CHAPTER 3
DESIGN INFORMATION AND RANGE DESCRIPTIONS

3-1. GENERAL. Listed below are design requirements that apply to all types of armor ranges.

a. Mandatory Line-of-Sight Analysis. The installation must submit to Huntsville Center the survey data and proposed firing and target positions in a computer format so that a complete line-of-sight analysis can be made. (Specific data format requirements for the submittal are listed in appendix C.) The data must be submitted before or concurrent with the 35-percent design. Then the data will be processed through the Range Analysis System in order to determine the extent to which the proposed range meets training table requirements. Furthermore, the installation must arrange for a trainer to be present at Huntsville Center during the line-of-sight analysis so that the analysis can be made in a timely manner.

b. Safety. Safety requirements for siting of the ranges must be in accordance with DA PAM 385-63 (see paragraph 2-5). The ranges must also accommodate the firing limits of the gunnery qualification tables in FM 1-140, FM 23-1, and/or FM 17-12-1-1 and -2. Finally, the installation safety officer must review construction plans.

c. Surface Danger Zone. The surface danger zone (SDZ) for all weapons to be used on the ranges must be determined during the planning and programming of the project. The installation range planner and the major command (MACOM) must verify SDZ limits during initial design phase. Target locations should maximize firing opportunities while minimizing SDZ requirements.

d. Target Layout.

(1) Site Adaptation and Training Requirements. Although the range designer must site adapt the layout (drawings L-01 through L-20), all target arrays and firing positions and distances must meet the training requirements of the of FM 1-140, FM 23-1, and/or FM 17-12-1-1 and -2 as well as any local training requirements. Therefore, the range designer must coordinate with the installation trainers in order to site adapt target locations and develop gun target engagement sequence tables.

(2) Calibration Targets. SAT screening/boresights are site-adapt items that must be coordinated with the trainer.

(3) Target Protection. Designers should use existing natural terrain to protect the targets, when feasible, thereby minimizing the size of any berms that might be required. See chapter 6 for detailed information on target protection.

e. Defilade Positions.

(1) Design. Defilade positions will be designed to include a hull-down and a turret-down position for the M60 tanks, M1 tanks, and BFV’s. Each defilade position should be adjusted according to site-specific conditions in order to provide line-of-sight to the target. The slope into the defilade position should be between 2 and 3 percent. Drawing C-11 shows the dimensions to be used to design the defilade positions. In addition to constructed positions, natural defilade positions may be obtained by taking advantage of the terrain, such as a drop in the trail or at a stream crossing. Dummy defilade positions may also be provided to facilitate training.

(2) Misfire Pits. Ideally, each defilade position should have a pit into which misfired tank rounds can be placed during training exercises. The pit should be 1,200- to 1,800 millimeters (4- to 6-feet) in diameter and 600 millimeters (2 feet) deep and surrounded by two rows of sandbags. (See paragraph 3-2 below.)

f. Firing Point Markers. Firing points along tank trails must be indicated with numbered markers in order to identify firing point locations for controllers and provide point cues for target display. Those markers must be positioned so that they are concealed from continuous observation by crews. The course should be designed to channel the tank crew into the best (i.e., tactically sound) engagement route for the target arrays on the range.

g. Trail Markers. At installations where local soil conditions do not require construction of maneuver trails, a system of trail identification for locating firing positions during the training exercise is required. Trail markers are also needed in order to avoid arbitrary maneuvering that can cause environmental damage to the range. The method of marking will be determined by the installation. However, since damaged markers must be replaced regularly, cost effective markers such as semiburied automobile tires with reflectors or wooden posts with reflectors are recommended.

h. Marking Emplacements

(1) Responsibilities. It is the responsibility of the range designer to assign the target emplacement designation and specify how the emplacements are to be marked. It is the responsibility of the range construction contractor to mark or tag the emplacements.

(2) Marking Method. The method of numbering the emplacements is to be determined by the designer. This manual uses one possible scheme in the electrical drawings in appendix F. Another scheme, preferred by the range operations and maintenance elements, is sequential numbering. The numeric designator (1, 2, 3, etc.) is assigned to each emplacement sequentially, beginning with the first emplacement on the range. The method of marking is to be site adapted by the designer; however, the method must be permanent, and the marking must be placed on the emplacement wall. Numbers should be 75 millimeters (3 inches) high and of reflective paint or material. Numbers may be stenciled directly on the emplacement concrete wall, or a metal plaque may be attached to the emplacement wall.

i. Foxholes (Optional). Foxhole positions are used for supporting infantry movement during dismounting training scenarios. Foxhole locations must provide concealment of the foxholes and a clear line-of-site to the infantry target arrays. See drawing C-12, appendix F.

j. AMTC Storage Building (Optional). If used, the AMTC storage building must be located at the end of the track nearest the firing point. See paragraph 5-3 for design information.

k. Electrical and Control Requirements.

(1) Downrange primary (4,160-volt minimum) and secondary power distribution are required.

(2) AMTC's require 277/480-volt, 3-phase power for the mover and 120/240-volt, single-phase power for mover control at or immediately adjacent to the target shelter/bunker. Because the AMTC power requirements greatly exceed other target loads, the AMTC emplacement can be used as a power and data distribution center from which smaller, nearby target arrays can be subfed. Voltage available for each target will be no less than 95 percent of its rated operating voltage.

(3) Downrange target control and data distribution cables are required. A multiple twisted-wire pair (TWP), No. 19 AWG cable will be installed from the TJB to the first data cable breakout box (DBB) and from DBB to DBB. A 6 TWP, No. 19 AWG data cable is required from the DBB to the target CJB and from CJB to CJB.

(4) General downrange wiring and interface requirements for RETS-equipped ranges are outlined in paragraph 4-5. Specific power and data requirements for each range type are presented in paragraph 4-1.

(5) MOUT requirements. Design of the electrical system must conform to the requirements of TM 5-811-1 and TM 5-811-2.

l. Ammunition Restrictions. Ammunition used on these ranges must be limited to inert rounds. Live fire of high-explosive ammunition is not permitted.

m. Night-Firing Qualification. Ranges should be designed with red lamps or lenses so that they can be used for night-firing exercises.

3-2. MISFIRE POSITIONS FOR THE BFV.

a. Siting. Misfire positions will be used to minimize the SDZ after BFV misfires. The installation range safety officer will determine the location.

b. Design. Misfire positions will be designed to fully contain an accidental firing during removal of misfired ammunition. Two conceptual designs for the BFV are shown in figures 3-1 and 3-2. The range designer is responsible for verifying the specific site adequacy of these designs. The misfire position designs are based upon the following criteria:

(1) Maximum pivot of 25-mm gun (from horizontal plane of vehicle) = 200 mils (or 11.25 degrees).

(2) Projectile diameter = 25 mm.

(3) Projectile weight = 185.5 grams (0.409 pounds).

(4) Maximum projectile velocity = 1,539 m/s (5,050 fps).

