next, turn the intercom accent switch to ON. .Third, turn the main power switch to NORM. .And last, flip the power circuit breaker switch to ON.	
	When these four switches are in their correct locations, the amplifier is set for operation.	
	Now, the crewman's station and amplifier are ready for operation. But there are still some steps to be performed at one more location. That is the radio transmitter.	6) Blank
	We will now show you the steps that must be performed to set the radio transmitter.	7) Radio transmitter chart
	There are three sets of controls to set on the radio transmitter.	
Point to speaker and power switch.	.the power controls, consisting of the power switch and the speaker switch,	
Point to function and volume controls.	.the radio controls, consisting of the volume control and the function control, and	
Point to Band, Frequency and AFC controls.	.the frequency controls, consisting of the Band switch, two	

SET AUDIO FREQUENCY AMPLIFIER

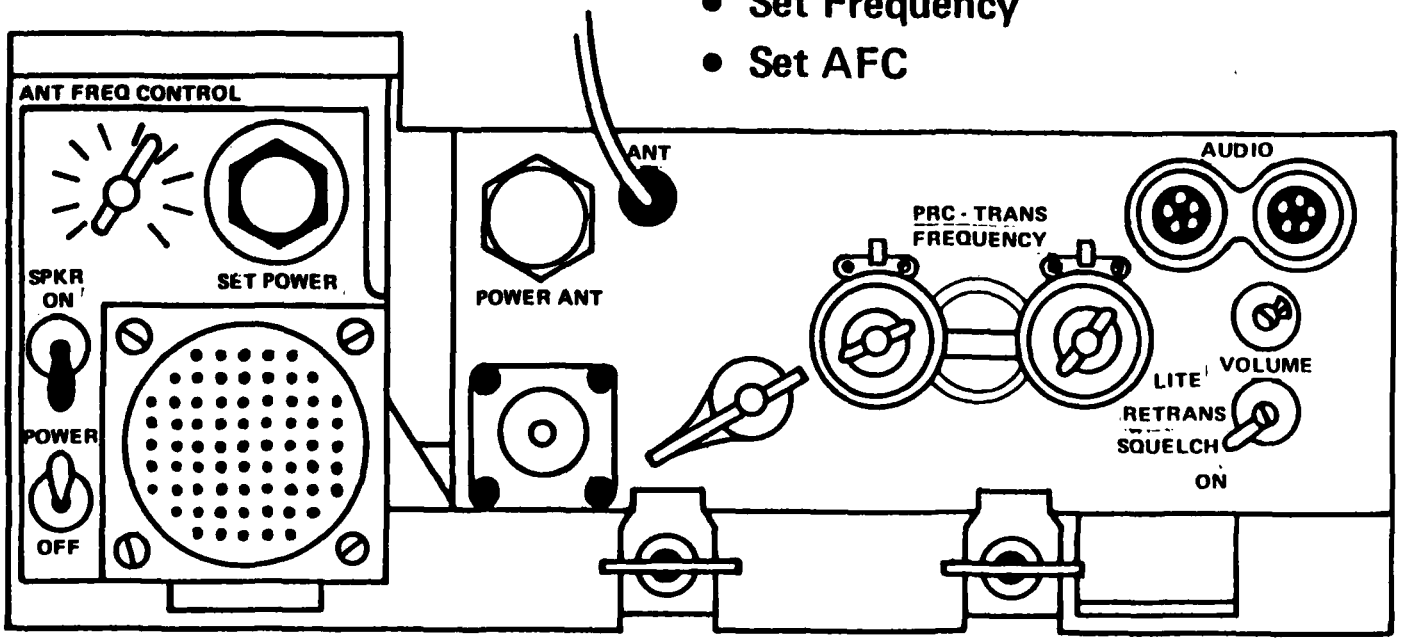
- Set Radio Transmitter
- Set INT Accent
- Set Main Power
- Set Power Circuit Breaker



SET RADIO TRANSMITTER

SET FREQUENCY

- Set Band
- Set Frequency
- Set AFC



SET SWITCHES

- Speaker Off
- Power On

ADJUST R-T CONTROLS

- Adjust Volume
- Set Function

	frequency knobs, and the Antenna Frequency Control.
Point to PWR ON and SPKR OFF, then squeeze them together.	To set the power controls on the radio transmitter, there are two steps. Put the power switch to ON and the speaker switch to OFF. Remember power on but speaker off. You can do those two steps at the same time just by squeezing the two switches together.
Set volume and function control.	The next steps in setting the radio transmitter are the volume and function controls. There are two steps involved in setting tnese controls. One is to set the volume and the other is to set the function. Set the volume at the maximum level -- 10. Set the function switch to squelch.
Point to chart.	Now the power controls are set, and the volume and function controls are set. The last thing to do on the radio transmitter is to set the frequency. There are four controls used to set the frequency.
Point to each.	.the Band switch .the two frequency knobs, and .the Antenna Frequency Control The settings for these four controls depends on the frequency assigned to your unit.

Follow each step.

Suppose we want the radio set for a frequency of 42.85. First, set the BAND switch to the 30-52 position because the assigned frequency is between those two numbers.

Next, set the left frequency knob to 42 and the right frequency knob to 85.

Finally, the Antenna Frequency Control knob must be set for the correct frequency range. The assigned frequency 42.85 is in the range between 42 and 47.5 so set the control to the position between 42 and 47.5.

Point to location of power and speaker switches, volume and function controls, and frequency controls.

With power and speaker switches set, the volume and function controls adjusted, and the frequency controls set, the radio transmitter is now ready for operation.

That completes the set of steps for putting the radio in operation. The crewman's station is prepared, the audio frequency amplifier is set and the radio transmitter is adjusted.

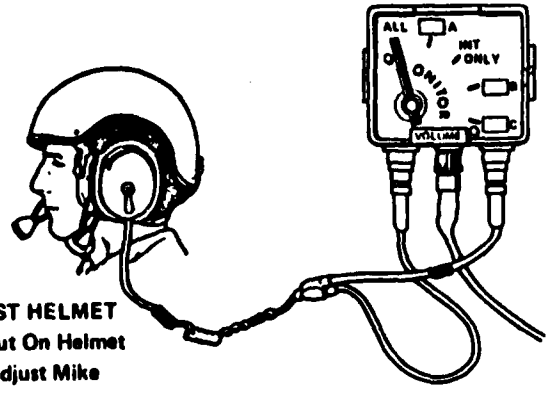
In a moment, you will practice the steps. When you practice try to remember that you must:

1. prepare the crewman's station.
2. set the amplifier.
3. adjust the radio transmitter.

8) Operate radio structure chart

OPERATE THE AN/VRC - 64 RADIO

PREPARE CREWMAN'S STATION



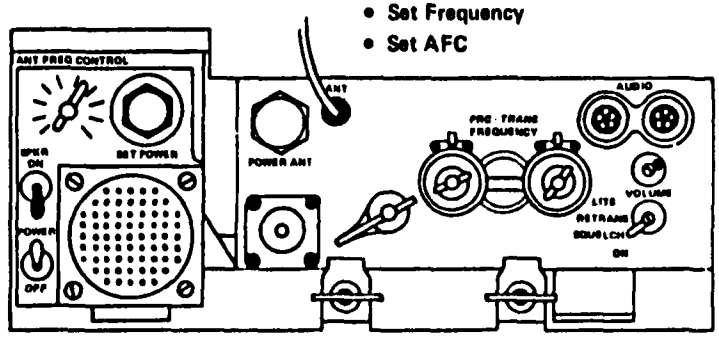
ADJUST HELMET
- Put On Helmet
- Adjust Mike
- Switch To Center

ADJUST CONTROL BOX
- Set Monitor
- Adjust Volume

CONNECT CABLES
- Connect Quick Disconnect
- Connect Audio Cables

SET RADIO TRANSMITTER

SET FREQUENCY
- Set Band
- Set Frequency
- Set AFC

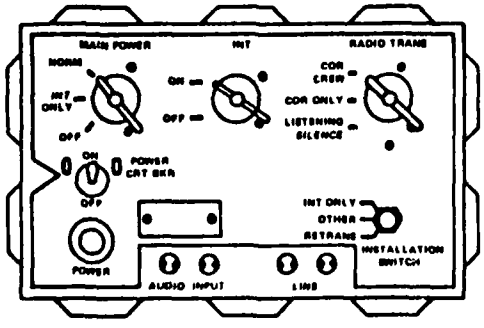


SET SWITCHES
- Speaker Off
- Power On

ADJUST R-T CONTROLS
- Adjust Volume
- Set Function

SET AUDIO FREQUENCY AMPLIFIER

- Set Radio Transmitter
- Set INT Accent
- Set Main Power
- Set Power Circuit Breaker



At the crewman's station you must:

1. put on and adjust the helmet.
2. connect the audio cables.
3. adjust the control box.

At the amplifier you set the four controls.

At the radio you must:

1. squeeze the power and speaker controls.
2. adjust the volume and function controls.
3. set the frequency controls.

The instructor will first talk you through the steps. Then you will practice. Say out loud which groups of steps you are about to do, using the outline that has just been described. Practice so that you can perform all the steps needed to operate the AN/VRC-64 radio without looking at the diagram.

