BY ORDER OF THE SECRETARY OF THE AIR FORCE

AIR FORCE INSTRUCTION 13-212, VOLUME 2

7 AUGUST 2001

Space, Missile, Command, And Control

RANGE CONSTRUCTION AND MAINTENANCE

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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This instruction, in conjunction with AFI 13-201, *Air Force Airspace Management*, implements AFPD 13-2, *Air Traffic Control, Airspace, Airfield, and Range Management*. It applies to all Air Force, Air National Guard (ANG), and Air Force Reserve Command (AFRC) Range Operating Agencies (ROA). It provides guidance for range construction and maintenance, as well as information on specialized equipment and scoring systems used on the range. AFI 13-212 is in three volumes: Volume 1, *Range Planning and Operations*; Volume 2, *Range Construction and Maintenance*; and Volume 3, *SAFE-RANGE Program Methodology*. This publication is influenced by the Paperwork Reduction Act of 1974 as amended in 1996. Maintain and dispose of records created as a result of processes prescribed in this publication in accordance with AFMAN 37-139, *Records Disposition Schedule*.

SUMMARY OF REVISIONS

This publication is substantially revised and must be completely reviewed.

This revision of AFI 13-212 reflects a more integrated operational and engineering approach to range management and provides clearer guidance on roles and responsibilities in the management of Air Force range operations. The following important changes are added: Equipment used for range maintenance and clearance/decontamination; and Equipment used for Electronic Combat Ranges (ECR)/Electronic Scoring Sites (ESS).

Chapter 1

CONSTRUCTION

1.1. Range Layout.

1.1.1. Service Class A (Conventional). When laying out a proposed range, a dual range affords the opportunity for Explosive Ordnance Disposal (EOD) operations in target areas (except the area behind the strafe targets) on one side of the range while missions are in progress on the other. In addition, it provides for both right and left-hand patterns, thus enhancing aircrew training. The Range Control Officer (RCO) must prevent unauthorized over flight of personnel working on the ground. **Figure 1.1.** and **Figure 1.2.** represent the two types of dual range configurations presently in use. Variations to these standard patterns and range configurations are acceptable. Variations in target placement (with the exception of strafe target parameters identified in the figures), flight pattern size, and alignment are also acceptable. A range needs at least two towers, the control tower and a flank tower. The control tower is the focal point of all activity on the range, while the flank tower(s) normally serve for scoring only. **Figure 1.3.** and **Figure 1.4.** illustrate the standard range sizes and typical flight patterns.

Figure 1.1. Dual Conventional Range (Two Tower).