3-3. MAINTENANCE AREA AND RANGE ACCESS.

a. Vehicle Holding/ Maintenance. This area will require about 7,500 square meters, which is sufficient space for a maneuvering and parking area for 28 vehicles. It will be located close to the baseline and the range operation and control area and will be constructed for use by tracked vehicles in accordance with chapter 7.

b. Service Roads and Tank Trails. Maintenance roads to the AMTC and SAT emplacements are required. Although tank trails should be used as much as possible, service roads can facilitate the installation and maintenance of the target mechanisms. Tank trails may consist of a gravel section or an existing roadbed, depending upon the local soil conditions at each installation. See chapter 7 for additional design information about tank trails.

c. Concrete Access Ramps. Intensive training and maneuvering can cause major maintenance problems on access ramps, particularly at hull-down firing positions, turret-down defilade positions, and tank trail intersections. To prevent access ramp surfaces from being displaced during quick stops and to minimize maintenance on heavily used ranges, the ramps should be constructed with concrete surfaces.

3-4. TANK GUNNERY RANGE (STATIONARY).

a. Purpose. The tank gunnery range is used to train tank and/or BFV crews in the rapid engagement and destruction of targets during both day and night exercises. It is also used to conduct subcaliber exercises against targets in tactical array. All exercises on this range are conducted from stationary vehicles.

b. Downrange Area.

(1) Layout. Drawing L-16, appendix F, shows a typical tank gunnery range layout. There are 15 firing positions, each 10-meters wide. The target area is 3,500 meters deep and 1,000 meters wide at the farthest target location. The firing line is slightly elevated, and each firing point is hardened to sustain turning tank traffic and main-gun back blast.

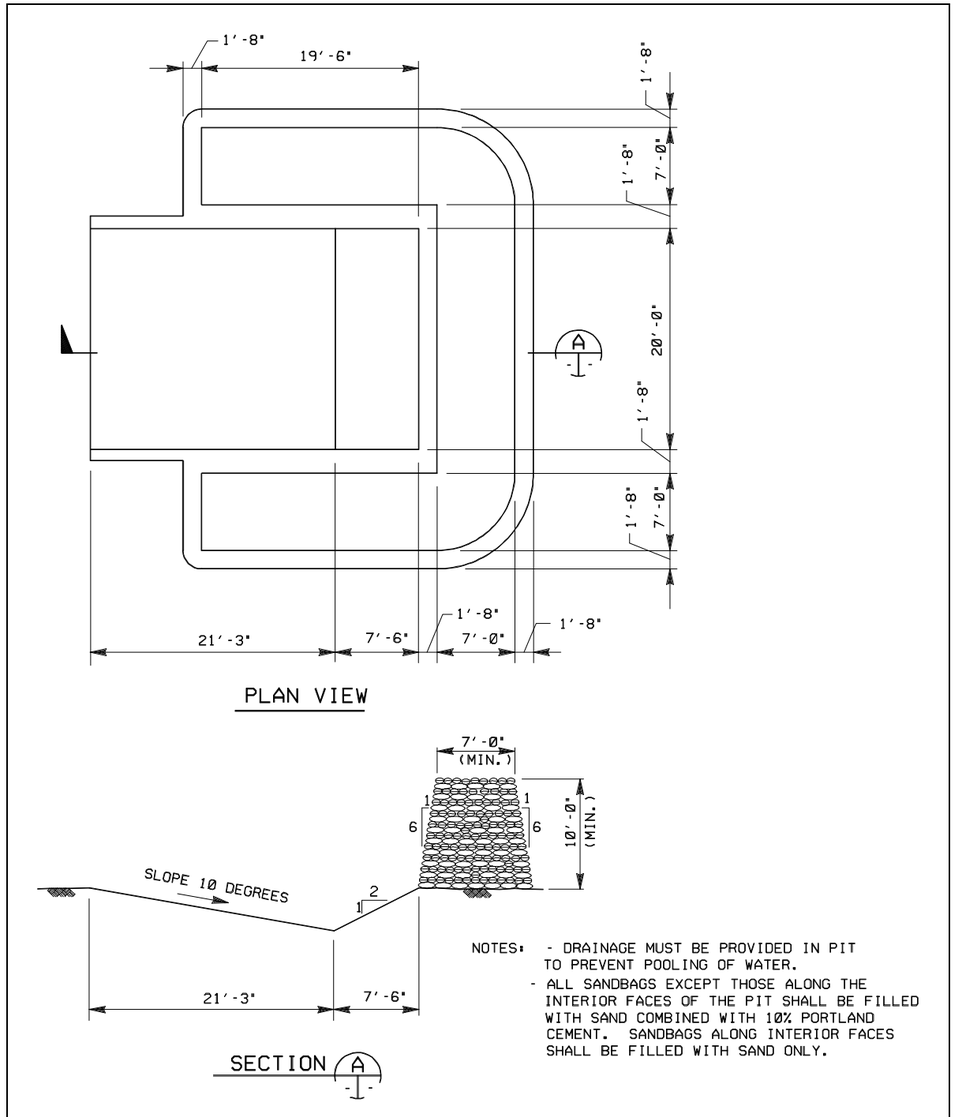

Figure 3-1 . BFV misfire position option 1

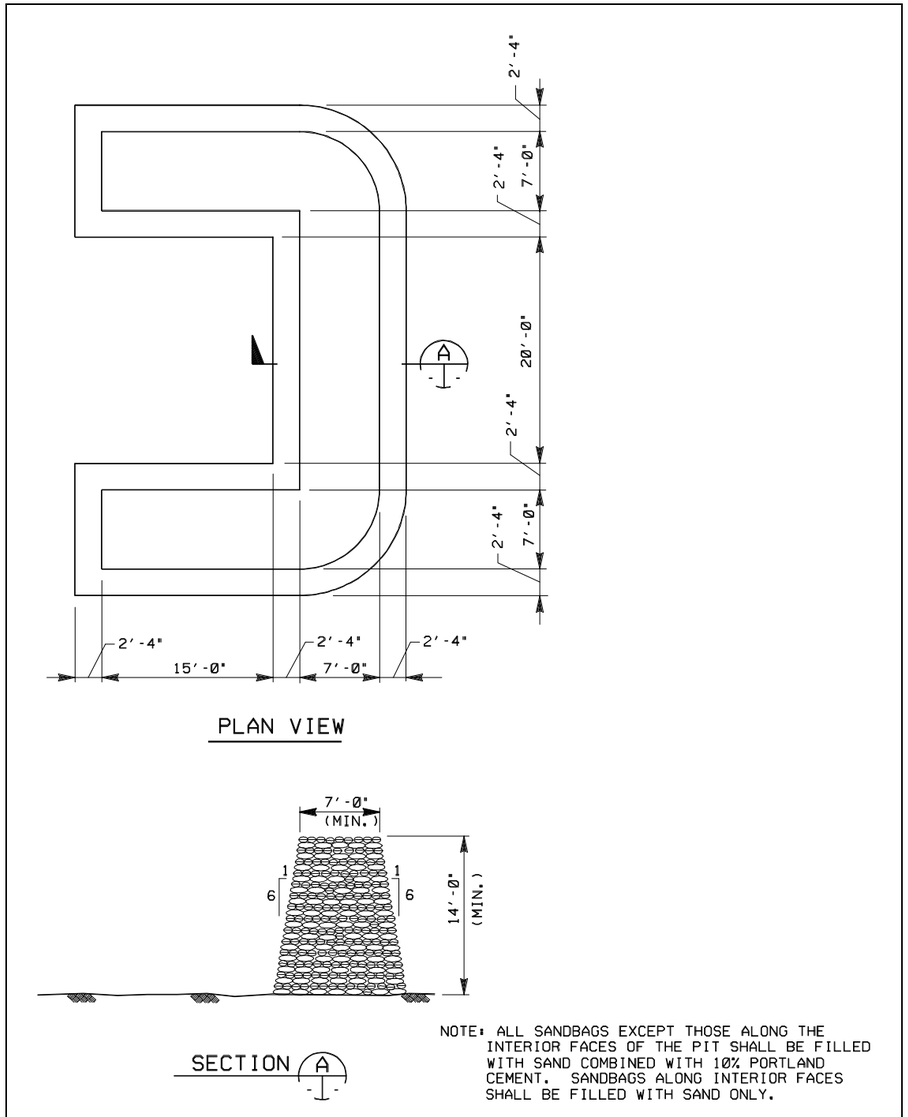

Figure 3-2. BFV misfire position option 2

(2) Targets. The 36 SAT's and the 26 SIT's arranged in 6 tactical arrays are located at various distances from the firing line. Four AMTC's on diagonal tracks are located between 500 and 3,000 meters. All SAT's are frontal views and AMTC's are flank views.

