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MACHINE GUN

Army Test and Evaluation Command
Aberdeen Proving Ground, Maryland

2 February 1973

U. S. ARMY TEST AND EVALUATION COMMAND
DEVELOPMENT TEST II (ST) - SYSTEM TEST OPERATIONS PROCEDURES

AMSTE-RP-702-102
*Test Operations Procedure 3-3-045

2 February 1973

MACHINE GUN

SECTION I
GENERAL

1. Purpose and Scope.

a. This document provides procedures for testing machine guns. It establishes test methods and techniques to determine whether the test machine guns meet the criteria described in applicable requirements

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13 ABSTRACT

Describes a method for evaluation of machine gun operational and performance characteristics. Identifies supporting tests, facilities, and equipment required. Provides procedures for preoperational inspection, physical characteristics, safety, personnel training, sights, mounts, accuracy, dispersion, tactical employment, man-portability, transportability, airdrop operations, durability, reliability, maintainability, and human factors evaluation. Applicable to ground-to-ground employment only.

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1-a

documents and whether they are suitable for use by the U.S. Army.

b. For the purpose of defining the scope of these procedures, a machine gun is an automatic weapon designed primarily to provide supporting fires and normally fired from a supporting mount.

c. The general concept of the test will be to determine the military worth of the test machine gun when used by troops representative of the intended users. Test exercises should be conducted under simulated tactical conditions or conditions similar to those expected in the areas of intended operational use. Instrumented test facilities should be used, if available. Test exercises should be conducted during both daylight and darkness.

d. These procedures address a preoperational inspection to determine the physical characteristics and serviceability of the test item, a series of appropriate tests designed to examine the functional performance of the test item, and an examination of the safety, human factors, and value engineering aspects of the test item. During all test phases, photographic coverage should be used where appropriate to supplement other data obtained.

e. This TOP is designed to test machine guns in ground-to-ground employment. It does not include ground-to-air and air-to-ground employment. Test procedures for other than ground-to-ground employment may be found in TOP 3-3-020, Antiaircraft Gun; TOP 3-3-046, Tank Machine Gun; and TOP 7-3-015, Aircraft Armament.

f. During all phases of testing, the test soldiers will be equipped with field uniforms, weapons, and equipment appropriate to the prevailing weather and the activities being conducted. Test soldiers will be informed of the overall test objectives and the specific objectives of each test phase in which they participate.

g. If the test machine gun is intended to replace a standard weapon, the standard weapon will be used as a control item.

2. Background.

a. The machine gun is an automatic weapon; that is, it has the capability of loading, firing, extracting, and ejecting continuously after the first round is loaded and fired. A supply of ammunition that is automatically fed to the weapon from a belt, magazine, or drum is required. Most U. S. Army machine guns have been belt fed. An outer stimulus is needed only to start and stop the firing.

b. Machine guns fire projectiles of approximately the same size and striking power as rifles, but the size, weight, and caliber of machine guns may vary considerably. The upper limit of size between machine guns and automatic cannons is determined administratively. Automatic weapons of caliber .60 and less are generally referred to as machine guns. However, within recent years this has varied from caliber .60 (15-mm) to 20-mm and even 37-mm. The lower limit of size between machine guns and automatic rifles is similiarly not specified. The magazine fed Browning automatic rifle M1918A2 and the belt fed Browning machine gun M1919A6 both were caliber .30, had a shoulder stock and a bipod, and could be fired from the shoulder, or while held in both hands and braced against the side of the body.

c. Light machine guns (weight less than approximately 35 pounds) may be supported by a bipod or muzzle rest which steadies the muzzle end of the gun while the firer, in a prone position, supports the breech end or stock with his shoulder. Heavy machine guns, because of their weight, are usually mounted on tripods or similar mounts. Some machine guns are designed to be fired from either a bipod or tripod mount, depending on the tactical employment.

d. The machine gun supports the rifleman in both the attack and defense, and is employed to engage distant targets with a heavy volume of controlled and accurate fire that is beyond the capability of individual weapons. It provides the rifleman with the heavy volume of close and continuous fire necessary to accomplish his mission in the attack. The long range, close defensive, and final protective fires delivered by the machine gun form an integral part of the unit's defensive fires.

e. The requirement for transporting the machine gun, its mount, and the requisite supply of ammunition is often solved by assigning several men, rather than an individual soldier, to each machine gun, or by mounting it on a truck or other vehicle. Employment can range from the shoulder-fired mode through firing from bipod, tripod, pintle, truck, or other vehicular mount. A machine gun should therefore be tested in all its possible modes of employment, using all possible mounts. In addition to the equipment and facilities defined in the documents listed in Section II, the following are required.

3. Equipment and Facilities.

a. Equipment.

(1) Test item and accessories (including maintenance package).

(2) Control item and accessories (when required).

(3) Photographic Equipment (still and motion).

(4) Tactical vehicles.

(5) Aircraft.

(6) Parachutes and related equipment.

(7) Stopwatches.

(8) Meteorological equipment.

(9) Ammunition.

(10) Weighing scales.

(11) Tape measures.

(12) Targets.

(13) Binoculars.

(14) Spotting scopes.

b. Facilities.

(1) Ranges (instrumented, if available).

(2) Training areas.

(3) Storage areas.