APPENDIX D

Respond to an Engine Compartment Fire Training Program

Engine Compartment Fire - M1 Tank
Unstructured POT Presentation

Instructor	Narrator	Slides
Introduction, as needed.		
Record student's name and related information on record form.		
Turn on tape recorder.	The task you are now going to learn is the procedure followed by the driver of an M1 tank to put out a fire in the tank's engine compartment. The M1 tank is the Army's most modern tank. It is a fast and highly accurate fighting vehicle. In addition, it is designed with a number of features (including special armor), which are designed to protect the crew from injury. One of these features is the fire extinguisher system. There are actually two fire extinguisher systems, one for the crew compartment inside the turret and one for the engine compartment. You are going to learn how to operate the fire extinguisher system for the engine compartment. Knowing the procedure for putting out an engine fire may save a tank and prevent personal injury if a fire should occur in the engine compartment. We will use this mock-up of the	

driver's compartment for demonstrating and practicing the procedure.

Here is how we will proceed. First, we will point out the driver controls you will use during the procedure for putting out an engine fire. Then we will demonstrate the procedure. After that, you will practice doing the procedure. The instructor will help you as you practice. You will continue to practice for the rest of the period of instruction.

We will begin by looking at the driver's compartment and by pointing out the driver displays and controls used during the engine fire procedure.

Point to each component.

Directly in front of the driver is the alert panel and on it is the master warning light. Below that is the steering control, throttle handgrips and transmission control. The service brake and parking brake are down in the front of the compartment. On the right side is the driver's master panel. We will use the master power switch which is near the bottom left corner of the master panel.

On the left side is the driver's instrument panel. We will use the fire light, first shot light and second shot switch. Down below the instrument panel is the engine

fire handle. These are the displays and controls you will need to use when there is an engine fire.

We will demonstrate the steps that you must follow when there is a fire in the engine compartment. First, however, let's get the controls set like they would be if the tank were being driven. The master power switch would be on, and the transmission control would be in D.

Set controls.

Operate lights on mock-up, adjust controls and switches as indicated.

If a fire starts in the engine compartment, the first thing that should happen is that the master warning light will come on. As soon as you see the master warning light, look at the instrument panel on the left. See if the first shot discharged light is on. This means that the fire extinguisher has discharged automatically. If the first shot light is on, immediately tell the tank commander "TC, there has been a fire and the engine compartment first-shot has been discharged."

Turn off master caution and first shot lights.

Sometimes when an engine fire occurs, the first shot fire extinguisher will not automatically discharge. If this happens, the master warning light will come on. When the master warning light comes on, look at the instrument panel. If the fire light on the instrument panel is on, reach down and pull

the engine fire handle. This discharges the first shot manually. Then tell the tank commander, "TC, there has been a fire in the engine and I have pulled the engine fire handle."

Whether the first shot extinguisher discharged automatically or was discharged manually, as soon as you have alerted the TC to the engine fire, drive the tank to a safe location. For example, on a battle field, you would drive to a covered position.

On a tank range, you may need to move off the tank line and away from the ammo point. In the motor pool, a safe location may be away from buildings and other tanks.

Push the steering control left or right.

In the mock-up we will simulate driving by pushing left or right on the steering control. The control doesn't move so don't push too hard, but you can get the idea. As you reach a safe location, turn the tank into the wind so the wind will blow the smoke away. When you get to a safe location, twist the throttle handgrips to the idle position, then press the service brakes to stop. Next, press the parking brake. Put the transmission control on "N". Then, remind the tank commander to move the turret so you can get out if you need to. Say: "TC, turn the turret around." Watch the fire light. If it goes out, or if it stays out,

tell the tank commander: "TC, the engine fire is out." If the engine fire light stays on or comes on, tell the tank commander: "TC, the fire is still burning."

Next, listen for the TC's command to use the second shot. If the fire is still burning, the tank commander should issue a command to fire the second shot. The second shot is the back-up fire extinguisher for the engine compartment. When the tank commander issues the command to fire second shot, open the second shot cover and flip the switch. Next, count slowly to 18 and listen for the swooshing sound that the extinguisher makes when if discharges. Watch the fire light. If the fire light goes out, tell the tank commander: "TC, the engine fire is out." If you do not hear the swooshing sound or if the fire light stays on, tell the TC: "TC, the engine fire is still burning." Then, flip the 2nd shot switch back to its initial position. Next, listen for the TC to tell you to turn off the master power. Do so, on command. Then, listen for the TC's orders to evacuate the tank. When he gives this command, get out of the tank. In this case, get out of the mock-up.

Finally, if you did not hear the swooshing sound, pull the engine fire handle on the outside of the

tank. This is the back-up for the second shot and should be used if the second shot fails to discharge after the second shot switch is thrown.

This completes the procedure for an engine compartment fire. Now you will practice the procedure. When you practice try to remember:

1. Watch the alert panel where you will see the master warning light come on.
2. Look at the driver's instrument panel where you will see either the first shot light or fire light come on.
3. If the first shot light is on, tell the tank commander that there is an engine fire, and the first shot discharged automatically.
4. If the fire light is on and the first shot light is not on, pull the engine fire handle. Then tell the TC there is an engine fire and that you pulled the engine fire handle.
5. Whether the first shot extinguisher discharged automatically or was discharged manually, drive to a safe location.
6. Turn into the wind.
7. Twist the throttle to idle.
8. Press service brake to stop.
9. Press the parking brake.
10. Set the transmission control in "N".
11. Remind TC to turn turret around.

12. Watch the fire light.
13. Tell the TC whether the fire is out or still burning.
14. If the fire is still burning, listen for and execute the TC's command to flip the second shot switch.
15. Count to 18 and listen for a swooshing sound.
16. Watch the fire light.
17. Tell the TC whether the fire is out or still burning.
18. If the fire is still burning, flip the second shot switch back.
19. Listen for and execute the TC's command to turn off the master power switch.
20. Listen for and execute the TC's command to evacuate the tank.
21. If you did not hear a swooshing noise, pull the outside engine fire handle.

The instructor will first talk you through the steps and then you will practice. Practice so that you can perform all the steps needed to put out a fire in the engine compartment.

The best way to learn this task so that you can remember how to do it is to practice the steps.

Engine Compartment Fire - M1 Tank
Bottom-up Presentation

Instructor	Narrator	Slides
Introduction, as needed.		
Record student's name and related information on record form.		
Turn on tape recorder.	The task you are now going to learn is the procedure followed by the driver of an M1 tank to put out a fire in the tank's engine compartment.	
	The M1 tank is the Army's most modern tank. It is a fast and highly accurate fighting vehicle. In addition, it is designed with a number of features (including special armor), which are designed to protect the crew from injury. One of these features is the fire extinguisher system. There are actually two fire extinguisher systems, one for the crew compartment inside the turret and one for the engine compartment. You are going to learn how to operate the fire extinguisher system for the engine compartment. Knowing the procedure for putting out an engine fire may save a tank and prevent personal injury if a fire should occur in the engine compartment. We will use this mock-up of the	

driver's compartment for demonstrating and practicing the procedure.

Here is how we will proceed. First, we will point out the driver controls you will use during the procedure for putting out an engine fire. Then we will demonstrate the procedure. After that, you will practice doing the procedure. The instructor will help you as you practice. After you have practiced for a while and learned how to do each of the steps, we will give you some additional information which will help you remember the task.

We will begin by looking at the driver's compartment and by pointing out the driver displays and controls used during the engine fire procedure.

Point to each component as it is mentioned.

Directly in front of the driver is the alert panel and on it is the master warning light. Below that is the steering control, throttle handgrips, and transmission control. The service brake and parking brake are down in the front of the compartment. On the right side is the driver's master panel. We will use the master power switch which is near the bottom left corner of the master panel.

	On the left side is the driver's instrument panel. We will use the fire light, first shot discharged light and second shot switch. Down below the instrument panel is the engine fire handle. These are the displays and controls you will need to use when there is an engine fire.
	We will demonstrate the steps that you must follow when there is a fire in the engine compartment. First, however, let's get the controls set like they would be if the tank were being driven.
Set controls.	The master power switch would be on, and the transmission control would be in D.
Operate lights on mock-up, adjust controls and switches as indicated.	If a fire starts in the engine compartment, the first thing that should happen is that the master warning light will come on. As soon as you see the master warning light, look at the instrument panel on the left. See if the first shot discharged light is on. This means that the fire extinguisher has discharged automatically. If the first shot light is on, immediately tell the tank commander "TC, there has been a fire and the engine compartment first shot has been discharged."
Turn off master caution and first shot lights.	Sometimes when an engine fire occurs, the first shot fire extinguisher will not automatically discharge. If this happens, the master warning light will come on.

When the master warning light comes on, look at the instrument panel. If the fire light on the instrument panel is on, reach down and pull the engine fire handle. This discharges the first shot manually. Then tell the tank commander, "TC, there has been a fire in the engine and I have pulled the engine fire handle."

Whether the first shot extinguisher discharged automatically or was discharged manually, as soon as you have alerted the TC to the engine fire, drive the tank to a safe location. For example, on a battle field, you would drive to a covered position.

On a tank range, you may need to move off the tank line and away from the ammo point. In the motor pool, a safe location may be away from buildings and other tanks.

Push the steering control left or right.