c. Other Criteria. Scenarios for this range indicate AMTC movement at speeds up to 40 kilometers per hour (25 miles per hour), with variable target exposure time. Target mechanisms should be sited so that they may be safely engaged from as many firing positions as practical. Simultaneous operations of multiple AMTC's must be in accordance with the gunnery tables in TC 1-140, FM 23-1, and/or FM 17-12-1-1 and -2.

3-5. MULTIPURPOSE TRAINING RANGE (MPTR).

a. Purpose. The MPTR is used to teach crews the skills needed for defeating stationary and moving targets in a tactical array. It is also used for tank crew qualification, BFV crew qualification, dry firing, and subcaliber engagements.

b. Downrange Area.

(1) Layout. This type of range consists of either a single BFV trail or a double tank/BFV trail as shown in the typical MPTR layouts in drawings L-17 and L-18, appendix F. Both range designs are approximately 500 meters wide.

(2) Targets. Targets are placed in tactical arrays along the tank trails. The single-trail course (BFV) has 12 SAT's, 2 AMTC's, and 34 SIT's. The double-trail course (tank/BFV) has 20 SAT's, 4 AMTC's, and 50 SIT's. SAT's are frontal views and AMTC's are flank views.

(3) Defilade Positions. The double trail has four defilade positions; the single trail has one defilade position.

3-6. MULTIPURPOSE RANGE COMPLEX (MPRC).

a. Purpose. The MPRC provides collective training facilities for BFV's, M1 tanks, M60 tanks, and attack helicopters. This range is used to teach the skills needed for defeating stationary and moving targets in a tactical array. It is also used for tank crew/platoon qualification, BFV crew/platoon qualification, dry firing, and subcaliber engagements.

b. Downrange Area.

(1) Layout. Drawing L-20, appendix F, shows a typical MPRC layout. The training area consists of three 4,500-meter by 300-meter lanes, each separated by a 50-meter buffer zone.

(2) Targets. Targets are placed in tactical arrays along the tank trails. Each lane contains 4 moving armor targets, 20 SAT's, 51 SIT's, and 15 IMT's. SAT's are frontal views and AMTC's are flank views.

(3) Defilade Positions and Foxholes. Each lane contains ten defilade positions and four foxholes.

3-7. MULTIPURPOSE RANGE COMPLEX, LIGHT INFANTRY (MPRC-LI).

a. Purpose. The MPRC-LI provides collective training facilities for BFV's, M1 tanks, M60 tanks, and attack helicopters. This range is used to teach the skills needed for defeating stationary and moving targets in a tactical array. It is also used for tank crew qualification, BFV crew qualification, dry firing, and subcaliber engagements.

b. Downrange Area.

(1) Layout. Drawing L-19, appendix F, shows a typical MPRC-LI layout. The training area consists of one 4,500-meter by 1,000-meter lane. Each lane contains 10 defilade positions.

(2) Targets. Targets are placed in tactical arrays along the tank trails. The layout contains 9 moving armor targets, 37 SAT's, 156 SIT's, 46 IMT's, and 45 optional IHFS's. SAT's are frontal views and AMTC's are flank views.

(3) Defilade Positions. Each lane contains 12 defilade positions.

3-8. ANTIARMOR TRACKING AND LIVE FIRE RANGE (AATLF).

a. Purpose. The AATLF range is used during both day and night exercises to teach the techniques of engaging targets with ground-mounted, tube-launched, optically tracked, wire-guided (TOW) weapons, vehicular-mounted TOW's (BFV's and M113's), Dragons, 90-mm recoilless rifles, 106-mm recoilless rifles, and improved TOW vehicles. This range is also used for field tracking exercises and for qualification exercises with tracking and launch-effect trainers. Trainers and range users are responsible for ensuring laser safety before using a laser device (See DA PAM 385-63.).

b. Downrange Area.

(1) Layout. Drawing L-15, appendix F, shows a typical layout for an AATLF range. Two raised firing lines are each 100 meters wide. One firing line has ten firing positions; the other line has ten vehicle positions. The target area width is 1,000 meters at 4,000 meters downrange. The last target should be 3,750 meters downrange, the maximum effective range of a TOW. The total length and layout of the roadway network should enable the gunners to observe the moving vehicle/tracking target from all directions. Spur roads, as shown on drawing L-15, appendix F, can be used.

(2) Targets. Four SAT's and two AMTC's are located on the AATLF range. The centers of the AMTC tracks should be located about 950 meters and 1,300 meters from the firing line (see drawing L-15, appendix F). SAT's are frontal views and AMTC's are flank views.

c. Other Criteria. Roadways with shoulders will be designed to support any tracked and wheeled vehicle. Crushed rock/gravel roadways are acceptable. Proper drainage must be provided. The road

width should allow only one lane of travel. Concrete turnaround pads will be located at roadway junctions and end points.

3-9. AUTOMATED FIELD FIRE RANGE.

a. Purpose. This range is used to develop individual speed and confidence when engaging realistic targets under field conditions similar to those found on the battlefield.

b. Downrange Area.

(1) Layout. Drawing L-01 shows a typical automated field fire range layout. ITM's are located in each lane at 75, 175, and 300 meters from the firing line. Target mechanism placements must conform as closely as possible to the established distances, but may vary by ±5 meters in order to avoid undesirable locations such as depressions or drainage.

(2) Targets. This range consists of 4 to 32 lanes, depending upon the troop training requirements at each location. Each lane is 16 meters wide and has three stationary pop-up targets and a number of IHFS's and NMFS's to be determined by the trainer. Each lane has a one-man foxhole at the firing line.

3-10. MODIFIED RECORD FIRE RANGE.

a. Purpose. This range provides the opportunity for soldiers to practice both field fire and record fire exercises on a single range facility.

b. Downrange Area.

(1) Layout. Drawing L-02 shows a typical modified record fire range layout. This range consists of 4 to 16 lanes, depending upon the troop training requirements at each location. Each lane is 20 meters wide.

(2) Targets. ITM's are located in each lane at 50, 75, 100, 150, 175, 200, 250, and 300 meters from the firing line. Target mechanism placements must conform as closely as possible to the established distances, but may vary by ±5 meters in order to avoid undesirable locations such as depressions or drainage features. Each lane has nine stationary pop-up targets, two IHFS's, and two NMFS's. Each lane has a one-man foxhole at the firing line.