SECTION II
TEST PROCEDURES

4. Supporting Tests.

a. The procedures outlined in this test operations procedure (TOP) provide general guidance for testing machine guns. Detailed specific procedures will be dependent on the characteristics of the machine gun being tested, and the stated criteria in applicable requirements documents.

b. In preparing for the test, the test officer should conduct the necessary administrative, personnel, and supply actions outlined in

the test officer's guide or manual, or in the organizational standing operating procedures (SOP). Sufficient pretest training must be accomplished to ensure that the test soldiers are equally familiar with the test and control items. The performance of the test item must not be degraded because it is new or test soldiers are unfamiliar with it.

c. During each subtest, sufficient data must be collected to support statistically valid conclusions. This goal may be constrained by limitations on the number of test items, time available for testing, manpower and funds available, or the support and control equipment available. When planning the test, the test officer should consult with methodology personnel, e.g., statistical analysts, experimental psychologists, human factors analysts, for assistance in developing an experimental pattern or experimental design.

d. Methodology personnel can advise and assist the test officer in determining the appropriate design or pattern to include the techniques for sampling, the sample size required to evaluate the true performance, in estimating average performance (or variability or performance) from a sample, in comparing materials or products with respect to average performance (or variability of performance), in estimating the number of test soldiers needed for the testing program, and in determining the number of repetitions required for a specific exercise.

e. A proper experimental pattern or design will aid in the control of bias, will simplify the requisite calculations of the analysis, and will permit the clear estimation of the effects of the factors. Additional statistical guidance can be found in TOP 3-1-002, Confidence Intervals and Sample Size, and in National Bureau of Standards Handbook 91, Experimental Statistics.

f. Common service TOPs, the tests defined in Section III, and other published documents to be considered in formulating a test plan are listed below. Additional reference material is in the appendix.

	TEST SUBJECT TITLE	PUBLICATION NO.
(1)	Preoperational Inspection and Physical Characteristics (refer to para 5)	3-3-500
(2)	Safety (refer to para 6)	3-3-517

	TEST SUBJECT TITLE	PUBLICATION NO.
(3)	Personnel Training (refer to para 7)	3-3-501
(4)	Photographic Coverage	7-3-519
(5)	Sights (refer to para 8)	3-3-116
(6)	Mounts (refer to para 9)	
(7)	Accuracy/Dispersion (refer to para 10)	
(8)	Tactical Employment (refer to para 11)	
(9)	Desert Environmental Test	3-4-001
(10)	Tropic Environmental Test	3-4-003
(11)	Arctic Environmental Test	3-4-006
(12)	Man-Portability/Transportability (refer to para 12)	10-3-506
(13)	Airdrop Operations	7-3-511 and 7-3-512
(14)	Durability and Reliability (refer to para 14)	
(15)	Maintainability (refer to para 15)	TECR 750-15
(16)	Security from Detection	1-3-515
(17)	Adverse Conditions	3-3-524
(18)	Human Factors Evaluation (refer to para 16)	3-3-521
(19)	Value Analysis	TECR 700-1

SECTION III
SUPPLEMENTARY INSTRUCTIONS

5. Preoperational Inspection and Physical Characteristics.

a. Objectives. To verify the completeness of the test item, compare the physical characteristics of the test item with criteria stated in requirements documents, and determine if the test item is in serviceable condition for testing.

b. Method.

(1) Upon receipt, carefully inspect all test items and control items in their shipping or packaging containers, for completeness, damage, and general condition. Record and photograph any evidence of damage or deterioration to the packing or containers. Record the adequacy of packaging and preservatives.

(2) Uncrate overpacks and remove test items from their individual containers. Record test item nomenclature, serial number(s), and manufacturer name.

(3) Carefully examine the test item, its components, and accessories for completeness and for obvious physical and mechanical defects such as rust, corrosion, cracked or broken parts, loose assemblies, bent parts, or other damage, using the Preliminary Operating and Maintenance Manual (POMM) as a guide. All defects or damage should be noted and corrected.

(4) Examine the tools and equipment for serviceability and compare with maintenance test package and/or basic issue item list for completeness.

(5) Weigh, measure, and photograph the test item, components, and accessories. Record the principal physical characteristics, such as:

(a) Weight of overall weapon, and of individual subassemblies.

(b) Overall length of weapon.

(c) Length of barrel.

(d) Description of rifling (number of grooves and lands).

(e) Type of operation (blowback-operated, gas-operated, recoil-operated, motor driven).

(f) Type of mechanism (open or closed bolt).

(g) Type of feed (belt, magazine, drum).

(h) Type of muzzle attachment (flash suppression, noise suppressor, compensator).

(i) Magazine or ammunition box capacity, and weight with and without ammunition.

(6) Disassemble the test item and examine all parts carefully. Repair or replace any defective parts. Photograph the test item with and without accessories and in various states of disassembly.

(7) Test-fire the machine guns (both test and control) in all design modes of fire and using all types of ammunition applicable to determine whether they are in serviceable and operable condition for testing.

NOTE: TECOM Reg 385-6, Verification of Safety of Materiel During Testing, requires a safety release be issued to testing agency so as to provide information pertaining to operational limitations and specific hazards peculiar to the test item. Ensure that the safety release has been received and is understood prior to firing the test machine gun.

(8) Additional guidance for applicable procedures may be found in TOP 3-3-500, Preoperational Inspection and Physical Characteristics, Armor and Individual Weapons.

c. Data Required.

(1) Description of any damage or deterioration to packaging or containers.

(2) Description of any damage, shortages, or other discrepancies in the maintenance test package or Basic Issue List Items.

(3) Description of any damage or deterioration to the test item.

(4) Description of the physical characteristics of the test item.

(5) Results of the test-firings.

d. Analytical Plan.

(1) Compare the physical characteristics of the test item with those specified in requirements documents to determine if applicable criteria are met.

(2) Make a subjective analysis of the test data pertaining to completeness and serviceability of the test item to determine if it is in serviceable condition for testing.

6. Safety.

a. Objective. To determine if the test item is safe for its intended use.

b. Method.

(1) To be safe for troop use, the test item must be safe when in field storage, when transported, and when handled and fired according to applicable regulations and procedures.

(2) Safety determination is a continuing process throughout the entire service test and, to the extent practicable, should be conducted concurrently or in conjunction with other testing.