In the mock-up we will simulate driving by pushing left or right on the steering control. The control doesn't move so don't push too hard, but you can get the idea. As you reach a safe location, turn the tank into the wind so the wind will blow the smoke away. When you get to a safe location, twist the throttle handgrips to the idle position, then press the service brakes to stop. Next, press the parking brake. Put the transmission control on "N". Then, remind the tank commander to move the turret

so you can get out if you need to. Say: "TC, turn the turret around." Watch the fire light. If it goes out, or if it stays out, tell the tank commander: "TC, the engine fire is out." If the engine fire light stays on or comes on, tell the tank commander: "TC, the fire is still burning."

Next, listen for the TC's command to use the second shot. If the fire is still burning, the tank commander should issue a command to fire the second shot. The second shot is the back-up fire extinguisher for the engine compartment. When the tank commander issues the command to fire second shot, open the second shot cover and flip the switch. Next, count slowly to 18 and listen for the swooshing sound that the extinguisher makes when it discharges. Watch the fire light. If the fire light goes out, tell the tank commander: "TC, the engine fire is out." If you do not hear the swooshing sound or if the fire light stays on, tell the TC: "TC, the engine fire is still burning." Then, flip the 2nd shot switch back to its initial position. Next, listen for the TC to tell you to turn off the master power. Do so, on his command. Then, listen for the TC's orders to evacuate the tank. When he gives this command, get out of the tank. In this case, get out of the mock-up.

Finally, if you did not hear the swooshing sound, pull the engine fire handle on the outside of the tank. This is the back-up for the second shot and should be used if the second shot fails to discharge after the second shot switch is thrown.

This completes the procedure for an engine compartment fire. Now you will practice the procedure. When you practice try to remember:

1. Watch the alert panel where you will see the master warning light come on.
2. Look at the driver's instrument panel where you will see either the first shot light or fire light come on.
3. If the first shot light is on, tell the tank commander that there was an engine fire, but the first shot discharged automatically.
4. If the fire light is on and the first shot light is not on, pull the engine fire handle. Then tell the TC there is an engine fire and that you pulled the engine fire handle.
5. Whether the first shot extinguisher discharged automatically or was discharged manually, drive to a safe location.
6. Turn into the wind.
7. Twist the throttle to idle.
8. Press service brake to stop.
9. Press the parking brake.

10. Set the transmission control in "N".
11. Remind TC to turn turret around.
12. Watch the fire light.
13. Tell the TC whether the fire is out or still burning.
14. If the fire is still burning, listen for and execute the TC's command to flip the second shot switch.
15. Count to 18 and listen for a swooshing sound.
16. Watch the fire light.
17. Tell the TC whether the fire is out or still burning.
18. If the fire is still burning, flip the second shot switch back.
19. Listen for and execute the TC's command to turn off the master power switch.
20. Listen for and execute the TC's command to evacuate the tank.
21. If you did not hear a swooshing noise, pull the outside engine fire handle.

The instructor will talk you through the steps, then you will practice.

(PRACTICE PERIOD)

Restart tape.

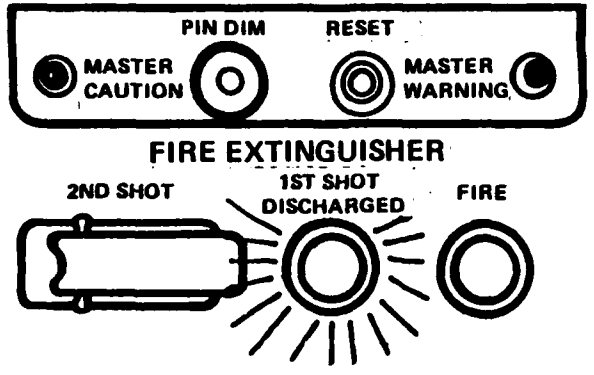
Now that you have practiced the procedure for putting out a fire in the engine compartment, we are going to review the steps and present to you a way of thinking about the task which should help you remember it more easily.

We'll begin by looking at the first few steps. When a fire begins in the engine compartment the master warning light and first shot discharge light come on telling you, the driver, that a fire has been detected by a fire sensor and that the first shot discharged automatically. You, in turn, tell the TC. We will call these steps, "detect and discharge." The first part of the engine fire procedure then is the detection and discharge phase, and that is what you will need to remember first. The engine fire is detected and the first shot discharged.

1) Detect and discharge slide

What happens if the first shot does not go off automatically? The fire is still detected by the sensors and the fire light will come on. You, the driver, must discharge the first shot manually by pulling the engine fire handle. The first shot is discharged whether it is done automatically or whether you do it manually. Of course, you still inform the TC that a fire has been detected and the first shot discharged. So again, remember that the first part of the procedure for putting out an engine compartment fire is detection and discharge. You will know that there has been an engine compartment fire by the lights that come on. Then, either automatically or by your own action, the first shot should be discharged.

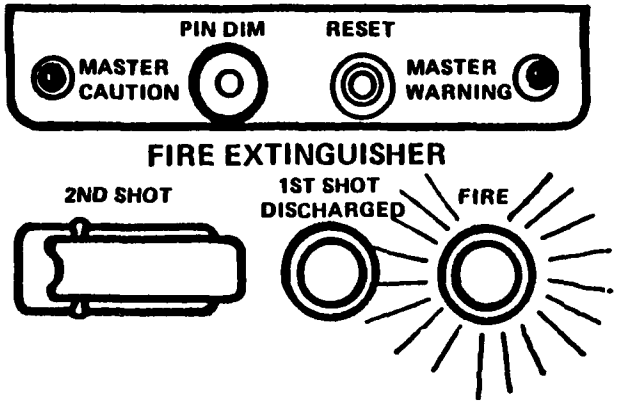
1st SHOT DISCHARGED



- Alert TC
  "Fire in Engine"

OR

FIRE/NO 1st SHOT



- Alert TC
  "Fire in Engine"
- Pull Engine Fire Handle

After the fire has been detected and the first shot has been discharged, the next steps are to drive to a safe location, turn into the wind, idle the engine, stop, set parking brake, and put the transmission in neutral. Then, the turret must be positioned for your exit.

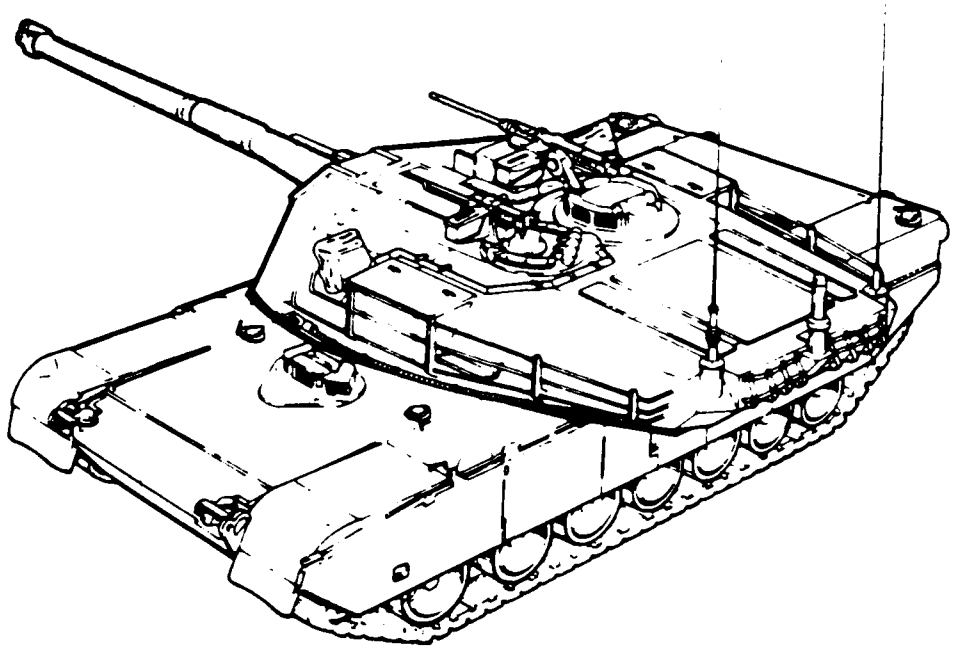
This series of steps positions the tank is a safe location so that surrounding equipment are protected and the crew is protected until further action is taken. Thus, the second phase of the procedure for putting out an engine fire is position the tank.

During the time that the tank is being positioned, you must also remember to watch the fire light. What you will do next depends on what happens with the fire light. If the fire light either goes out or stays out, this tells you that the fire is out. The procedure for putting out an engine fire is then completed after the tank is positioned and the TC is alerted that the fire is out.

If the fire light is on after the tank is positioned, the procedure continues. The next four steps are to alert the TC that the fire is still burning; listen for and execute the TC's command to flip the second shot switch; wait and listen for the second extinguisher to discharge, and watch the fire

2) Position Tank slide.

POSITION TANK



- Drive to Safe Location
- Turn into Wind
- Stop Tank
  - Idle
  - Stop
  - Set Park Brake
  - Trans in "N"
- Turret Positioned
- Watch Fire Light

light. These are the steps needed to activate the second shot fire extinguisher and see if it works to put out the fire. We call these steps "use second shot." Use second shot, then, is the third phase of the procedure for putting out an engine fire. However, it is necessary to use the second shot only if the first shot extinguisher does not put out the fire. Also, the second shot should not be used until the TC orders because using it shuts off the engine. When the engine shuts off, the tank can no longer be moved.