3-11. AUTOMATED RECORD FIRE RANGE.

a. Purpose. This range is used for practice in engaging personnel targets and to obtain a qualification rating.

b. Downrange area.

(1) Layout. Drawing L-03 shows a typical automated record fire range layout. This range consists of 4 to 16 lanes, depending upon the troop training requirements at each location. Each lane is 20 meters wide.

(2) Targets. ITM's are located in each lane at 50, 100, 150, 200, 250, and 300 meters from the firing line. Each lane has seven stationary pop-up targets, two IHFS's, and two NMFS's. Target mechanism placements must conform as closely as possible to the established distances, but may vary ±5 meters in order to avoid undesirable locations such as depressions or drainage features. Each lane has a one-man foxhole at the firing line.

3-12. FIRE AND MOVEMENT RANGE.

a. Purpose. This range helps develop speed and accuracy when engaging personnel targets during patrol encounters similar to those found on the battlefield. This range also supports the requirements of initial entry training.

b. Downrange Area. Layouts for the automated field fire (paragraph 3-9), modified record fire (paragraph 3-10), and automated record fire ranges (paragraph 3-11) are acceptable for the fire and movement.

3-13. SNIPER TRAINING FIELD FIRE RANGE.

a. Purpose. The sniper training field fire range is used for day and night exercises that provide the sniper with practical experience in detecting and engaging realistic targets under conditions similar to those found on the battlefield. The sniper range is used for advanced rifle marksmanship training for selected personnel.

b. Downrange Area.

(1) Layout. Drawing L-05 shows a typical sniper range layout. The ideal sniper range is located on terrain that has been left primarily in its natural state. As shown in drawing L-05, appendix F, there are four firing lanes, each 20 meters wide at the firing line. The lanes become wider as the distance from the firing line increases, reaching 150 meters wide at the most distant target. Firing positions must be provided along the firing line within each lane. Training requirements include engagements from prone, sitting, kneeling, and standing-supported positions. Firing positions should be on slightly elevated ground and designated with numbered markers. To reduce target and land requirements, the sniper range may be overlaid on lanes of a multipurpose machinegun transition range

(2) Targets.

(a) SIT emplacements are located in each lane at 100, 175, 250, 300, 400, 475, 500, 600, 700, 800, 900, and 1,000 meters from the firing line. Target locations should conform as closely as possible to the established distances, but may vary by ±5 meters in order to avoid undesirable locations such as depressions or drainage features.

(b) A zero target, to be used as a calibration point, will be a SIT without an ITM and must be located 300 meters from the firing lane. Because of the zero target's function, no variation is allowed in its location.

3-14. MULTIPURPOSE MACHINEGUN TRANSITION RANGE.

a. Purpose. The multipurpose machinegun transition range is used to qualify gunners on squad automatic weapons (SAW's) and M60 and/or 0.50-caliber machineguns.

b. Downrange Area.

(1) Layout. Drawing L-06 shows a typical multipurpose machinegun range layout. The range has 10 lanes, each 10 meters wide at the firing line and becoming wider as the distance from the firing line increases. Ranges built to accommodate 0.50-caliber machinegun training will have a lane width of 100 meters at the most distant target, 1,000 meters from the firing line. Ranges built only for the M60 and/or SAW will have lane widths of not less than 70 meters at the most distant target, 800 meters from the firing line. Each lane will have a one-person or walk-in foxhole (see drawing C-12, appendix F.

(2) Targets.

(a) Drawing L-06, appendix F, shows all SIT's required for SAW, M60, and 0.50-caliber machinegun training and the target requirements. Target requirements for only one weapon or any combination of weapons can be calculated by using the symbols shown on the drawing. (Note that mechanisms with a single target arm are employed at ranges out to 300 meters, and dual target arm mechanisms are used at 400 meters and beyond.) Both the M60 and 0.50-caliber machineguns require a single SIT emplacement at 800 meters, and the SAW requires an array of four SIT emplacements on 10-meter centers. The array may be in one of three configurations: diamond, linear, or linear with depth (see detail 1 on drawing L-06, appendix F).) More than one of those configuration options can be used on a range in order to provide variations for trainees and make the best use of existing terrain. To meet the training requirements for the SAW and the machineguns, each target within the 800-meter array must be capable of being activated independently of or simultaneously with the other targets in the array.

(b) Target distances from the firing line will conform as closely as possible to those established in drawing L-06, appendix F, but may vary by ±5 meters in order to avoid undesirable locations such as depressions or drainage features.

3-15. COMBAT PISTOL QUALIFICATION COURSE.

a. Purpose. The combat pistol qualification course is used for instructional training and combat pistol qualification.

b. Downrange Area.

(1) Layout. Drawing L-04 shows a typical combat pistol qualification course. The range consists of 15 lanes, each 31 meters long with a uniform width of 8 meters. All lanes are identical. The firing positions should be slightly elevated to provide a better vantage point for the trainee and to improve drainage.

(2) Targets. A SIT is located at 10, 13, 16, 17, 23, 27, and 31 meters from the firing line. A 1-meter-wide by 20-meter-long foot trail is located at the center of each lane in order to provide access to moving engagements. Ascending slope emplacements must be used where access trail and moving engagements are required.

3-16. INFANTRY SQUAD AND PLATOON BATTLE COURSES.

a. Purpose.

(1) The ISBC and the IPBC provides ranges where a dismounted infantry squad/platoon can conduct mission-oriented training exercises in accordance with ARTEP 7-8-MTP. The basic training exercises are offense, defense, and retrograde. On the IPBC, the dismounted platoon has an area to practice the critical training maneuvers of ambush, movement to contact, attack, raid, retrograde, defend, and reconnaissance/security. Drawings L-10 through L-14 show typical functional layouts of the ISBC and IPBC and the maneuvers. The squad/platoon can conduct individual maneuvers as well as collective maneuvers (battle drills). The ISBC and IPBC are not designed to accommodate aerial gunnery support activities.

(2) The training exercises can be performed with live fire only when all safety aspects can be met; otherwise, exercises should be conducted under non-live fire conditions. For non-live fire exercises, personnel-safe laser equipment must be used.

b. Installation Requirements. It is critical that each ISBC/IPBC be tailored to the requirements set by the installation's training requirements and specific site terrain features. The strategies for the final range layout will be based on the following criteria:

(1) Training directives, priorities, and guidance established by the installation's chain of command.

(2) Squad/platoon battle tasks.

(3) Squad/platoon mission-essential task list.

(4) Squad/platoon training priorities.

(5) Training resources and availability.

(6) Terrain availability.

c. Siting. Terrain is the most critical element to be considered when selecting a suitable location for a battle course, since the site's terrain features should support the user's training requirements as well as the critical training maneuvers. Although one site may not support all the critical training maneuvers, careful site selection and terrain use will greatly increase battle course training capabilities.

d. Course Objectives. The sample ISBC/IPBC layouts depicted in drawings L-10 through L-14 include the defensive enemy battle positions described in (a) through (f) below. Note that the distances cited below pertain only to the nonsite-specific layouts presented in this manual. Specific target and objective layouts must be coordinated with the installation trainer and based upon the type of weapons and ammunition to be used.

(1) Objective A.

(a) Squad. Consists of four SIT's simulating a enemy outpost position. Objective A should be sited 200 to 300 meters downrange on a ridge line or other strategic area that can be engaged from a frontal suppressing engagement and a lateral (flanking) defeating engagement.