(3) Prior to committing the test item to field exposure or firing performance, review the applicable Safety Statement or Safety Release and examine all test items for conformity, and for presence of other hazardous conditions. Review the Safety Release to determine if it places undue restrictions on tactical use of the test item. Place particular emphasis on verification of safety limitations cited in the Safety Release, and on the compilation of safety data pertinent to the Safety Confirmation required by TECOM Reg 385-6.

(4) During the service test, the test officer must constantly consider not only the hazards which may be encountered during "normal" conditions, but those which could be encountered under the worst conditions of training and combat. The test officer should not intentionally perform tests which create unsafe conditions, but he must ensure all phases of safety have been considered. Conditions not covered in the approved test plan, but which appear to be needed during the process of testing, should be recommended for inclusion in applicable tests.

(5) Safe test procedures must be followed throughout all phases of testing. Test soldiers will continuously observe and inspect for indications of safety hazards. Record all instances of safety hazards at the time they are observed or noticed. Unsafe characteristics will be classified in accordance with TOP 1-1-012, Classification of Deficiencies and Shortcomings. In the event a suspected safety hazard or potential safety hazard develops, the problem must be resolved on the side of safety before the test is permitted to continue.

(6) During live firing exercises, consideration should be given to the wearing of ear and eye protection equipment by all firers and adjacent personnel.

(7) Additional guidance for test procedures may be found in TOP 3-3-517, Infantry Weapons and Ammunition Safety, and in TOP 4-3-514, Safety Hazards.

c. Data Required.

(1) The results of studying the Safety Release, and any limitations which may place undue restrictions on the tactical use of the test item.

(2) A comparison of safety features of the test item with those stated in the applicable criteria.

(3) Any safety hazards reported or observed during conduct of the test.

(4) Any additional data which will serve as a basis for the Safety Confirmation.

d. Analytical Plan. The test data will be analyzed subjectively to determine if safety criteria have been met. The report of test must include a statement in compliance with TECOM Reg 385-6 as to whether or not the test machine gun is safe for use. If it is concluded the test item is not safe for use, the specific unacceptable safety hazard must be fully described in detail.

7. Personnel Training. Accomplish the procedures in TOP 3-3-501, Personnel Training. The training evaluation should assess the adequacy of the training package developed for the test item. Test soldiers should normally be trained by utilizing the training program proposed in the training package. The test report should contain statements concerning training implications and the adequacy of the training package.

8. Sights.

a. A machine gun will normally have sights that are an integral part of the weapon. In addition, special purpose sights may be available, such as telescopic sights or night sights. The service test of a machine gun should include an evaluation of the integral sights as an intrinsic part of the test item. Special purpose sights will be evaluated as required by the test directives, or as considered essential in determining the military worth of the test item.

b. Special purpose sights may be evaluated in separate subtests of the machine gun test, or in a separate test for the particular sight. The testing of these sights may be accomplished by following the procedures in TOP 3-3-116, Sights, Direct Fire, or TOP 3-3-067, Sights, Indirect Fire, as applicable for the particular type of sight to be tested.

c. Evaluation of the integral sights on the test item does not require a separate subtest; rather, the effects of the sights are considered in the overall areas of evaluation of the test item. Any characteristic of the sights that affects safety, accuracy, personnel training, portability, transporatability, durability, reliability, maintainability, security from detection, human factors engineering, or value analysis should be noted and reported under the affected area of evaluation. For example, a sight that breaks easily may be reported under durability; a sight that requires complicated techniques for adjustment may be reported under personnel training or human factors engineering; a sight with hard-to-see markings or graduation may be reported under human factors engineering, and so on.

9. Mounts.

a. Objectives.

(1) To determine the suitability of mounting systems furnished with the test item.

(2) To determine the compatibility of the test item with existing mounting systems (if applicable).

b. Method.

(1) A machine gun may have a mount which is an integral part of the weapon, and it may have a mount that is detachable but considered to be a component of the machine gun. In addition, the test machine gun may be designed for use with other mounts of standard type for either ground or vehicular mounting. For example, the M60 Machine Gun has a bipod mount as an integral part of the weapon. The M60 is also designed

for use with the standard type M122 tripod mount for ground use, and the standard type M4 pedestal mount for vehicular use.

(2) The service test of a machine gun should include an evaluation of all mounting systems furnished with the test item. The integral mounts and the mounts that are components of the test item should be evaluated as an intrinsic part of the test item. That is, the effects of these mounts should be considered in the overall areas of evaluation of the test item. Any characteristic of the integral or component mount that affects safety, accuracy, personnel training, portability, transportability, durability, reliability, maintainability, security from detection, human factors engineering, or value analysis should be noted and reported under the affected area of evaluation. In regard to other standard type mounts with which the test item may be used, the evaluation should be aimed at determining the compatibility of the test machine gun for use with these mounts.

(3) The evaluation of mounts should be conducted concurrently with other subtests to the maximum extent practicable. All test exercises should be conducted under tactical field conditions.

(4) Test personnel should attempt to mount the test item on all existing applicable machine gun mounting systems.

(5) Test soldiers organized and equipped as machine gun crews should execute crew drill and place the test and control weapons into and out of operation in accordance with furnished POMM or applicable portions of existing field manuals or related items.

(6) Firing exercises should include the use of all furnished mount systems. Gunners will use all positions (sitting, kneeling, prone) which are applicable to the mount. During the conduct of firing, observations should be made to include the following areas:

(a) Stability of mounts

(b) Ease of manipulating the test item on the mount

(c) Ease of manipulating the mounts' controls

(d) Adequacy of any indirect fire controls, if applicable

c. Data Required:

(1) A record of existing mounting systems which can be used with the test item.

(2) Time required to place the test and control weapons into action.

(3) Time required to take the test and control weapons out of action.

(4) A record of the observations and comments of the test soldiers and test supervisory personnel.