3) Use second shot slide

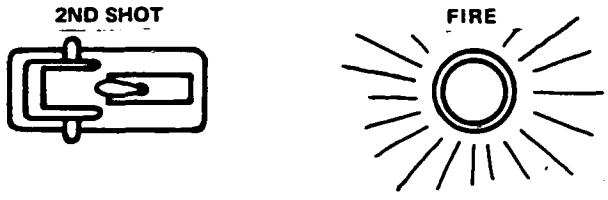
So far we have divided the steps of the procedure for putting out an engine compartment fire into three parts or phases:

.Detect and discharge
.Position tank and
.Use second shot

If the fire is put out during the use second shot phase of the procedure, then the procedure is finished as soon as the TC is notified that the fire is out. On the other hand, if the fire does not go out (you can tell because the fire light will stay on), the procedure continues with several more steps. Let's look at those remaining steps.

USE SECOND SHOT

FIRE EXTINGUISHER



- Alert TC
  "Fire Still Burning"
- 2nd Shot, on Command
- Wait 18 seconds for 2nd Shot to Discharge
- Check Fire Light

If the fire light does not go out after you use the second shot, then first tell the TC the fire is still burning; second, flip the second shot switch back to its original position, turn off the master power when the TC commands, and exit the tank when the TC commands. These are the steps needed to complete the shut down of the tank and get out. We'll call these steps the exit phase of the procedure.

4) Exit phase

There is one last step to the exit phase which occurs if the second shot did not discharge using the second shot switch inside the tank. That is to pull the engine fire handle located outside of the tank. This will manually discharge the second shot extinguisher.

These four or five steps, make up the exit phase and the exit phase is the last of the four phases of the engine compartment fire procedure.

Let's look at the entire procedure one more time.

The first phase is the detect and discharge phase. Second, is the position tank phase. If the first shot puts out the fire, the procedure is finished as soon as the tank is positioned and the TC is alerted that the fire is out. If the fire continues to burn, the third phase is to use the second

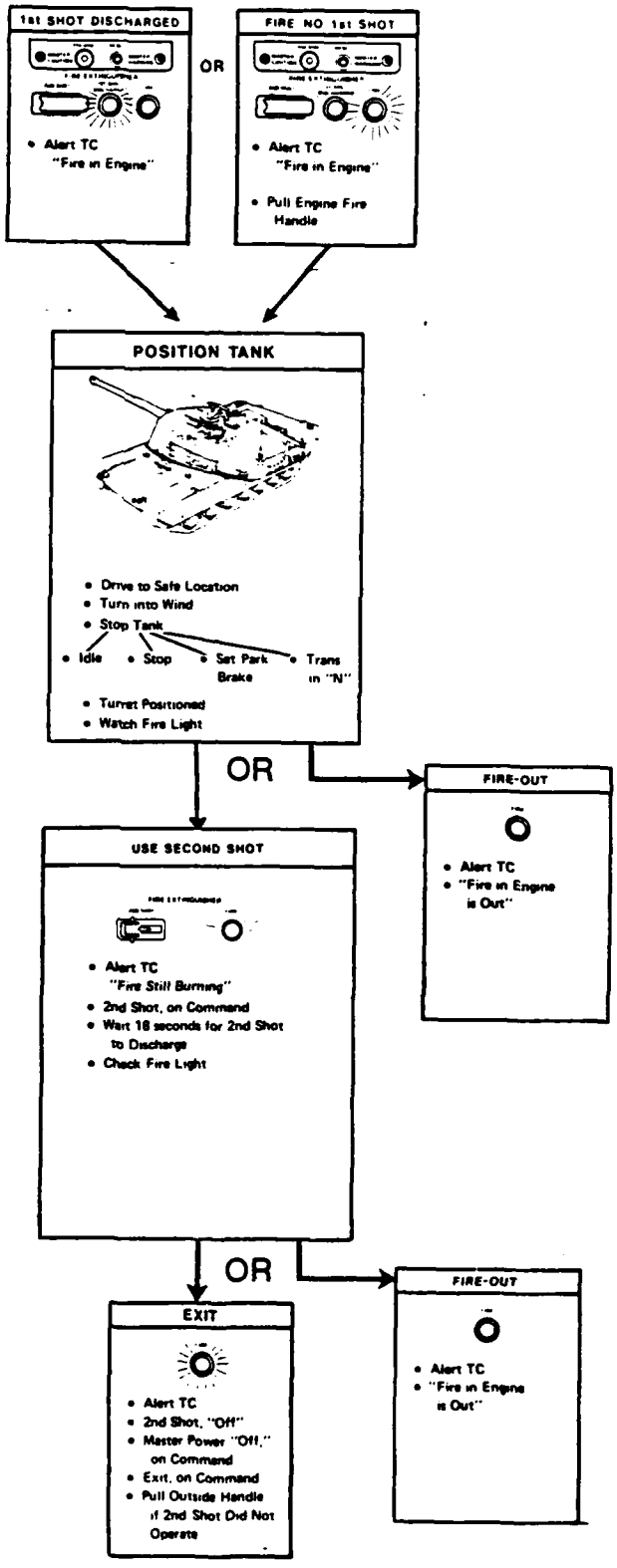
4) Total structure.

EXIT

- Alert TC
- 2nd Shot, "Off"
- Master Power "Off," on Command
- Exit, on Command
- Pull Outside Handle if 2nd Shot Did Not Operate

ENGINE COMPARTMENT FIRE M1 TANK

DETECT & DISCHARGE



shot. If the second shot puts out the fire, the procedure is finished as soon as the TC is alerted. If the second shot does not put out the fire, the fourth and final phase is the exit phase.

Now you will practice all of the procedures. When you practice try to remember the four phases of the procedure:

First, detect the fire and make sure the first extinguisher is discharged.

Second, position the tank.

Third, use the second shot, if necessary.

Fourth, exit, if necessary.

During the first phase, you will first see a master warning light.

Then, looking at your instrument panel, either the first shot discharged light or the fire light will be on. If the fire light is on and the first shot discharged light not on, pull the engine fire handle. In either case, alert the TC.

During the second phase, the position tank phase, you drive to a safe location, turn into the wind, stop, have the turret positioned and watch the fire light.

If the fire light is still on after you have positioned the tank in a safe location, then perform the third phase, use second shot. During the use second shot phase, you alert the TC, activate the second shot on the TC's command, wait and listen for the second shot to discharge, and watch the fire light.

If the fire light still does not go out, during the fourth exit phase you, alert the TC; flip the second shot switch back to off; on his command, turn off the master power; and on his command, exit the tank. Finally, if the second shot did not discharge, pull the outside engine fire handle.

Now, you will continue to practice. This time, say out loud the phases of the procedure as you do them. Practice so that you can perform all of the steps needed to put out a fire in the engine compartment without looking at the diagram.

Engine Compartment Fire - M1 Tank
Top-down Presentation

Instructor	Narrator	Slides
Introduction, as needed.		
Record student's name and related information on record form.		
Turn on tape recorder.	The task you are now going to learn is the procedure followed by the driver of an M1 tank when there is a fire in the tank's engine compartment.	
	The M1 tank is the Army's most modern tank. It is a fast and highly accurate fighting vehicle. In addition, it is designed with a number of features including special armor, which are designed to protect the crew from injury. One of those features is the fire extinguisher system. There are actually two fire extinguisher systems, one for the crew compartment in the turret and one for the engine compartment. You are going to learn the appropriate responses for operating the fire extinguisher system for the engine compartment. Knowing the procedure for an engine fire may save a tank and possible personal injury if a tank you are working on should ever catch fire.	

We will use this mock-up of the driver's compartment for demonstrating and practicing the procedure.

Here is how we will proceed. First, we will point out the driver controls you will use during the procedure. Then, we will give you an overview of the four phases (or parts) of the procedure. We will then demonstrate the steps in each of the phases. You will then practice the procedure. An instructor will help you as you practice. You will continue to practice the procedure for the rest of the period of instruction.

We will begin by showing you the driver's compartment and pointing out the driver's displays and controls used during the engine fire procedure.

Point out the controls.

The controls used to drive the tank are the steering control and throttle handgrips which operate something like a motorcycle. The transmission works like an automatic transmission on a car. The service brake to stop the tank and the parking brake also work like a car. Above the steering control is the driver's alert panel with a master warning light. This light comes on if there is some kind of malfunction or problem in the tank. To the left of the driver's position is the instrument panel. We will be using the fire light, the

first shot discharged light and the second shot switch. Down below the instrument panel is the engine fire handle. Finally, to the right of the driver's position is the driver's master panel. We will use the master power switch which is in the bottom left corner of the master panel.

These are the displays and controls you will need to use when there is an engine fire.

Before we demonstrate the procedure, we'll first give you an overview. There are two fire extinguishers in the engine compartment. The first fire extinguisher, which is called the first shot, should go off automatically. If it doesn't, it can be discharged manually. If the first fire extinguisher does not put out the fire, the second fire extinguisher can be discharged by the driver. The second fire extinguisher, which is called the second shot, can be discharged either inside the tank or outside of the tank.

The steps in the procedure for putting out an engine fire can be divided into four separate phases. It will help you to remember the procedure as four separate sequences of events and actions.