(b) Platoon. Consists of two SIT's simulating a enemy outpost position. Objective A should be sited about 250 meters downrange on a ridge line or other strategic area that can be engaged from a frontal suppressing engagement and a lateral (flanking) defeating engagement.

(2) Objective B.

(a) Squad. This is the final objective, consisting of two groupings with four SIT's and a single IMT in each grouping. Infantry targets should be located approximately 15 meters apart in each grouping. Each target grouping will also include one enemy trench, one SAT, and one machinegun bunker. The target groupings in objective B should be sited downrange approximately 500 to 600 meters from the baseline.

(b) Platoon. Group one consists of four SIT's, one IMT, and one machinegun bunker. Group two consists of two SIT's, one IMT, and one SAT. The course also requires one mortar simulation device (MSD). Objective B should be sited about 1,100 meters from the baseline.

(3) Objective C.

(a) Squad. Objective C is the enemy counterattack force that repels squad advancement into objective B. Objective C requires two SAT's, an armored moving target, and an observation bunker and should be sited about 200 meters downrange of objective B.

(b) Platoon. Consists of five SIT's, two IMT's, one SAT, and one MSD. Objective should be sited about 1,500 meters from the baseline.

(4) Objective D.

(a) Squad. A counterattack force consisting of five SIT's, two IMT's, one SAT, and one machinegun bunker. Should be sited about 900 to 1,000 meters downrange from the baseline.

(b) Platoon. Consists of a trench with a machinegun bunker, one SIT, an MSD at each end, and a mine field and/or an impassable contaminated area that will channel troops toward the trench. Objective D should be sited about 2,600 meters from the baseline.

(5) Objective E.

(a) Squad. Same as objective D.

(b) Platoon. Consists of three target groupings. The first group contains seven SIT's (two located in the assault\defend house), two IMT's, one SAT, one machinegun bunker, and one MSD. The second group contains one machinegun bunker and one SIT. The third group contains six SIT's, three IMT's, one AMTC, one machinegun bunker, and one MSD. Objective E should be sited about 3,500 meters from the baseline.

(6) Objective F (Platoon Only). Consists of three target groupings. The first group contains three SIT's, three IMT's, one SAT, one machinegun bunker, and one MSD. The second group contains six SIT's, one SAT, and one machinegun bunker. The third group contains five SIT's, two IMT's, one SAT, one machinegun bunker, and one MSD. Objective F should be sited about 3,850 meters from the baseline.

e. Bunker. The earth-covered and sand-bagged bunker depicted in drawing C-13, appendix F, simulates a typical enemy defensive machinegun bunker.

(1) Description. Each machinegun bunker should be accompanied by one SIT, one NMFS, and one IHFS. The SIT, NMFS, and IHFS should be positioned in a manner that will draw attention to the bunker. To accommodate the standard design, the SIT, NMFS, and IHFS must be located outside of the bunker. Note that the IHFS must always be placed within 6 meters (20 feet) of the CJB and target mechanism because of cable length.

(2) Bunker Construction. The bunker should be constructed of wood. The bunker should have at least three walls with a side opening for repair and practice grenade retrieval. The exterior beams of the bunker should be attached so that damaged beams can be replaced easily. The designer must perform all structural calculations for the bunker design. (The SIT emplacement with an ITM and the IHFS and NMFS machinegun simulators must be located outside of the structure.)

(3) Bunker Siting Criteria. Bunker emplacements should be sited on ascending slopes in order to facilitate proper concealment of the bunker's defensive position. Bunkers should be strategically located, using the natural terrain's protective cover and camouflage properties. The trench network should also interconnect a supply or communication line (trench) with the bunker. See drawing C-13, appendix F, for a suggested ascending-slope bunker emplacement design.

f. Trench layout and location.

(1) Trench Layout and Design. The location and layout of the trench must be in an area that supports desired strategies. The layout presented in this manual is for enemy strategies. The defensive positions for an enemy motorized rifle squad are generally linear, with individual fighting positions spaced approximately 5 meters apart. (Those positions are based on training for a war in Europe and should be adjusted to accommodate specific training goals). The total length of an enemy trench

should be approximately 50 to 60 meters. See drawing C-14, appendix F, for details and sections of a suggested trench design. On flat, open terrain, a broken or zigzag trench layout is appropriate. On mountainous terrain, trenches should be stepped or receding, with trenches connecting one relief feature to another. Where relief in the terrain dictates, a curvilinear trench may be used.

(2) Trench Location. On hilly or mountainous terrain, a trench can be placed at the foot of the slope, mid-slope, or near the topographic crest. The actual location depends on existing vegetation and terrain conditions and troop communication requirements. The trench should be located in the most advantageous, defendable, and survivable position.

(3) Trench Defense. According to enemy strategies, antitank and antipersonnel obstacles are normally erected in front of the trench line, although that is not shown on the design drawings. A trench would also include firing positions for rifles, machineguns, and grenade launchers. Trenches will not be used for live grenade training.

g. Assault/Defend House.

(1) The assault/defend house should be sited within objective E. This building is a two-story structure with targets in the windows of the lower level of the assault side (see drawings A-21 and A-22, appendix F). The first floor of the assault side is not intended to be accessed during training exercises. The door will be secured with a hasp and padlock. Both the assault side and the defend side of the building have exterior stairs for access to the second floor. The defend side has an interior stairway for access from the second floor to the first floor.

(2) This building can be used for live fire if there is an adequate SDZ for all weapons to be employed. (See paragraph 2-5 for SDZ safety requirements.)

h. Landing Zone/Pickup Zone (LZ/PZ). Troop transportation downrange requires that certain areas of the range be designated for helicopter accessibility. The designer, in cooperation with the range training officer, should determine the locations and number of LZ/PZ’s required. Downrange LZ/PZ’s should be cleared and leveled and the existing earth compacted if possible in order to maintain a realistic training environment. In order to maintain the realism of the range, the helipad design shown on drawing C-15, appendix F, should be constructed behind the assembly area only. Refer to TM 5-823-4 for helipad design marking requirements.

i. Danger Area. A danger area is any area void of a protective cover that could aid in the concealment of the platoon during movement exercises. The danger area is not a mandatory feature for all ISBC’s/IPBC’s, but could be incorporated into the range layout, depending upon specific training needs. The design features of each course depend upon the type of training desired for each range.

3-17. MILITARY OPERATIONS ON URBANIZED TERRAIN TRAINING COMPLEX

a. GENERAL. The MOUT training complex consists of the following two separate facilities:

(1) MOUT Assault Course (MAC). The MAC is the individual/small unit training facility, which has structures designed for the supervised training of individual skills necessary for MOUT operations.

(2) Collective Training Facility (CTF). The CTF provides a contiguous setting consisting of roads, buildings, and supporting features arranged to replicate urbanized terrain.

b. MAC.

(1) Description. The MAC component of the MOUT training complex provides individual and low-level collective training by employing either live-fire exercises or the Multiple Integrated Laser Engagement System (MILES). The live-fire MAC must be separated or shielded from the collective training portion of the MOUT complex by a distance that will allow concurrent use of each facility. A live-fire MAC may also need to be separated or shielded from adjacent training ranges as well.

(2) Structures. The MAC consists of the following structures:

(a) Urban Defense Building, drawing A-44, appendix F.

(b) Underground Trainer, drawing A-45, appendix F.

(c) Vault and Fight, drawing A-46, appendix F.