(5) Hit probability and time to shift fire for each type mount (obtained from the results of the firing exercises in other subtests).

d. Analytical Plan.

(1) Perform a subjective evaluation of data collected relative to suitability of mounting systems furnished with the test item.

(2) Conduct an appropriate statistical analysis of the test data pertaining to compatibility of test item with existing standard type mounts to determine if statistically significant differences exist between the test and control items or the test item and established criteria.

10. Accuracy and Dispersion.

a. Objective. To determine the accuracy and dispersion characteristics of the test item.

b. Method.

(1) Confusion sometimes exists with the terminology associated with the ability of a weapon system to hit a target, because the popular concept of the word "accuracy" differs from its definition as used in ballistics. In popular terms, accuracy is the ability of a weapon system, when properly aimed to hit the point of aim repeatedly. Figure 1 and the definitions below explain accuracy and dispersion as used in weapon systems evaluations and in this Test Operations Procedure.

(a) Accuracy. The ultimate in target accuracy is achieved when the mean point of impact (center of impact) coincides with the point of aim. (In figure 1 the aiming points are the centers of the targets as shown by the intersecting centerlines). Targets A and C, figure 1, indicate perfect target accuracy, in that the centers of impact coincide exactly with the aiming points. Poor accuracy is shown in targets B and D, in which the centers of impact fall at some distance from the aiming points. It should be noted that perfect accuracy does not imply all rounds must impact on the point of aim; some degree of dispersion in the impact pattern is always to be expected.

(b) Dispersion. Small target dispersion is achieved when the projectiles impact closely about the center of impact, i.e., when the distance of every impact from the center of impact is small, regardless of the relationship between the point of aim and the center of impact. In figure 1, small dispersion is shown in targets A and D, large dispersion in targets B and C. When dispersion is small, a

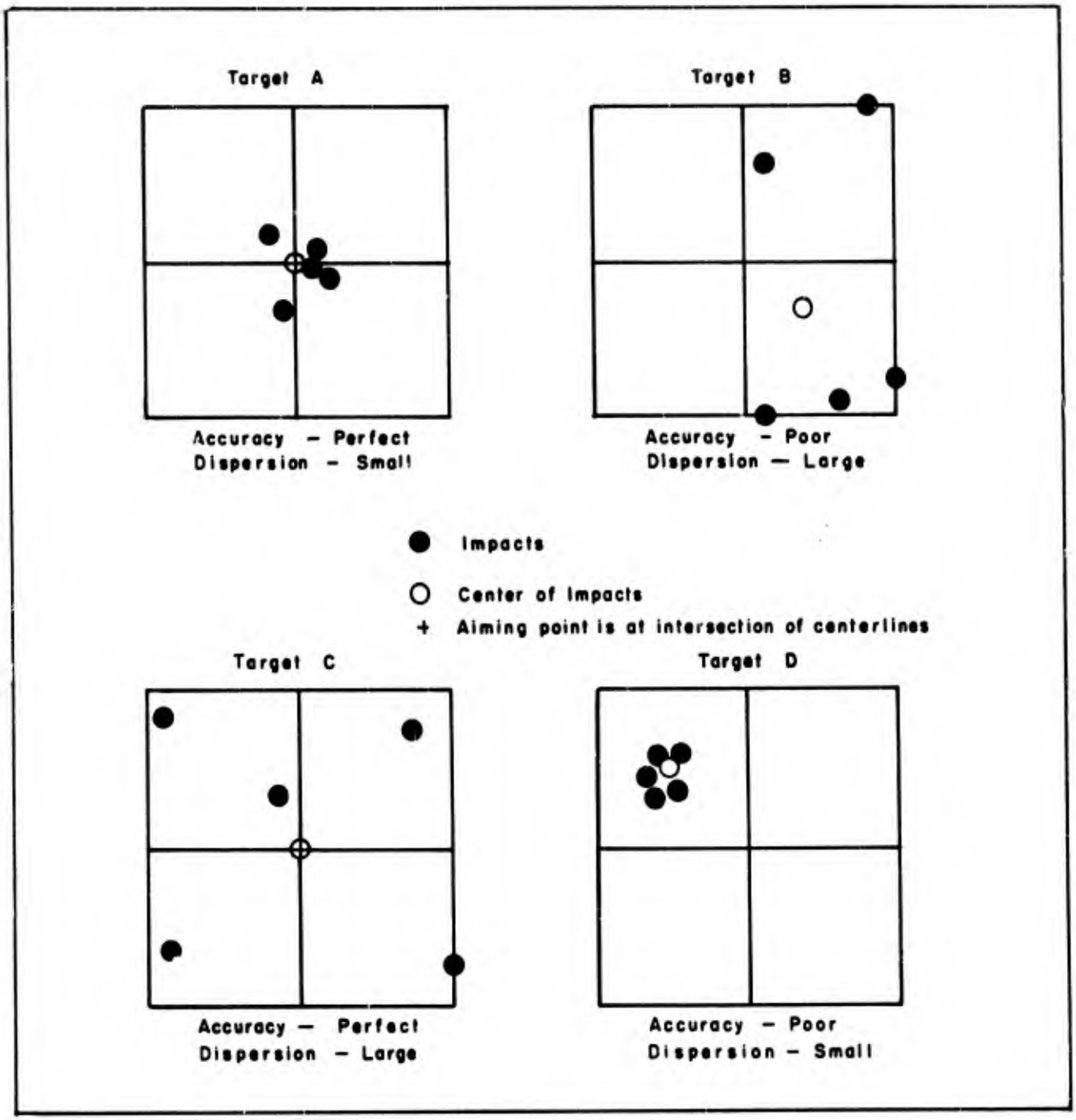

Figure 1. Accuracy and Dispersion Targets

correction in aiming the weapon will bring all impacts close to the point of aim.