In the first phase, which we'll call the detect and discharge phase, sensors in the engine compartment detect a fire and signal the driver. The first shot is also discharged during this first phase of the procedure.

The second phase, which we call positioning the tank, involves moving the tank to a safe location. The third phase occurs only if the first fire extinguisher did not put out the fire. In this phase the second fire extinguisher is activated from inside the tank. We'll call this phase, use second shot. If the first shot puts out the fire, this phase of the procedure is not done and the procedure ends after the second phase when the tank is positioned.

The fourth phase occurs only if activating the second shot from inside the tank fails to put out the fire, after is is activated from inside the tank. If it does not put out the fire, the fourth phase is to exit the tank.

To repeat, the engine fire procedure has four phases:

The first phase is detection of the fire and discharge of the first fire extinguisher.

The second phase is positioning the tank. The tank is always positioned in a safe location.

1) Show phases without steps.

ENGINE COMPARTMENT FIRE M1 TANK

DETECT & DISCHARGE

↓

POSITION TANK

↓

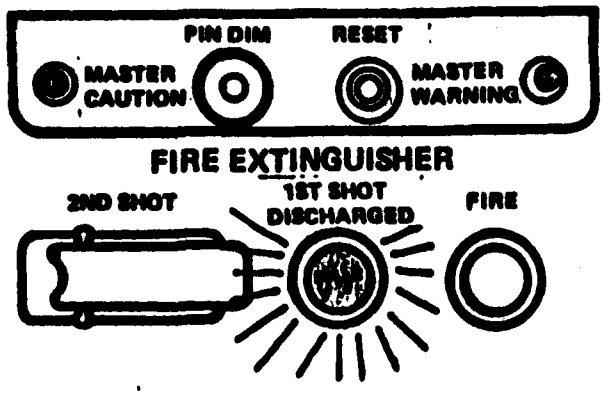
FIRE OUT or USE SECOND SHOT

↓

FIRE OUT or EXIT

	The third phase, which occurs only if the first extinguisher did not put out the fire, is using the second fire extinguisher, the second shot, to put out the fire. The fourth phase is exiting the tank, which occurs only if activating the second fire extinguisher does not put out the fire. Before we begin demonstrating the steps in the procedure, tell the instructor what the four phases of the procedure are.	
Prompt using chart, if necessary. Set controls.	(Pause on tape) Before continuing, let's get the controls set like they would be if the tank were being driven. That is, the parking brake would be released, the master power would be switch on, and the transmission control would be in D.	
	We will begin the demonstration with the first phase of the engine fire procedure, the detect and discharge phase. The fire compartment has a number of sensors which can detect an engine fire. These sensors are working any time an M1 is operating.	2) Detect diagram.
Turn on lights as announced.	If everything functions correctly, when the sensors detect a fire, three things happen automatically,	

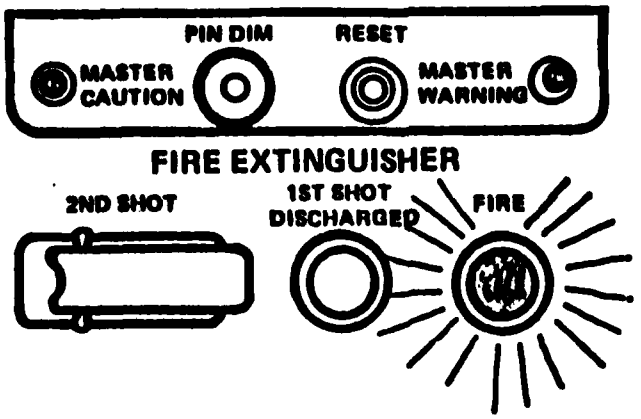
1st SHOT DISCHARGED



- Alert TC
  "Fire in Engine"

OR

FIRE/NO 1st SHOT



- Alert TC
  "Fire in Engine"
- Pull Engine Fire Handle

all at once. One, the master warning light comes on. Two, the first shot discharged light comes on. Three, and most importantly, the first fire extinguisher in the engine compartment the first shot will be discharged. This should all happen automatically. The alert panel is right in front of the driver, so the first thing the driver will see when all of this happens is the master warning light. Any time an alert panel light comes on, the driver must look to his left at the instrument panel. If the sensors have detected a fire and the first fire extinguisher has been discharged automatically, the driver will see that the first shot discharged light. As soon as the driver sees this light, he alerts the tank commander: "TC, there has been a fire in the engine compartment and the first shot discharged."

So, in the detect and discharge phase of the engine compartment fire procedure, the normal sequence of steps is to first see the master warning light, then to see the first shot light and to immediately alert the TC.

Sometimes an engine fire will occur and for some reason the first fire extinguisher will not automatically discharge. If this happens, the first phase of the engine compartment fire procedure is still the detection of the fire and discharge

of the extinguisher. However, the lights will be different and the driver must manually discharge the first shot extinguisher. If there is a fire and the first shot does not go off automatically, the first thing the driver will see is the master warning light. Again, any time an alert panel light comes on, the driver looks at his instrument panel. This time, he will see that the fire light is on and that the first shot light is not lit. The driver must immediately, reach down to his left and pull the engine fire handle to manually discharge the first shot. The driver must also alert the tank commander: "TC, these has been a fire in the engine and I have pulled the engine fire handle.

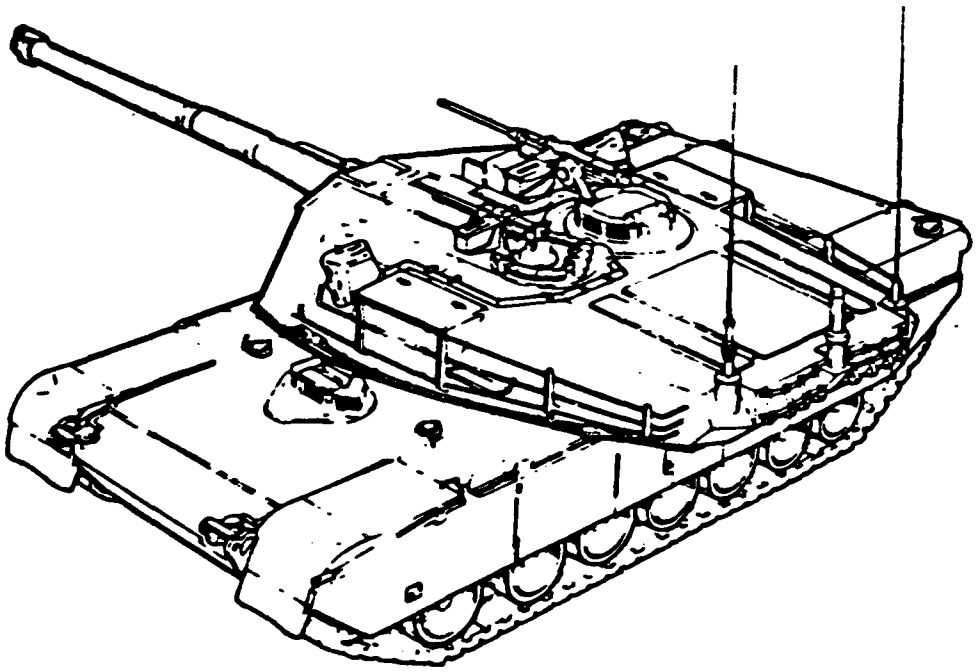
To review, the first phase of the engine compartment fire procedure is the detection and discharge phase. The driver will first see the master warning light. He then looks at the instrument panel. If the first shot light is on, he alerts the TC. If the fire light is on, he pulls the engine fire handle and alerts the TC.

This completes the first phase of the engine fire procedure. The next phase is to position the tank in a secure location.

3) Position diagram.

Positioning the tank in a secure location means you drive the tank to a safe location, turn into the

POSITION TANK



- Drive to Safe Location
- Turn into Wind
- Stop Tank
  - Idle
  - Stop
  - Set Park Brake
  - Trans in "N"
- Turret Positioned
- Watch Fire Light

wind so any smoke or fire extinguisher gas will blow away from the crew, stop the tank, and have the turret turned around so that you can get out if you need to. On a battle field a safe location might mean a covered and concealed position. On a tank range, you might have to move off the tank line and away from the ammo point. In the motor pool, a safe location may be away from buildings and other vehicles. In the mock-up we will have to simulate driving to a safe location and turning into the wind. The steering control works like a motorcycle. Accelerate by twisting back on the handgrips. Push left or right to steer. The controls in this mock-up don't move, so don't push hard. But you can get the idea.

To stop the tank, twist the handgrips forward to idle and press the service brakes to stop. Then, set the parking brake with the pedal on the right and put the transmission in "N" for neutral. When the tank is stopped also make sure the turret is positioned so that you can get out. Just remind the TC: "TC, turn the turret around." Finally, while you are positioning the tank, keep watching the fire light, because what you do next depends on what happens with the fire light.

That completes the positioning the tank phase of the engine fire procedure. Again, it consists of driving the tank to a safe location, turning into the wind, stopping and make sure the turret is positioned for your exit. In addition, watch the fire light so you will know what to do next.