(d) Clearing Techniques Building, drawing A-47, appendix F.

(e) Grenadier Gunnery, drawing A-48, appendix F.

(f) Destiny Doorway, drawing A-49, appendix F.

(g) Dodge City, drawing A-50, appendix F.

(h) Grenade House (optional), drawing A-51, appendix F. This is an optional live-fire training structure, designed with shock absorbing concrete for close quarter use of small arms and fragmentation hand grenades. Standard design detail drawings are available upon request.

(i) Latrine, drawings A-07, A-08, A-13, A-14, and A-15, appendix F.

(3) Live-Fire Requirements. If the MAC facility is designated for live-fire training exercises, it must:

(a) Be designed (as recommended on the drawings mentioned in b above) to protect the main structural elements from live-fire damage and constructed of materials that minimize the danger of ricochet.

(b) Be separated (as shown in the drawings mentioned in b above) by a protective earthen berm thick enough and high enough to protect MAC training personnel in adjacent areas from cross fire. (Berms may also be required where live fire is adjacent to other training facilities.)

(c) Be in compliance with DA PAM 385-63 safety requirements.

(4) Nonlive-Fire Requirements. MAC facilities designated for nonlive-fire areas (underground trainer and urban defense buildings) must use the MILES training system. Nonlive-fire MAC facilities do not require an SDZ to be established and may be located in a local garrison training area.

(5) Land Requirements. The live-fire MAC facility requires approximately 2.4 hectares (6 acres), plus the area needed for the SDZ. An additional 2.4 hectares (6 acres) will be required if live hand grenades are used in grenade house training (see drawing L-09, note 5, appendix F). Those land requirements assume a linear arrangement of MAC training structures along the peripheral edge of an SDZ. The nonlive-fire MAC facility requires approximately 2 hectares (5 acres) of training land. The MAC training area land must accommodate the following:

(a) MAC primary training structures as in drawings A-05 through A-19, appendix F.

(b) Protective safety berms separating individual MAC training structures.

(c) A pre-exercise staging area. Such an area should be isolated from the live-five training area and be able to accommodate the using unit in either a tactical or administrative training situation. A major criterion of this area is the capability to provide a location where the using unit can prepare for and initiate its exercise against the MOUT facility.

(d) Vehicular parking for troop transport and range operations and maintenance personnel.

(6) MAC Siting.

(a) General. The MAC layout in drawing L-09, appendix F, is intended for illustrative purposes only. The designer is responsible for adapting the site and ensuring that the layout complies with the training objectives in TC 25-8.

(b) Layout Orientation and Safety. In order to verify range safety and orientation, the construction contractor, range safety officer, training officer, and construction representative should evaluate the MAC layouts after buildings have been staked out in order to confirm and, if necessary, adjust the original facility design.

(c) Topography. Where possible, the MAC training facilities should occupy gently rolling terrain. The maximum recommended slope gradient for lay-of-the-land roads within the built-up urban complex is about 15 percent.

(d) Drainage. The MAC area should be well drained. Existing natural drainage should be incorporated into the overall facility drainage design as much as possible.

(e) Vegetation. Existing vegetation throughout the MAC area should be retained and incorporated into the overall facility plan as much as possible.

c. CTF.

(1) Description. The MOUT CTF is a nonlive-fire training facility designed to accommodate the MILES training system. The CTF consists of buildings and vehicular and pedestrian circulation systems. Supporting features such as overhead and underground utility systems, walls and fences, and streetscape elements arranged to depict urbanized terrain may be added as options. The CTF will be either a platoon or company CTF as described below.

(a) Platoon CTF. This is a platoon/company team training facility. As indicated on drawing L-08, appendix F, the platoon CTF consists of a 17-building urban complex with 10 intact buildings (including a latrine) and 7 rubble buildings, approximately 3,950 square meters (42,500 feet) of paved road and parking surfaces, an underground sewer system, and supporting features. (See table 3-1 for a list of buildings.)

(b) Company CTF. This is a company/battalion task force training facility. As indicated on drawing L-07, appendix F, the company CTF consists of a 33-building urban complex with 17 intact buildings (including a latrine) and 16 rubble buildings, 5,150 square meters (55,450 square feet) of road and parking surfaces, an underground sewer system, and supporting features. (See table 3-2 for a list of buildings.)

(2) Land Requirements. CTF land requirements encompass two areas: the maneuver and staging area and the urban complex.

(a) Maneuver and Staging Area. The CTF must include sufficient training lands to support a peripheral maneuver and staging area surrounding a built-up urban complex. The maneuver and staging area training lands must:

- Provide a generally unobstructed maneuver area surrounding the urban complex.
- Provide site characteristics that reinforce the realism of the training exercise.
- Accommodate peripheral tank maneuver trails concealed from the urban complex for undetected maneuvering in the staging areas.
- Provide cover and concealment for staging and maneuver operations.

(b) Urban Complex. The built-up urban complex for the platoon CTF and the company CTF training areas requires about 1.7 and 3.2 hectares (4.2 and 8.0 acres), respectively.

Table 3-1. Platoon CTF Building Breakdown

Name	Rubble	Intact	Total # of Buildings

Hotel/City Hall	0	1	1
Apartment	0	1	1
School	0	1	1
Townhouse	2	1	3
Business/Residential	0	1	1
Office	1	1	2
Warehouse	0	1	1
Service Station	1	0	1
Retail/Bank	0	1	1
Residential	3	1	4
Latrine	0	1	1
Total	7	10	17

Table 3-2. Company CTF Building Breakdown

Name	Rubble	Intact	Total # of Buildings
Hotel/City Hall	1	1	2
Apartment	2	1	3
School	1	1	2
Townhouse	2	2	4
Business/Residential	2	2	4
Office	1	2	3
Warehouse	1	1	2
Service Station	1	1	2
Retail/Bank	1	1	2
Residential	4	4	8
Latrine	0	1	1
Total	16	17	33

(3) CTF Layout and Siting.

(a) General. The MOUT CTF layouts in drawings L-07 and L-08, appendix F, are intended for illustrative purposes only. The designer must site-adapt the arrangement of the CTF components (roads, buildings, and supporting features), ensuring that the layout complies with the MOUT training objectives in TC 25-8 are incorporated into the design. A proposed site for the CTF should satisfy the following criteria:

- The site should accommodate lay-of-the-land development and require minimal site work with respect to topography or vegetation, and the site should contribute to and enhance training realism.

- Rubble, such as broken masonry units, brick, and concrete, that accumulates during construction must be stockpiled at a designated location. After construction has been completed, the rubble material is to be deposited around the rubble structures to enhance realism.

(b) CTF Built-Up Urban Area. This area must be arranged as follows:

- The urban complex must have residential, retail/commercial, public institutional, high-density residential, and light industrial land-use categories that are arranged in distinct sectors within the overall urban layout. (See drawing L-08, appendix F.)

- Land-use sectors must be arranged to provide an increasing level of urbanization from the periphery to the center of the urban complex.

- The built-up urban area must approximate a radial pattern, concentrating the highest level of urbanization near the center of the urban complex.

(c) CTF Building Siting. The intact and rubble buildings that compose the CTF are the most dominant elements within the urban complex. The position of buildings within the urban complex implicitly defines exterior space; it is essential, therefore, that the siting of each building be based on the relationship of the building to the comprehensive urban layout. The arrangement of buildings in the CTF built-up urban complex must:

- Limit unobstructed line-of-sight to approximately 90 meters (300 feet) on the ground plane.