(2) Dispersion can be attributed to many factors, such as those inherent to the weapon-ammunition combination; tolerances in the weapon mount and in the traversing, elevating and fire control systems; and those relating to the soldier-weapon combination. All of these factors except the last one usually will have been determined to a great extent under ideal test conditions during the design and engineering phases of testing. The DT II (service test) is normally the first time a weapon system will be tested under tactical field conditions by soldiers with the skill and aptitudes of those expected to use it in combat.

(3) After completion of pretest training to determine accuracy and disperson, test soldiers will fire the test and control machine guns against vertical targets at appropriate known distances. The modes of fire, rounds per burst or shots per target, type of ammunition, type of mount, and target ranges may be obtained from requirements documents pertaining to the machine gun under test.

(4) When control items are furnished, comparative data will be obtained for both the test and control items.

(5) Vertical targets of paper or other material suitable for easy marking and replacing should be used. An aiming point near the center of the target should be established. The target size should be large enough to ensure the impact location can be determined for all rounds fired. When dispersion at a prescribed range is greater than a practical size target, the range should be reduced and the reasons therefore explained in the test plan and/or report as applicable.

(6) Accuracy firing should be conducted during daylight with good visibility and relatively stable weather conditions, since rapid changes in temperature, wind speed, or wind direction may cause inconsistencies in the firing results. To avoid unnecessary exposure to wind changes, the selected number of rounds for each target should be fired without undue delay. Ammunition on hand at the firing point should be sheltered from direct sunlight or other weather effects to minimize temperature changes in group firings. The temperature, barometric pressure, and humidity should be recorded every hour during the firing. Continuous measurements should be recorded of the wind speed and direction.

(7) Weapon should be zeroed just prior to firing the accuracy groupings. TOP 3-3-503, Boresight and Zero should be reviewed for applicable procedures. The initial zeroing should be verified at the end of firing, or more often if sizable shifts in center of impact locations become apparent during firing.

(8) All modes of firing (semiautomatic, automatic, controlled bursts) appropriate for the weapon should be used. Trials with varying burst size may be conducted if deemed appropriate. All mounting systems furnished with the test item should be used during the accuracy firings.

(9) A sufficient number of groupings should be fired to obtain statistically sufficient data for each mode of fire, burst size, type of ammunition, type of weapon, type of mount, and target range. The target should be changed after each group of shots, or each shot in each group should be marked, whichever is more economical.

(10) The following data for each group of rounds fired should be recorded:

(a) Date and time of firing.

(b) Location of firing range.

(c) Firer's name.

(d) Targer range (distance).

(e) Weapon identification.

(f) Ammunition nomenclature and lot number.

(g) Firing mode.

(h) Size of burst.

(i) Firing position.

(j) For each round fired, the location of impact on the target should be determined. These locations should be expressed in terms of horizontal and vertical distances from the aiming point. Measurements should be made to the center of each hole with the best degree of precision that is practicable.

c. Data Required.

(1) The data resulting from b(10), above. The horizontal and vertical standard deviations; horizontal, vertical, and extreme spread; mean radius; and deviation of the center of impact from the point of aim may be determined from the coordinate data of impact points.

(2) Accuracy results of shot groups containing tracer rounds (combat mix) may require identification of tracer impacts, so that three analyses (all shots, tracer alone, and non-tracer alone) may be made to determine the variations in characteristics. Tracer round

impact points may be identified by applying non-drying paint, dye or other similar material to the tracer projectiles, which will leave identifying traces of the paint around the edges of target impact points.

d. Analytical Plan.

Appropriate statistical tests or analyses of variance will be performed to determine if there are significant differences in the measures of accuracy and dispersion between the test and control item, or between the test item and established criteria. Comparison results should indicate if the test item is worse than, equal to, or better than the control item or the established criteria.

11. Tactical Employment.

a. Objectives: To determine the accuracy, responsiveness, and sustainability of the test item when employed against targets in tactical disposition.

b. Method.

(1) This subtest will provide a realistic evaluation of weapon performance in a tactical environment. Field exercises will be conducted to provide influencing factors similar to those felt in combat, such as fatigue, noise, dust, smoke, stress, dirt, and rain. The field conditions should also add realism to the test environment through the effects of terrain, vegetation, temperature, simulated enemy weapons and tactics, fields of fire, and engagement ranges. TOP 1-1-046, Field Combat Test Exercises, may be used as a guide in planning field exercises.

(2) The test soldiers will be presented with simulated tactical situations that require the test item to be employed in both the defense and the attack, and during daylight and darkness. The test soldiers, firing the test and control items and using combat mixes of ball and tracer ammunition as applicable, will engage targets that depict enemy formations machine gunners would be likely to engage on a battlefield. Field target firing courses should be used to provide this environment. These firing courses should be located on irregular terrain so gunners have the opportunity to fire into various types of ground. Silhouette targets of types E, F, and M may be arranged to represent the enemy in linear, deep, and linear-with-depth formations. See TM 9-6920-210-4, Small Arms Targets and Target Materials, for descriptions of targets. Target installations should include short exposure time (pop-up) targets, concealed targets, stationary targets, and moving targets.

(3) The types of fire to be used, classified with respect to the gun, should include fixed, traversing, searching, traversing and searching, swinging traverse, and free gun, as appropriate for the type of target, type of weapon, and type of mount being used. A representative type machine gun range is depicted in the sketch at Figure 2, and firing courses that may be used for defense and attack exercises, in daylight and darkness, are discussed below.

(4) The range to be used should have sufficient terrain on which to maneuver the tactical unit (platoon, squad, fire team, or reconnaissance section) to which the test items are normally assigned. The firing area should be large enough to allow the test and control weapons to be fired at their minimum and maximum ranges of target engagement, including provisions for required safety buffer zones. When planning the firing area, maximum ranges will be determined from the characteristics of the machine guns to be fired and the range criteria specified in requirements documents.