Positioning the tank is the second phase of the engine fire procedure. The third phase is to use the second shot. You use the second shot only if the fire is <u>not</u> put out by the first shot. If the fire is put out by the first shot, the fire light will <u>not</u> be on. In that case you will report to the TC: "TC, the fire in the engine is out," the engine compartment fire procedure is finished, after the tank is positioned in a safe place.

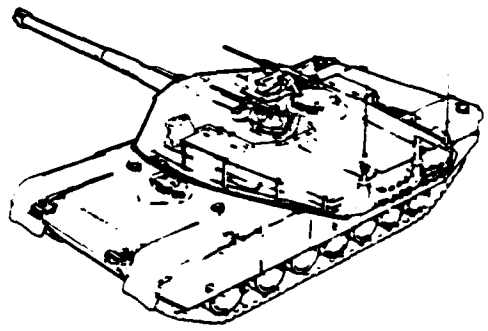
4) Position to use second shot.

On the other hand, if the first shot does not put out the fire, the fire light will be on and you will need to execute the second shot phase after the tank is positioned.

The second shot phase consists of four steps. The first step is to alert the tank commander that the fire in the engine is still burning. Say, "TC, the fire is still burning." The next step is to wait for the TC's command to use the second shot. It is important not to use the second shot too

5) Use second shot.

POSITION TANK



- Drive to Safe Location
- Turn into Wind
- Stop Tank
  - Idle
  - Stop
  - Set Park Brake
  - Trans in "N"
- Turret Positioned
- Watch Fire Light

OR

USE SECOND SHOT

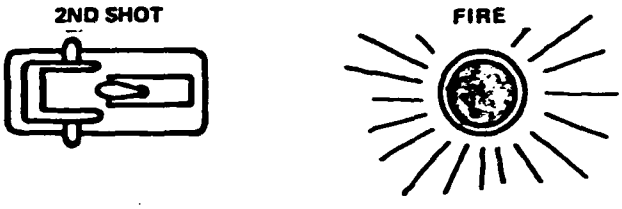
- Alert TC "Fire Still Burning"
- 2nd Shot, on Command
- Wait 18 seconds for 2nd Shot to Discharge
- Check Fire Light

FIRE-OUT

- Alert TC
- "Fire in Engine is Out"

USE SECOND SHOT

FIRE EXTINGUISHER



- Alert TC
  "Fire Still Burning"
- 2nd Shot, on Command
- Wait 18 seconds for 2nd Shot to Discharge
- Check Fire Light

soon because it shuts off the engine, and you will not be able to move the tank. On the TC's command, open the second shot cover and flip the switch. Then, count slowly to eighteen and listen for the second fire extinguisher to discharge. It makes a swooshing noise when it discharges. Also, watch the fire light. Whether or not you continue to the fourth phase will depend on what happens to the fire light.

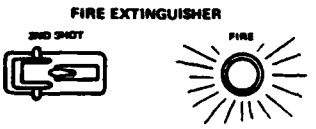
These four steps complete the third phase of using the second shot. You alert the TC that the fire is still burning. On his command, you activate the second shot switch. You then listen for the second shot to discharge; wait at least eighteen seconds. Then you watch the fire light.

Using the second shot is the third phase of the engine compartment fire procedure. The fourth phase is to exit the tank. You exit if the fire is still burning after you have completed the second shot steps. If the second shot puts out the fire, the fire light will go off and you will report to the tank commander: "TC, the engine fire is out."

On the other hand, the second shot steps may not put out the fire. That is, you may hear the swooshing noise telling you the second shot discharged, but the fire

6) Use second shot to exit.

USE SECOND SHOT



- Alert TC
  "Fire Still Burning"
- 2nd Shot, on Command
- Wait 18 seconds for 2nd Shot to Discharge
- Check Fire Light

OR

EXIT

- Alert TC
- 2nd Shot, "Off"
- Master Power "Off," on Command
- Exit, on Command
- Pull Outside Handle if 2nd Shot Did Not Operate

FIRE-OUT

- Alert TC
- "Fire in Engine is Out"

light may stay on. Or, you may wait the eighteen seconds, not hear the extinguisher discharge, and see that the fire light stays on. In either case, the fire is still burning and the fire light is still on, so you go to the exit phase of the procedure.

There are four or five steps to the exit phase, depending on whether or not you heard the second shot extinguisher discharge. In either case, the first step is to alert the tank commander that the fire is still burning: "TC, the fire is still burning." Next, flip the second shot switch back to its initial or "off" position. The next step is to listen for the TC's command to turn off the master power switch. Make sure the second shot switch is off because it overrides the master power switch and the master power switch will not shut off the tank's electrical system. Then, listen for the TC's order to evacuate the tank, and do so, on command.

The final step depends on whether or not you heard the second shot discharge. If you did not hear it, then pull the engine fire handle on the outside of the tank. This manually discharges the second shot fire extinguisher. These steps complete the exit phase and the exit phase is the last of the four phases of the engine compartment fire procedure.

7) Exit diagram.

EXIT

- Alert TC
- 2nd Shot, "Off"
- Master Power "Off," on Command
- Exit, on Command
- Pull Outside Handle if 2nd Shot Did Not Operate

Cue with diagram.

The first phase is the detect and discharge phase. Second, is the position tank phase. If the first shot puts out the fire, the procedure is finished after the position tank phase and as soon as the TC is alerted that the fire is out. If the fire continues to burn, the third phase is to use the second shot. If the second shot puts out the fire the procedure is finished as soon as the TC is alerted. If the second shot does not put out the fire, the fourth and final phase is the exit phase.

Now you will practice all of the procedures. When you practice try to remember the four phases of the procedure:
First, detect the fire and make sure the first extinguisher is discharged.
Second, position the tank.
Third, use the second shot, if necessary.
Fourth, exit, if necessary.

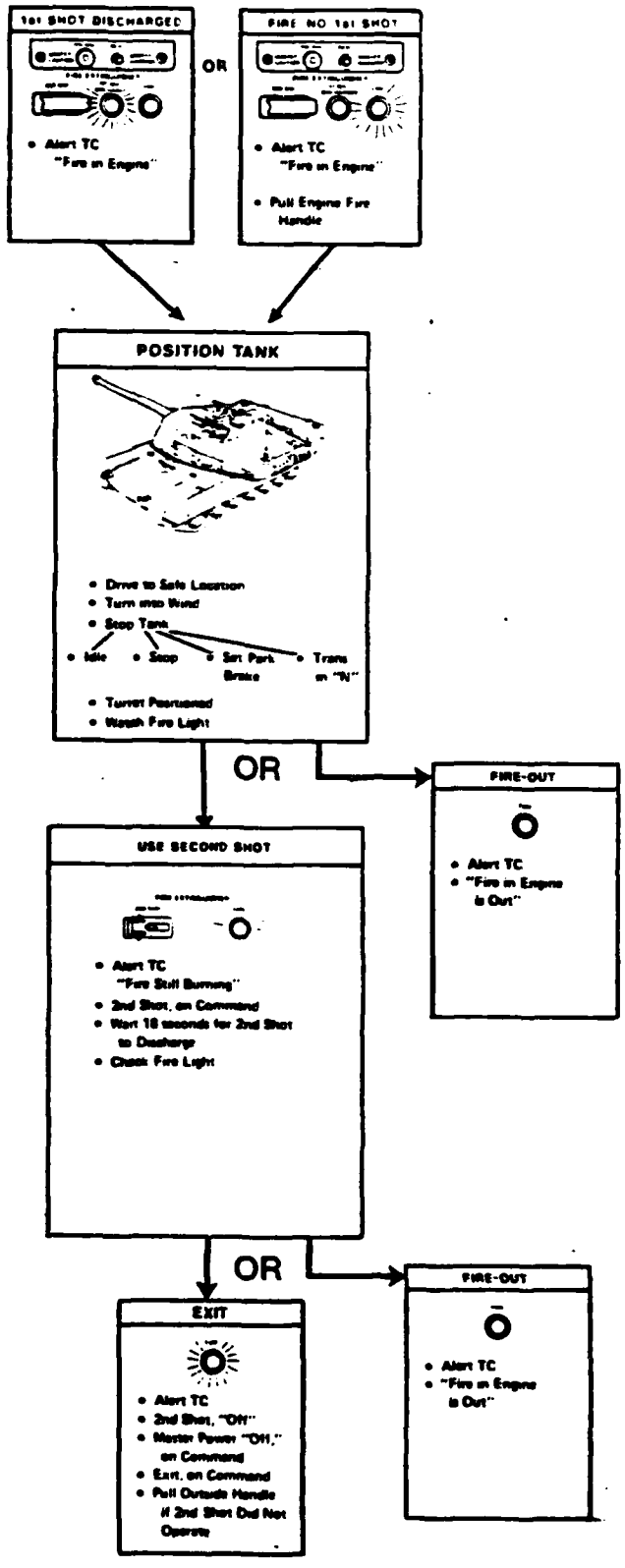
During the first phase, you will first see a master warning light.

Then, looking at your instrument panel, either the first shot discharged light or the fire light will be on. If the fire light is on and the first shot discharged light not on, pull the engine fire handle. In either case, alert the TC.

8) Total structure.

ENGINE COMPARTMENT FIRE M1 TANK

DETECT & DISCHARGE



During the second phase, the position tank phase, you drive to a safe location, turn into the wind, stop, have the turret positioned and watch the fire light.