- Channel vehicular and nonvehicular flow to control the degree of accessibility throughout the urban area.

- Site buildings to delineate exterior space, providing a diversity of urban open space in terms of volume, configuration, and enclosure.

- Exploit the inherent structural characteristics of each building, such as height, window arrangement, and mass, in order to maximize tactical opportunities.

(d) CTF Enclosed Space. The arrangement of buildings influences the degree to which open space is enclosed in the urban area. The following guidelines should help create enclosure:

- For residential and light industrial land use, the horizontal distance to the farthest vertical enclosing element should be approximately four times the vertical height of the enclosing element.

- For public/institutional, high-density residential, and retail commercial (central business district) land use, the horizontal distance should be, at the most, three times the vertical height of the enclosing element.

(e) CTF Urban Open Space. Open space in the urban complex consists of dedicated and vacant areas dominated by a relatively unobstructed horizontal ground plane, such as a plaza, park, or parking area. Open space in residential and light industrial areas is defined by ground plane delineation, such as roads, drainage, corridors, and low-level (single- and two-story) structures. In urban land-use areas (such as high-density residential, public/institutional, and retail/commercial areas), open space is characterized by a predominantly hard-surfaced ground plane and rigidly defined by two- and three-story structures providing a high degree of spatial enclosure. Urban open-space layout considerations must include: (1) Provision for the diversity of spatial configuration and visual openness, and (2) provision for a variety of categorical open spaces, such as the highly structured, hard-surfaced plaza located in the central business district, vacant service areas located to the rear of major building complexes, and residential open space providing natural ground covers.

(f) Topography. Where possible, the CTF built-up urban complex should occupy gently rolling terrain. The maximum recommended slope gradient for lay-of-the-land roads within the built-up urban complex is about 15 percent.

(g) Soils. The soil characteristics within the built-up urban complex should provide a stable subsurface that will support the building foundations for the representative structures shown in drawings A-21 through A-43, appendix F, and the roads accommodating the largest vehicles used in the complex.

(h) Drainage. The CTF area should be well drained. Existing natural drainage should be incorporated into the overall facility drainage design as much as possible.

(i) Vegetation. Existing vegetation throughout the CTF area should be retained and incorporated into the overall facility plan as much as possible.

d. MOUT CTF Structures. Both MOUT CTF's are composed of the intact and rubble buildings listed in tables 3-1 and 3-2. The buildings represent a generic architectural style that incorporates MOUT-specific training features. The conceptual drawings in appendix F provide the basis for the preparation of detailed design documents. The detailed design of MOUT buildings must incorporate the MOUT-specific features listed in table 3-3 and described below:

(1) Hotel. (See drawings A-23 and A-24, appendix F.)

(a) The hotel/city hall should be located in the central business district (retail/commercial land-use area) near the center of the urban complex. Building 1 in drawings A-07 and A-08, appendix F should be designated either "hotel" or "city hall."

(b) A semifinished first floor reception/lobby area must be provided and must consist of a service counter and painted walls.

(c) The elevator denotes the shaft opening only.

Table 3-3. CTF Building Characteristics

Buildings	Drawing Numbers—Appendix F	MOUT-Specific Features					Physical Characteristics			
		roof hatches	mouseholes	loopholes	reinforced window ledges	rappel anchors	number of floors	floor area (sq ft)	roof type	optional basement (sq ft)
Hotel\City Hall	A-23, A-24			X	X	X	3	9,408	flat	1,568
Apartment	A-25, A-26	X	X	X	X	X	3	7,680	flat	1,280
School	A-33, A-34	X		X	X	X	2	8,640	flat	—
Townhouse	A-27, A-28		X	X	X	X	2	6,400	sloped	1,280
Business\Residential	A-29, A-30	X	X	X	X	X	2	4,608	sloped	704
Office	A-31, A-32		X	X	X	X	2	4,480	flat	—
Warehouse	A-39, A-40	X					1	4,150	sloped	—
Vehicle Service Station	A-37, A-38						1	1,664	flat	—
Retail\Bank	A-41, A-42		X	X	X		1	1,152	flat	—
Residential	A-35, A-36		X	X			1	1,093	sloped	528

(d) Roof access is provided via the elevator shaft penthouse.

(e) Rigid safety railings must be provided around the elevator shaft roof opening and at the shaft opening on each floor.

(f) Fire escape ladder and rear exit doors must be provided.

(g) Additional interior doors to the elevator shaft must be provided at each stair landing surrounding the elevator shaft.

(h) Rappel anchors must be located in the vicinity of the elevator shaft openings.

(i) High ground-floor windows must be provided to satisfy a two-man entry technique requirement.

(j) A safety net at the bottom of the elevator shaft opening must be provided.

(2) Apartment. (See drawings A-25 and A-26, appendix F.)

(a) The apartment building should be located in the high-density residential land-use area immediately adjacent to the central business district.

(b) Roof access is provided via a roof hatch.

(c) Tactical features in the interior layout are rigidly partitioned repetitive spaces.

(3) Townhouse. (See drawings A-27 and A-28, appendix F.)

(a) The townhouse should be located in or adjacent to the high-density residential land-use area.

(b) Dormer structures provide access to the roof and attic area.

(c) The central portion of the attic, which is subject to traffic, must be floored.

(d) A tactical feature is a common attic area connecting two or more units.

(4) Business/Residential. (See drawings A-29 and A-30, appendix F.)

(a) The business/residential building should be located in the central business district in the retail/commercial land-use area.

(b) A tactical feature is a maximum room size of approximately 41 square meters (440 square feet).

(c) Roof access is to be provided via a roof hatch.

(5) Office. (See drawings A-31 and A-32, appendix F.) The office building should be located in either the public institutional, light industrial, or retail/commercial land-use area near the central business district.

(6) School. (See drawings A-33 and A-34, appendix F.)

(a) The school should be located in the public institutional land-use area.

(b) A fixed, exterior fire escape must be provided to the second floor.

(c) Roof access is to be provided via a roof hatch.

(d) The tactical features are a long central corridor, high exposure afforded by exterior window openings, and maximum room size of approximately 39 square meters (418 square feet).

(7) Residential. (See drawings A-35 and A-36, appendix F.)

(a) The residential buildings must be located in the residential land-use area.

(b) The bottom chord of the roof truss must be designed to accommodate an additional concentrated load of 1,110 newtons (250 pounds) at the center of the chord. Nail chicken wire to the underside of the bottom chord of the trusses.

(8) Vehicle Service Station. (See drawings A-37 and A-38, appendix F.)

(a) The vehicle service station should be located in the light-industrial land-use area.

(b) No roof access is to be provided.

(9) Warehouse. (See drawings A-39 and A-40, appendix F.)

(a) The intact warehouse should be a pre-engineered metal building.

(b) The rubble warehouse should be a pre-engineered building with concrete masonry unit walls.

(c) The warehouse should be used as the range administration, instruction, and briefing building.

(d) Electrical service must be provided.

(e) Walls and ceilings of the intact warehouse must be insulated to prevent condensation.

(f) The warehouse should be located in the light-industrial land-use area.

(g) Roof access is to be provided via a roof hatch.

(10) Retail/Bank. (See drawings A-41 and A-42, appendix F.)