(5) In the sketch at figure 2, some typical locations for firing points are indicated, based on the following considerations:

(a) Line A-B. Positions along this line can be used to conduct the long-range firing for defensive operations and the heavy volume of fire required in the firing element of fire and maneuver actions.

(b) Line C-D. Positions along this line can be used to fire the defensive fires necessary for both the deliberate and hasty defense, dependent upon the type of prepared firing position. These positions can also be used as an initial point for fire and maneuver actions.

(c) Lines E-F, G-H, I-J, and K-L. Positions along these lines can be used for fire and maneuver, retrograde operations, hasty defense, and advance to contact.

(d) Line M-N. Positions along this line can be used for the initial point in the assault role of the machine gun.

(e) Line O-P. Positions along this line can be used for position defilade firing.

(f) Testing the machine guns in the quick-fire role can be accomplished by emplacing appropriate targets along the approaches to firing points E-F, G-H, K-L, and O-P.

(g) Typical locations for moving targets are shown by the lines labeled MTP (Moving Target-Personnel) and MTV (Moving Target-Vehicle).

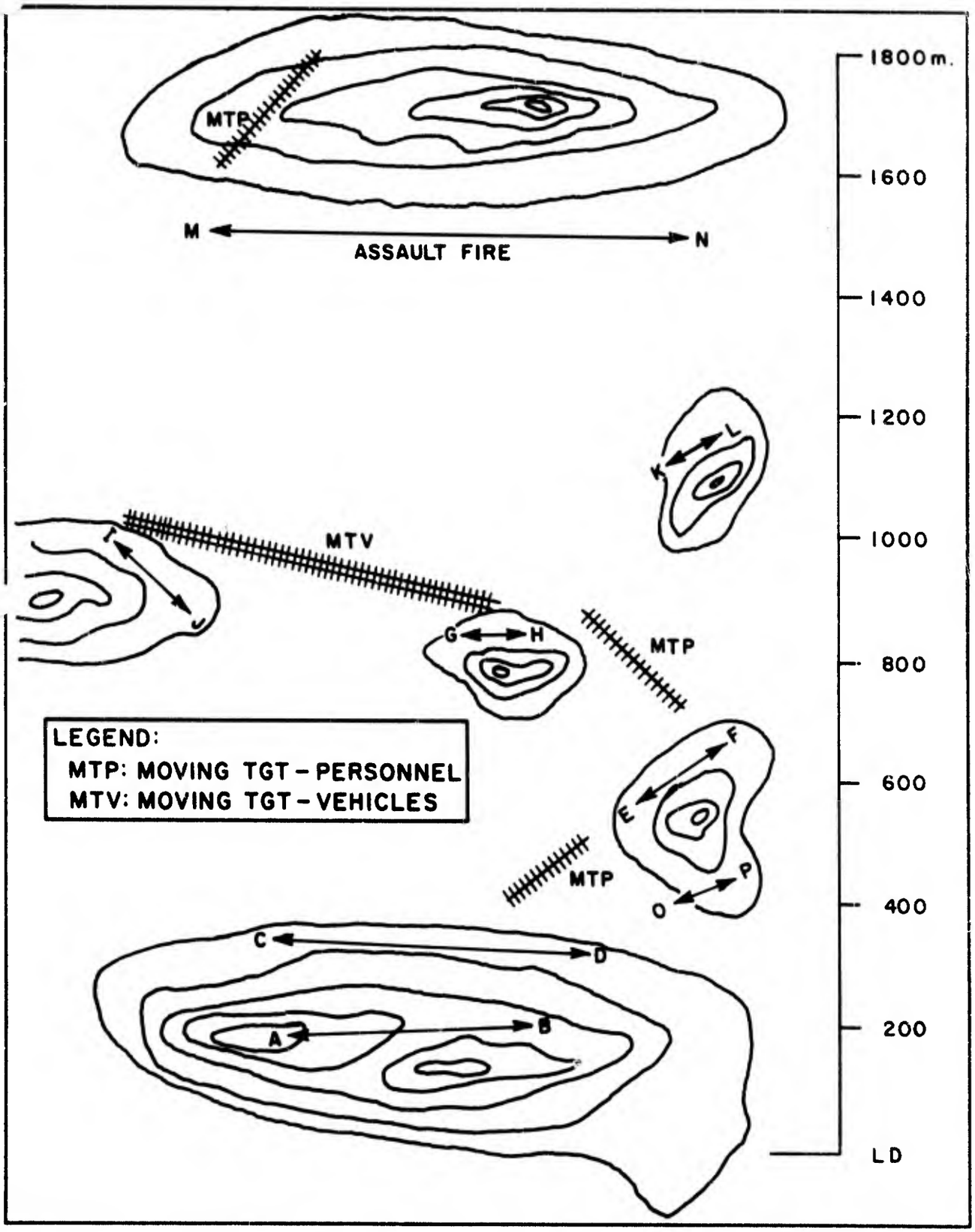

Figure 2. Representative Machine Gun Range

(6) Daylight Defense.

(a) Test soldiers organized as weapons crews will be given simulated missions for defensive situations, requiring them to deliver long range fires, close defensive fires, and final protective fires.

(b) The firing course should include short exposure-time (pop-up) targets arranged in various formations out to the maximum effective range; concealed targets emplaced at selected ranges out to the maximum range; stationary targets at the longer ranges; and realistically placed moving targets at selected ranges.

(c) The movable and pop-up targets should be controlled and manipulated so targets are exposed in a logical sequence to simulate enemy troops advancing, and should be equipped with signature devices to simulate enemy fire when the targets are exposed.

(d) All applicable modes of fire (e.g., semiautomatic, automatic, controlled bursts), and all mounting systems furnished for the test should be used in this exercise. The firing time permitted for each target array should be controlled.