If the fire light is not out after you have positioned the tank in a safe location, then perform the third phase, use second shot. During the use second shot phase, you alert the TC, activate the second shot on the TC's command, wait and listen for the second shot to discharge, and watch the fire light.

If the fire light still does not go out, during the fourth exit phase you, alert the TC; flip the second shot switch back to off; on his command, turn off the master power; and on his command, exit the tank. Finally, if the second shot did not discharge, pull the outside engine fire handle.

The instructor will first talk you through these steps. Then you will practice. Say out loud which phase of the procedure you are about to do. Practice so that you can perform all the steps needed to correctly respond to an engine compartment fire.

APPENDIX E

Talk-thru Scripts

Clear the M240 - Talk Through Script
(POT & Bottom-up)

Equipment Set-up

Cover closed

Not cocked

Script

Now you are going to practice clearing the M240 machinegun. I will tell you each step, and then you do it. After we have gone through all of the procedure, you will then try to clear the weapon on your own. Okay, let's begin.

First, check that the safety is on F. (wait)

Next, pull the charging handle to the rear until you hear it catch. (wait)

Third, put the safety on S. (wait)

The fourth step is to push in the latches and open the cover. (wait)

Next, check the feed tray. If there is an ammo belt on the feed tray, remove it. (wait)

Now raise the feed tray. (wait)

The seventh step is to look and feel for ammo in the receiver and chamber. (wait)

Next, close the feed tray. (wait)

Now close the cover. (wait)

The tenth step is to put the safety on F. (wait)

The final step is to hold back on the charging handle and press the trigger. Be sure to ride the handle to the forward position. (wait)

You have now cleared the M240. Now try to clear it on your own. (Instructor puts ammo belt on feed tray, safety on S, and closes cover.)

Clear the M240 - Talk Through Script
(Top-Down Presentation)

Equipment Set-up

Cover closed

Not cocked

Script

Now you are going to practice clearing the M240 machinegun. I will tell you each step, and you will then do it. After we have gone through all of the procedure, you will then try to clear the gun on your own.

Remember, there are three things you need to do to clear the M240 machinegun: open the weapon, check the receiver and chamber for ammo, and close the weapon.

To open the weapon, check that the safety is on F. (wait)

Next, pull the charging handle to the rear until you hear it catch (wait)

Third, put the safety on S. (wait)

Finally, push in the latches and open the cover. (wait)

Now that the weapon is open, you have to check the receiver and chamber for ammo. To do this, you first check the feed tray. If there is an ammo belt on the feed tray, remove it. (wait)

Now, raise the feed tray. (wait)

Next, look and feel in the receiver and chamber. (wait)

Now that you have checked the weapon for ammo, you have to close it. First, close the feed tray. (wait)

Next, close the cover. (wait)

Now, place the safety on F. (wait)

Finally, hold back on the charging handle and press the trigger. Be sure to ride the handle to the forward position. (wait)

You have now cleared the M240. Now try to clear it on your own. (Instructor puts ammo belt on feed tray, safety on S, and closes cover.)

Set the Headspace on the M2 Machinegun - Talk Through Script
(POT and Bottom-up)

Equipment Set-Up

M2 with barrel partially screwed in and uncocked.
GO and NO GO gages

Script

Now you are going to practice setting the headspace on the M2 machinegun. I will tell you each step, and then you do it. After we have gone through all of the procedure, you will then try to set the headspace on your own. Okay, let's begin.

First, stand on this side of the weapon (point) and push back on the charging handle until you can see the locking lug in the center of the small hole on the right side of the weapon.

Second, hold the charging handle in this position while you screw in the barrel all the way.

Next, screw the barrel out two clicks.

Now let go of the charging handle.

To cock the weapon, stand behind it and put your left hand on the end. With your right hand, palm up, quickly pull the charging handle all the way to the rear.

Next, hold the charging handle tightly, press the bolt release, and let the handle move forward slowly.

Now, twist the latch and raise the cover.

A. The next step is to retract the charging handle so that the bolt moves back slightly.

Then try to insert the GO gage. Be sure not to force it. (If it fits go to B)

Now push back again on the charging handle until you can see the locking lug in the center of the small hole on the right side of the weapon.

The next step is to hold the charging handle in this position while you screw the barrel out one click.

Now release the charging handle.

(Go back to A)

B. Retract the charging handle so that the bolt moves back slightly. Try to insert the GO gage.

Next, try to insert the NO GO gage.

Now push back on the charging handle until you can see the locking lug.

Turn the barrel in one click.

The next step is to release the charging handle.

Now retract the charging handle so that the bolt moves back slightly.

Try to insert the NO GO gage.

Next try to insert the GO gage.

The headspace is now set. Now try to set the headspace on your own. (Instructor moves barrel so that it is partially screwed in and makes certain weapon is cocked.)

Set the Headspace on the M2 Machinegun - Talk Thru Script
(Top-down)

Equipment Set-Up

M2 with barrel partially screwed in and uncocked
GO and NO GO gages

Script

Now you are going to practice setting the headspace on the M2 machinegun. I will tell you each step, and then you do it. After we have gone through all of the procedure, you will then try to set the headspace on your own. Okay, let's begin.

Remember there are two parts to the procedure for setting the headspace on the M2. First you have to set up the gun so that the headspace can be checked and adjusted. Then you have to check and adjust the headspace.

To set the M2, you need to position the barrel, cock the weapon, and open the weapon.

To position the barrel, first stand on this side of the weapon (point) and push back on the charging handle until you can see the locking lug in the small hole on the right side of the weapon.

Then hold the charging handle in this position while you screw in the barrel all the way.

Next, screw the barrel out two clicks.

Finally, release the charging handle.

Next you need to cock the weapon. To cock it, first stand behind it and put your left hand on the end. With your right hand, palm up, quickly pull the charging handle all the way to the rear.

Now hold the charging handle tightly, press the bolt release, and let the handle move forward slowly.

The last thing you need to do to set up the M2 is to open the weapon. To open it, twist the latch and raise the cover.

That completes the set-up procedure. Next you need to check and adjust the headspace. Remember there are two things you have to do to check and adjust the headspace. You have to check the headspace with the headspace gage and adjust the headspace by screwing the barrel in or out.

To check the headspace, you have to use the GO gage and the NO GO gage.

You begin checking the headspace using the GO gage. To insert the GO gage, first retract the charging handle slightly.

Then try to insert the gage. Be sure not to force it. (If it fits go to B)

A. Since the GO gage does not fit, you must adjust the headspace by screwing the barrel out. To screw the barrel out, you first need to push back on the charging handle until you can see the locking lug in the center of the small hole in the right side of the weapon.

Then hold the charging handle in this position while turning the barrel out one click.

Finally, release the charging handle.

Now that you adjusted the headspace out one space, you have to check it again using the GO gage. To insert the GO gage, first retract the charging handle slight.

Then try to insert the gage. (If it fits go to B; if not, go to A)

B. Now that the GO gage fits, you need to check the headspace with the NO GO gage.

Try to insert the NO GO gage.

Since the NO GO gage fits, you need to adjust the headspace by screwing the barrel in. To screw the barrel in, push back on the charging handle until you can see the locking lug in the center of the small hole in the right side of the weapon.

Then you hold the charging handle in this position while you turn the barrel in one click.

Finally you release the charging handle.

Now that you adjusted the headspace in one space, you have to check it again using the NO GO gage. To insert the NO GO gage, first retract the charging handle slightly.

Next, try to insert the NO GO gage. (Go to C or D)

C. Since you adjusted the headspace so that the NO GO gage would not fit, you now have to check the headspace again using the GO gage. To insert the GO gage, first retract the charging handle slightly.

Then try to insert the gage.

D. Since the GO gage fits and the NO GO gage does not, the headspace is now set. Now try to set the headspace on your own.

Operate the Radio - Talk Through Script
(POT and Bottom-up)

Equipment Set-up

Helmet switch to rear Mike - all the way out and down Audio cables disconnected Control box: Volume all the way left MONITOR - INT ONLY	Amplifier: RADIO TRANS-LISTENING SILENCE INT ACCENT - OFF MAIN PWR - OFF CKT BKR - OFF	Radio Transmitter: PWR - OFF SPKR - ON Function - OFF VOLUME - 0

Script

Now you are going to practice setting up the radio. I will tell you each step, and then you do it. After we have gone through all of the procedure, you will then try to set up the radio on your own. Okay, let's begin.

First put on the CVC helmet. The mike goes on the right. (wait)

Next, adjust the microphone on the helmet so that it is centered right in front of your mouth. You may have to loosen the adjusting screw on the right side ear phone. (wait)

Third, set the switch on the left side of your helmet so that it is in the center position. (wait)

Now, connect the quick disconnect on the end of the audio cable to the CVC cord. Be sure to match the notch on the connector with the tab on the CVC cord. (wait)

The next step is to connect the two cords on the other end of the audio cable to the control box. Start with the long cord. First take the connector from the long cord. (wait) Turn the flat portion of the connector to the front (hold it with your thumb),(wait) push the connector onto the

left side of the control box (wait) and twist it to the right. (wait) Pull down on it to make sure it is connected. (wait) Now go ahead and connect the short cord to the right side of the control box.