(a) The retail/bank should be located in the retail/commercial land-use area in the central business district.

(b) Interior finishes must provide a service area with a counter.

(c) Large, reinforced window openings must be provided in the front facade of the retail/bank.

e. Architectural Considerations.

(1) Durability and Performance Characteristics. The MOUT CTF structures must be designed and constructed of durable, cost-effective materials that have a projected 25-year life span. All structural designs should be based on site-specific conditions and meet or exceed the following normal floor live-load conditions:

(a) MAC structures .....2 kPa (40 psf)
(Except urban defense building)....2.5 kPa (50 psf)

(b) CTF structures .....2.5 kPa (50 psf)

(c) Stairs (all facilities) ... 5 kPa (100 psf)

The designer may substitute locally available materials that equal or exceed the durability and performance characteristics of the materials recommended herein. Building foundation and roof load requirements must be designed to accommodate site-specific conditions.

(2) Protection of Structures.

(a) Live-Fire Protection. In order to reduce ricochet and protect structures, it is important to minimize construction material exposure at target locations where live fire is used.

(b) Waterproofing. The buildings referred to in this document have not been designed as waterproof structures. Therefore, all masonry walls of rubble structures exposed to the weather must receive a waterproofing treatment.

(3) MOUT Features. The following features are unique to the MOUT and should be incorporated into the CTF buildings. (See drawings A-21 through A-43, appendix F.)

(a) Mouse holes. These are 600- by 600-millimeter (2- by 2-foot) holes randomly located in walls and floors. Floor mouse holes must have a hinged cover flush with the floor and must be designed to withstand floor live load.

(b) Loopholes. These are randomly spaced 200- by 400-millieter (8- by 16-inch) openings in exterior walls and roofs. Loopholes on gabled roofs must be flashed in order to protect wooden structures from rain runoff. Loopholes in exterior walls must be a minimum of one course above the finish floor. Loopholes must not be located directly below second and third story window openings.

(c) Roof Hatches and Openings. All intact two- and three-story CTF structures must provide 600- by 600-millimeter (2- by 2-foot)(minimum size) access through the roof.

(d) Reinforced Window Ledges. All structures, including rubble structures, must be equipped with reinforced window ledges. The reinforced window ledges on the second and third story must be protected from grappling hook impact.

(e) Rappel Anchors. These anchors should be steel rings with a minimum 50-millimeter (2-inch) diameter. They must be securely mounted in the upper-level floors and roofs of two- and three-story flat-roofed buildings and capable of supporting a 1,555-newton (350-pound) live load. Rappel anchors should be located in each quadrant of two- and three-story flat-roofed buildings and randomly located throughout the upper floors of other types of two- and three-story buildings. Two rappel anchors, 300 millimeters (12 inches) apart, must be located at each anchor point.

(f) Rubble Structures. These structures must be designed in accordance with the same structural design criteria used for intact buildings and should be constructed of similar materials. The rubble structures are intended to enhance training realism, provide a cost-effective screening and spatial delineation alternative to intact buildings, and furnish a diversity of tactical conditions. Rubble structures must be designed to ensure proper drainage so that water does not collect in empty spaces. All exposed, hollow-core masonry units and hollow-core slabs must be capped or filled in order to obstruct the collection of water, snow, and debris and prevent bird nesting.

(g) Plumbing Vent Pipes and Chimney Stacks. All intact structures with gabled roofs must be supplied with randomly located plumbing vent pipes and chimney stacks capable of supporting a 1,555-newton (350-pound) live load. Rubbled structures should be provided with plumbing vent pipes only. All plumbing vent pipes must be flashed.

(4) Structural Design Criteria. All CTF structures must be designed in accordance with the following requirements, unless otherwise indicated herein:

(a) Ground floors of all buildings, except those over basement areas, must be constructed of a concrete slab.

(b) All interior floors must be sloped a minimum of 10-millimeters per meter (1/8-inch per foot) in order to drain outlets.

(c) All windows, including those in rubble structures, must be provided with reinforced window ledges.

(d) All exterior masonry surfaces should undergo a sand-finished, earth-tone masonry treatment.

(e) Flat roofs must be surfaced with a 50-millimeter-minimum (2-inch-minimum) concrete topping mixture and sloped a minimum of 20-millimeters per meter (1/4-inch per foot) in order to drain roof outlets.

(f) The top course of a parapet must be reinforced.

(5) Basements. Partial basements must be provided in a minimum of four buildings, furnishing approximately 390 square meters (4,200 square feet) of total basement area. Although basements may be constructed in either intact or rubble buildings, basement locations in the CTF should be determined by site-specific conditions. When applicable, design for the track vehicle surcharge on basement walls is the responsibility of the designer.

f. CTF Vehicular Circulation System.

(1) CTF Maneuver and Staging Area. The vehicular circulation system in the CTF maneuver and staging area should consist of designated tank trails designed in accordance with chapter 5 herein.

(2) CTF Built-Up Urban Complex. The vehicular circulation system in the CTF built-up urban complex must include primary, secondary, local, and service category roads. The arrangement of roads in the built-up urban complex should be designed to:

(a) Channel the primary traffic flow (vehicles in excess of 8,165 kilograms (18,000 pounds)).

(b) Minimize site work through a lay-of-the-land road layout.

(c) Furnish diverse traffic and maneuver situations, incorporating various intersection configurations and maneuver obstacles, such as minimal turning radii and structurally constricted travelways.

(3) Construction Materials. CTF roads may be constructed with crushed aggregate material or concrete. The design of crushed aggregate roads is addressed in chapter 5. The design of concrete roads is addressed in TM 5-822-6. Where crushed aggregate is used, concrete turning pads designed for 54,430 kilogram (120,000 pounds)(category VII) tracked vehicles should be provided at each intersection.

(4) Bridge. The primary vehicular route through the urban built-up area must contain a bridge element. An arch-type culvert with a minimum span of 7.6 meters (25 feet) may be used as an acceptable alternative to conventional bridge construction.

g. Underground Sewer Network. The CTF should incorporate a closed conduit storm drainage system. The underground system must include a minimum of four manholes and 107 linear meters (350 linear feet) of 1,050-millimeter-diameter (42-inch-diameter) (minimum) reinforced concrete or corrugated metal pipe. Layout consideration for the underground system must include:

(1) A functionally designed system.

(2) Concentration of the branching portion of the system near the center of the urban complex.

(3) Connection of the underground system for discharge to a peripheral open channel or a natural drainage system.

h. Drainage Provisions.

(1) Interior Drainage. All subsurface features (such as basements and the storm sewer system) within the built-up urban complex must incorporate adequate provisions to ensure positive drainage. The interior floor surfaces of all CTF buildings should be sloped to discharge storm drainage to drain outlets or discharge points. Basement drains must provide positive drainage.

(2) Slope Requirements. Finished grades adjacent to all buildings should be sloped a minimum of 2 percent away from the buildings in unpaved areas and 1 percent in paved areas. Roads should be sloped a minimum of 2 percent for a cross slope and 1 percent for a longitudinal slope.

(3) Additional Drainage. To ensure positive drainage, site-specific conditions may require additional drainage provisions for the overall MOUT complex.

i. Scale Model. A scale model of the MOUT CTF and the MAC must be available for support briefings before operations and for after-action reviews. The model may be located in the MOUT CTF intact warehouse, which may be used as a briefing/training area. This model may be financed through sources other than construction funds.