(7) Night Defense.

(a) Test soldiers organized as weapons crews, will provide supporting defensive fires during darkness, or other periods of reduced visibility.

(b) The test soldiers should emplace the test and control machine guns in firing positions during daylight or under conditions of good visibility. The machine guns should be laid for preselected sectors of fire and a final protective line (FPL), in accordance with techniques for predetermined fire as described in applicable field manuals or instructions for the weapons.

(c) A range card should be prepared for each weapon, with firing data for a series of selected aiming points. The range card data should be verified by firing during daylight.

(d) During darkness, or other periods of reduced visibility, the targets at the predetermined aiming points and the FPL should be exposed, to simulate enemy crew-served weapons positions and enemy troops advancing. The test soldiers should fire the test and control machine guns at the exposed targets, using the range card data. All applicable modes of firing and all mounting systems furnished for the test should be used in this exercise.

(8) Daylight Attack.

(a) Test soldiers organized as weapon crews will be given simulated tactical missions for attack situations, requiring them to assist the attacking elements with supporting fires, including close-up fire support during the assault. The simulated situations will require the machine gun crews to support initially by fires from the vicinity of the line of departure (LD) and then advance by bounds from position to position as the attack progresses.

(b) The firing course should contain personnel type pop-up target arrays and stationary targets. As the test soldiers advance from position to position, the pop-up targets should be exposed in a logical sequence and engaged as soon as they are seen by the gunners. The stationary targets should be engaged at will as they are observed. The firing time permitted for each target array should be controlled.

(c) All applicable modes of fire, all applicable firing positions (shoulder, hip, underarm, sling-supported), and all appropriate mounting systems should be used in this exercise.

(d) The exercise should include a simulated counter-attack during consolidation, from pop-up target positions beyond the assault objective. The test soldiers should engage those targets from designated foxholes or other type firing positions appropriate for the weapons being fired.

(9) Night Attack.

(a) Test soldiers organized as weapon crews will participate in a night attack as part of the assault element. The simulated tactical mission will require the conduct of a night attack by stealth. During the move from assembly area to probable line of deployment, the machine guns will be located in the formation where they can best deploy for the assault.

(b) The firing course will contain personnel type pop-up targets equipped with signature devices to simulate enemy fire. The test soldiers will move forward from the line of deployment on order. As they advance in the assault, the pop-up targets will be exposed in a logical sequence and engaged as soon as they are seen by the gunners. The firing time permitted for each target array will be controlled.

(c) All applicable modes of fire, all applicable firing positions (shoulder, underarm, hip, and sling-supported), and all appropriate mounting systems should be used in this exercise.

(d) The exercise should include a simulated counterattack during consolidation, from pop-up target positions beyond the assault objective. The test soldiers will engage those targets from designated foxholes or other type firing positions appropriate for the weapons being fired.

c. Data Required. For each exercise, record the following:

(1) Identification of weapon.

(2) Firer's (Gunner) name.

(3) Type and lot number of ammunition.

(4) Description of range, targets, and weapon emplacement.

(5) Number of targets presented, by range (distance).

(6) Target exposure time.

(7) Number of bursts fired, by range.

(8) Number of rounds fired, by range.

(9) Number of targets hit, by range.

(10) Number of target hits, by range.

(11) Time to first round, for each target array.

(12) Time to first hit, for each target array.

(13) Time between bursts.

(14) Time to shift fires.

(15) Visibility and effectiveness (for ranging or target designation) of tracers.

(16) Mode of fire (semiautomatic, automatic, controlled bursts).

(17) Firing position (shoulder, underarm, hip, sling-supported).

(18) Type of mount used.

(19) Weather data (temperature, precipitation, wind speed and direction).

(20) Ambient light, in foot candles (for nighttime or other period of low visibility).

d. Analytical Plan. Appropriate statistical tests or analyses of variance will be performed to determine if there are significant differences in accuracy, responsiveness, and sustainability between the test and control item, or between the test item and established criteria. Comparison results should indicate if the test item is worse than, equal to, or better than the control item or the established criteria. Some measures of effectiveness that may be used in the comparisons are:

(1) Accuracy. Hit probability (per round fired, per burst fired, per engagement). These may be further categorized for each target range, mode of fire, type of mount, and visibility condition.

(2) Responsiveness.

(a) Time to first round (from target exposure until the first round is fired).

(b) Time to first hit (from target exposure until a target hit is achieved).

(c) Time between bursts (when more than one burst is fired in the automatic mode). This provides information on recoil and the man/weapon sight picture when the weapon is fired.

(d) Time to shift fires (after achieving a target hit). This incorporates acquisition of new target, position change, sight alignment and firing.

(3) Sustainability. This measure reflects the combat life of a weapon in a combat environment with respect to the basic load of ammunition. It may be expressed as hits achieved per pound of ammunition expended, or hits achieved per basic load of ammunition.

12. Man-Portability/Transportability. Accomplish the procedures presented in TOP 10-3-506, Man-Portability/Transportability. These procedures will provide an evaluation of the test item's suitability and compatibility while being handled or carried under simulated combat conditions by soldiers equipped with fighting and existence loads.

13. Airdrop Operations.

a. Accomplish the applicable procedures of TOP 7-3-511, Airdrop Operations, to determine the suitability of the test item for delivery by individual parachutist. Those procedures allow the test item to be evaluated in an actual parachute jump, to determine if a representative parachutist is able to successfully complete a jump while carrying the equipment.

b. Accomplish the procedures described in TOP 7-3-512, Airdrop (Suitability of Supplies and Equipment for), to determine the suitability of the test item for airdrop delivery from aircraft, rigged on airdrop platforms, skids, or in containers. Container loads may be dropped from aircraft ramps, personnel doors, wing shackles, or helicopter cargo hooks.