Adjust the volume control on the control box to the mid range position by turning the knob until the tab is to the front. (wait)

Next, turn the monitor switch on the control box to ALL. (wait)

Next, turn the radio transmitter switch on the amplifier to COMMANDER plus CREW position. (wait)

Turn the intercom accent switch to ON. (wait)

Now, turn MAIN POWER switch to NORM. (wait)

Flip the POWER CIRCUIT breaker switch to ON. Next squeeze together the radio transmitter power switch to ON and the speaker switch to OFF. (wait)

Set the radio transmitter volume at the maximum level -- 10. (wait)

Then, set the radio transmitter function switch to squelch. (wait)

The next step is to set the BAND switch to the frequency range assigned to you. To set the band for a frequency of 53.75, set the BAND switch to 53-75. (wait)

Next, set the left and right frequency knobs. Set the left knob to 53 (wait) and the right knob to 75. (wait)

Last, set the Antenna Frequency Control to the range of your frequency. For 53.75, set the knob to the position between 53 and 56. (wait) That completes the set up. Now you will try on your own. Take off the helmet. (Instructor disconnects cables and puts switches in set-up position. See Record Form.)

Operate the Radio - Talk Through Script
(Top-down Presentation)

Equipment Set-up

Helmet switch to rear Mike - all the way out and down Audio cables disconnected Control box: Volume all the way left MONITOR - INT ONLY	Amplifier: RADIO TRANS-LISTENING SILENCE INT ACCENT - OFF MAIN PWR - OFF CKT BKR - OFF	Radio Transmitter: PWR - OFF SPKR - ON Function - OFF VOLUME - 0

Script

Now you are going to practice setting up the radio. I will tell you each step, and then you do it. After we have gone through all of the procedure, you will then try to set up the radio on your own. Okay, let's begin.

Remember, there are three things you need to do to set-up the radio: prepare the crewman's station, set the audio frequency amplifier and set the radio transmitter.

To prepare the crewman's station you adjust the helmet, connect the cables and adjust the control box.

To adjust the helmet, you first put on the CVC helmet. The mike goes on the right. (wait)

Next, adjust the microphone on the helmet so that it is centered right in front of your mouth. You may have to loosen the adjusting screw on the right side ear phone. (wait)

Third, set the switch on the left side of your helmet so that it is in the center position. (wait)

Next you connect the cables. First, connect the quick disconnect on the end of the audio cable to the CVC cord. Be sure to match the notch on the connector with the tab on the CVC cord. (wait)

The next step is to connect the two cords on the other end of the audio cable to the control box. Start with the long cord. First take the connector from the long cord. (wait) Turn the flat portion of the connector to the front (hold it with your thumb), (wait) push the connector onto the left side of the control box (wait) and twist it to the right. (wait) Pull down on it to make sure it is connected. (wait) Now go ahead and connect the short cord to the right side of the control box.

The control box controls are next. Adjust the volume control to the mid range position by turning the knob until the tab is to the front. (wait)

Next, turn the monitor switch on the control box to ALL. (wait)

That completes the crewman's station controls. Next is the audio frequency amplifier.

First, turn the radio transmitter switch on the amplifier to COMMANDER plus CREW position. (wait)

Turn the intercom accent switch to ON. (wait)

Now, turn MAIN POWER switch to NORM. (wait)

Flip the POWER CIRCUIT breaker switch to ON. Now the amplifier is all set. Next is the radio transmitter. On the radio transmitter you need to set the speaker and power switches, the volume and function control and the frequency controls. First squeeze together the radio transmitter power switch to ON and the speaker switch to OFF. (wait)

Next, set the radio transmitter volume at the maximum level -- 10 and, set the radio transmitter function switch to squelch. (wait)

The next step is to set the BAND switch to the frequency range assigned to you. To set the band for a frequency of 53.75, set the BAND switch to 53-75. (wait)

Next, set the left and right frequency knobs. Set the left knob to 53 and the right knob to 75. (wait)

Last, set the Antenna Frequency Control to the range of your frequency. For 53.75, set the knob to the position between 53 and 56. (wait) That completes the set up for the radio transmitter. The crewman's station, amplifier and radio transmitter are all set, so the radio is ready for operation. Now you will try on your own. Take off the helmet. (Instructor disconnects cables and puts switches in set-up position. See Record Form.)

Engine Compartment Fire - M1 Tank
Talk Through Script
(POT and Bottom-up)

Equipment Set Up

On the instructor's panel:
Power - ON

In the driver's compartment:
Master power - ON
Transmission control - D

Script

Now you are going to practice the procedure for putting out a fire in the M1 tank. First, you'll need to get in the mock-up we have. (pause)

I will tell you each step, then you do it. After we have gone through all of the procedures for putting out a fire in the engine compartment, you will then try to do it on your own. Okay, let's begin.

First, you will see the master warning light come on.

Immediately, look at the instrument panel to your left.

You see that the first shot discharged light is on.

Now you say to the TC: "TC, there has been a fire in the engine compartment and the first shot has been discharged.

In some cases the fire light is on but the first shot light is not on; pull the fire engine handle.

Tell the TC there is an engine fire and that you pulled the engine fire handle.

After the first shot has been discharged, either automatically or manually, drive to a safe location and turn the tank into the wind.

When you have turned the tank, twist the throttle to idle the engine.

Now press the service brake to stop the tank.

Press the parking brake.

Once the parking brake is set, move the transmission control to "N" (neutral).

Remind the TC to turn the turret around in case you need to get out.

Again, watch the fire light.

Now, tell the TC whether the fire is out or is still burning.

If the fire is still burning, flip the second shot switch on the TC's command.

Count to 18 and listen for a swooshing sound of the extinguisher discharging.

If the fire light goes out after flipping the second shot switch, tell the TC, "The engine fire is out."

If you didn't hear a swooshing sound or if the the fire light is still on, tell the TC that the engine fire is still burning.

Now flip the second shot switch back to its original position.

When the TC tells you to turn off the master power switch (on your right), do so.

Wait for the TC's orders to evacuate the tank.

When the command to evacuate the tank is given, get out of the tank.

If you did not hear a swooshing sound, pull the fire engine handle on the outside of the tank.

The outside handle should be used if the second shot fails to discharge after the second shot switch is thrown.

That completes the procedure for putting out a fire in an M1 tank. Now try to complete the task by yourself.

Engine Compartment Fire - M1 Tank
Talk Through Script
(Top-down)

Equipment Set Up

On the instructor's panel:
Power - ON

In the driver compartment:
Master power - ON
Transmission control - D

Script

Now you are going to practice the procedure for putting out a fire in the M1 tank. First, you'll need to get in the mock-up we have. (pause)

I will tell you each step, then you do it. After we have gone through all of the procedure for putting out a fire in the engine compartment, you will then try to do it on your own. Okay, let's begin.

Remember, there are four phases to putting out a fire in the engine compartment: detect and discharge, position tank, use second shot and exit the tank. The third phase, use second shot, occurs only if the first fire extinguisher did not put out the fire. The fourth phase, exit the tank, occurs only if the fire is not put out by the second fire extinguisher.

In the detect and discharge phase you observe the alert panel and the driver's instrument panel. Tell the TC there is a fire in the engine and if necessary pull the fire engine handle.

FIrst you watch the alert panel to see if the master warning light comes on.

If the master warning light comes on, immediately look at the instrument panel to your left.

You see that the first shot discharged light is on.

Now you say to the TC: "TC, there has been a fire in the engine compartment and the first shot has been discharged.

In some cases, the fire light is on but the first shot light is not on. Pull the fire engine handle.

Tell the TC there is an engine fire and that you have pulled the engine fire handle.

In the second phase, positioning the tank, the tank is moved to a safe place, stopped and the transmission is put into neutral.

After the first shot has been discharged, either automatically or manually, drive the tank to a safe location.

Turn the tank into the wind.

When you have turned the tank, twist the throttle to idle the engine.

Now, press the service brake to stop the tank.

Press the parking brake to set the brake.

After the brake is set, move the transmission control to "N" (neutral).

Tell the TC to move the turret around in case you need to get out.

Watch the fire light so that you will know what to do next.

That completes the position tank phase.

Remember, the third phase, use second shot occurs only if the first fire extinguisher did not put out the fire.

After observing the fire light you tell the TC whether the fire is out or still burning.

If the fire is still burning, flip the second shot switch on the TC's command.

Count to 18 and listen for a swooshing sound of the extinguisher discharging.

If the fire light goes out after flipping the switch, tell the TC "the engine fire is out.

If you didn't hear a swooshing sound or if the fire light is still on, tell the TC: "the engine fire is still burning."

That completes the third phase. Next is the exit the tank phase. The fourth phase occurs only if the fire is not put out by the second fire extinguisher. This phase includes turning off the second shot switch, turning off the power, exiting the tank and using the fire handle on the outside of the tank.

After notifying the TC that the fire is still burning, flip the second shot switch back to its initial or "OFF" position.

When the TC tells you to turn off the master power switch (on your right), do so.

(SCORER: "Power OFF!")

Wait for the TC's orders to evacuate the tank.

(SCORER: Evacuate tank!)

When the command to evacuate the tank is given, get out of the tank.

If you did not hear a swooshing sound, pull the fire engine handle on the outside of the tank.

The outside handle should be used if the second shot fails to discharge after the second shot switch is thrown.

That completes the procedure for putting out a fire in an M1 tank. Now try to complete the task by yourself.