14. Durability and Reliability.

a. Objective. To determine the durability and reliability of the test item under tactical conditions.

b. Method.

(1) A careful review of all requirements documents and test directives should be made to insure specific requirements which relate to the durability and reliability of the test item are thoroughly examined.

(2) Throughout the conduct of all other subtests, note all failures and occurrences which pertain to durability and reliability, and integrate the data with this subtest. Throughout all testing, a record should be maintained for each major component of the test machine gun and its ancillary equipment, to document accurately the time and circumstances of events pertaining to the subject.

(3) Field exercises should be conducted to evaluate the test and control items in a simulated combat environment and to develop a history of deterioration, degradation, weaknesses, malfunctions, and failures. Examples of appropriate field exercises may be found in TOP 1-1-046, Field Combat Test Exercises. The exercises conducted should be of sufficient duration to determine if the durability and reliability criteria stated in applicable requirements documents are met. The firing exercises described in paragraphs 10 and 11, above, should be incorporated into these field exercises if practicable.

c. Data Required.

(1) A record of all test and control item failures, malfunctions, breakage, or other weaknesses which occurred during the test period, and the conditions or circumstances under which they occurred.

(2) A record of the total number of rounds fired per weapon in relation to all failures and malfunctions.

d. Analytical Plan.

(1) Collate all data and prepare a narrative report of significant findings resulting from the collection of comments, opinions, and observations. Support the narrative with photographs where appropriate.

(2) Accomplish an appropriate statistical analysis of variance to determine any significant differences between the test and control item, or between the test item and established criteria.

15. Maintainability.

a. Objective.

To determine if the test item can be properly maintained at the directed levels of maintenance skill, and to determine the adequacy of the maintenance package.

b. Method.

(1) The evaluation of the test items' maintainability characteristics should be a continuing process conducted concurrently with the other phases of the test.

(2) First echelon maintenance should be assigned to normal crew members, their performance closely supervised, and the resultant condition of the test item accurately recorded. Higher echelon maintenance requirements should be performed by personnel representative of the skills and capabilities normal to the level of operation.

(3) All maintenance should be performed by using the maintenance package tools, equipment, and parts and should follow maintenance package instructions.

(4) TECOM Reg 750-15, Maintenance Evaluation During Testing, contains detailed maintenance procedure instructions.

c. Data Required.

(1) The comments, observations, and opinions of test personnel which pertain to the care and cleaning, repair, parts usage, and ease of keeping the test item in a serviceable condition. Any features of the test item which require complex, frequent, and time consuming maintenance or repair should be identified.

(2) Comments and supporting data to judge the adequacy of the maintenance package.

(3) Maintenance data for test and control item. This should include down-time, repair-time, and availability of parts information.

d. Analytical Plan.

(1) Collate significant data and prepare subjective analysis of information obtained from comments, observations, and opinions of test personnel. Support the analysis with appropriate photographs where applicable.

(2) Conduct an appropriate statistical analysis of the maintenance data to determine any significant differences between test and control item, or test item and stated criteria.

16. Human Factors Evaluation.

a. Accomplish the applicable procedures of TOP 3-3-521, Human Factors Engineering, to determine if the test item meets human factors criteria expressed in requirements documents, is in accordance with basic human factors principles, and to what degree the test weapon meets with troop approval.

b. In recommending a new weapon as suitable for Army use, considerable care must be given to evaluating the man-machine relationship which affects compatibility with the skills, aptitudes, and limitations of the soldier who will employ it. The referenced TOP addresses the subject in a series of tests which produce both subjective and quantitative data.

c. Human Factors personnel should be consulted prior to beginning the service test for assistance in preparing pertinent portions of the plan and reports, and to aid in the development of interview and questionnaire items.

Recommend changes to this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: AMSTE-ME, Aberdeen Proving Ground, Maryland 21005. Technical information related to this publication may be obtained from US Army Infantry Board, ATTN: STEBC-MO-M, Fort Benning, Georgia 31905. Additional copies of this document are available from the Defense Documentation Center, Cameron Station, Alexandria, Virginia 22314. This document is identified by the accession number (AD No) printed on the first page.

APPENDIX
REFERENCES

1. AR 70-10, Test and Evaluation During Acquisition and Development of Materiel.

2. FM 23-12, Technique of Fire of the Rifle Squad and Tactical Applications.

3. FM 23-15, Browning Automatic Rifle, Cal. 30, M1918A2.

4. FM 23-16, Automatic Rifle Marksmanship.

5. FM 23-55, Browning Machine Guns, Cal. 30, M1919A6 and M37.

6. FM 23-65, Browning Machine Gun, Cal. 50, HB, M2.

7. FM 23-67, Machine Gun, 7.62mm, M60.

8. TM 9-6920-210-4, Small Arms Targets and Target Materials.

9. National Bureau of Standards Handbook 91, Experimental Statistics.

10. TECR 70-23, Equipment Performance Reports.

11. TECR 70-24, Documenting Test Plans and Reports.

12. TECR 385-6, Verification of Safety of Material During Testing.

13. TECR 700-1, Quality Assurance; Value Engineering.

14. TECR 750-15, Maintenance Evaluation During Testing.

15. TOP 1-1-012, Classification of Deficiencies and Shortcomings.

16. TOP 1-1-019, Testing Armament and Individual Weapons.

17. TOP 1-1-046, Field Combat Test Exercises.

18. TOP 3-1-002, Confidence Intervals and Sample Size.

19. TOP 3-2-045, Machine Guns and Automatic Weapons.

20. TOP 3-3-020, Antiaircraft Gun.

21. TOP 3-3-046, Machine Gun, Tank.

22. TOP 3-3-503, Boresight and Zero.

23. TOP 3-3-600, Sights, Indirect Fire.

24. TOP 4-3-514, Safety Hazards.

25. TOP 7-3-015, Aircraft Armament.