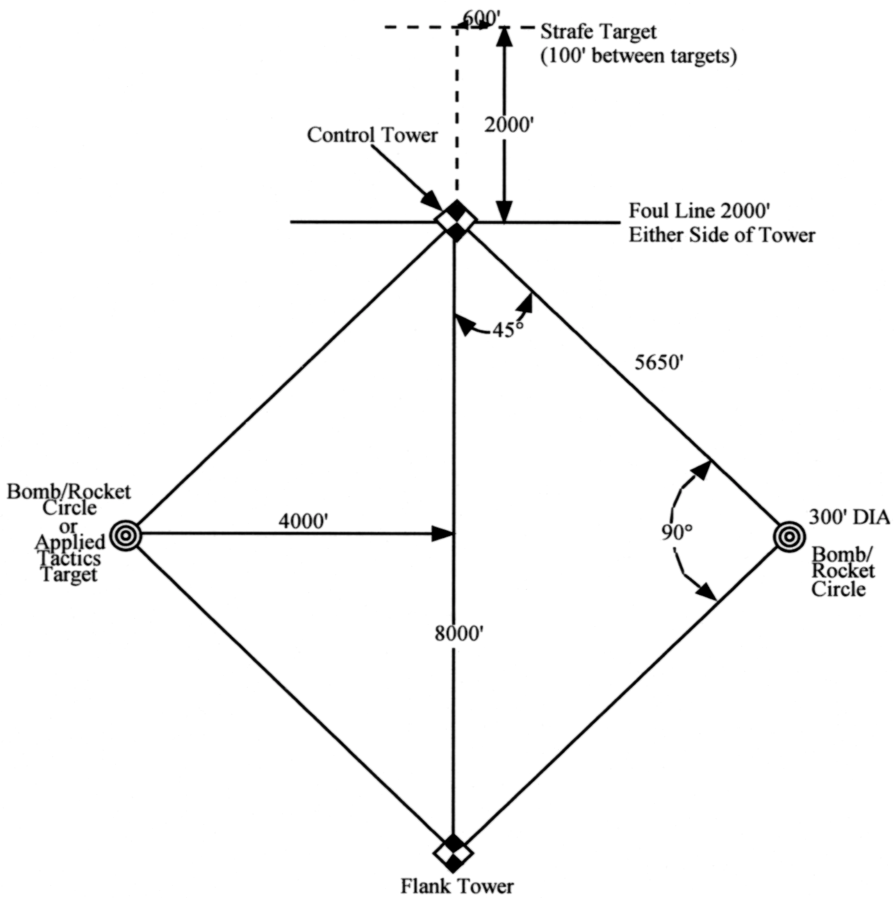


Figure 1.2. Dual Conventional Range (Three Tower).

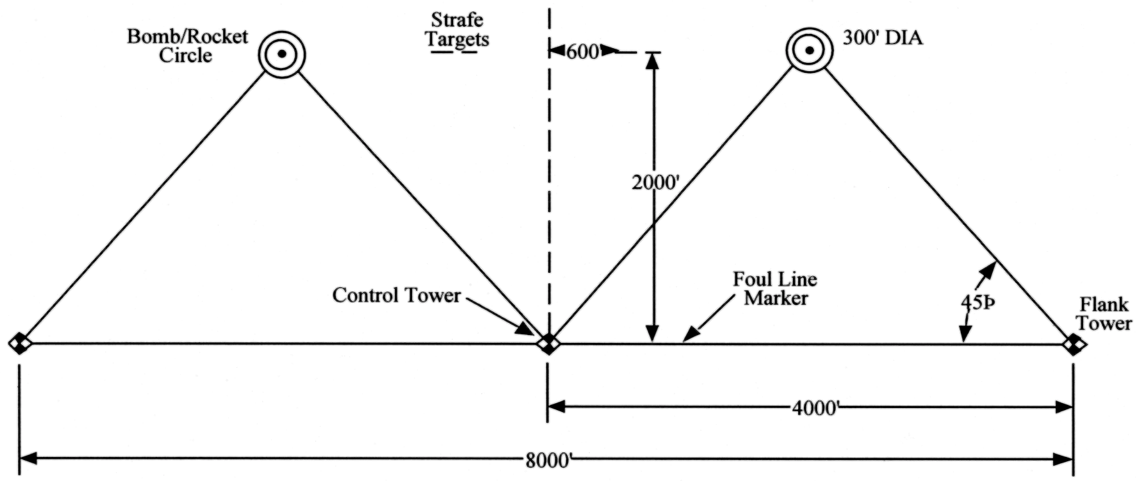


Figure 1.3. Standard Patterns for Conventional Two Tower Range.

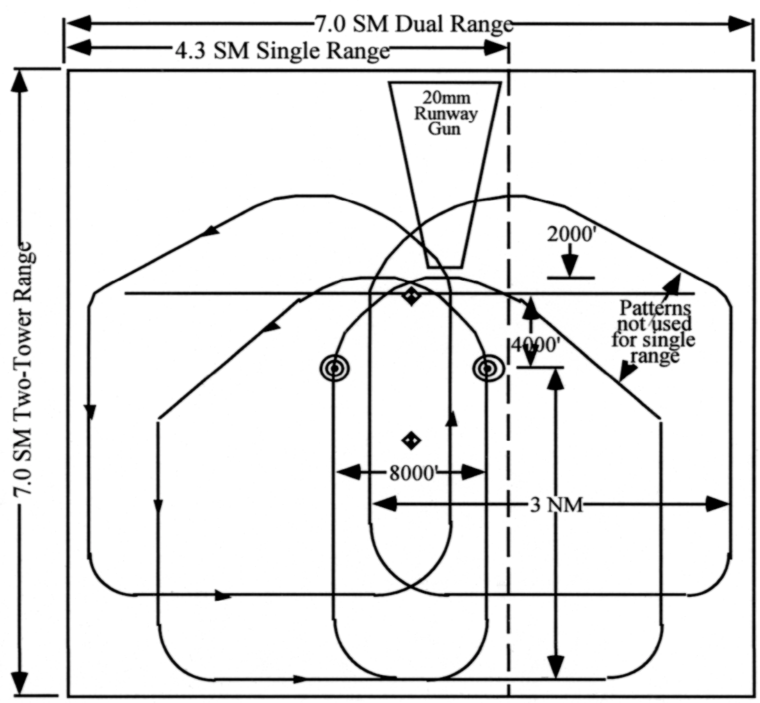
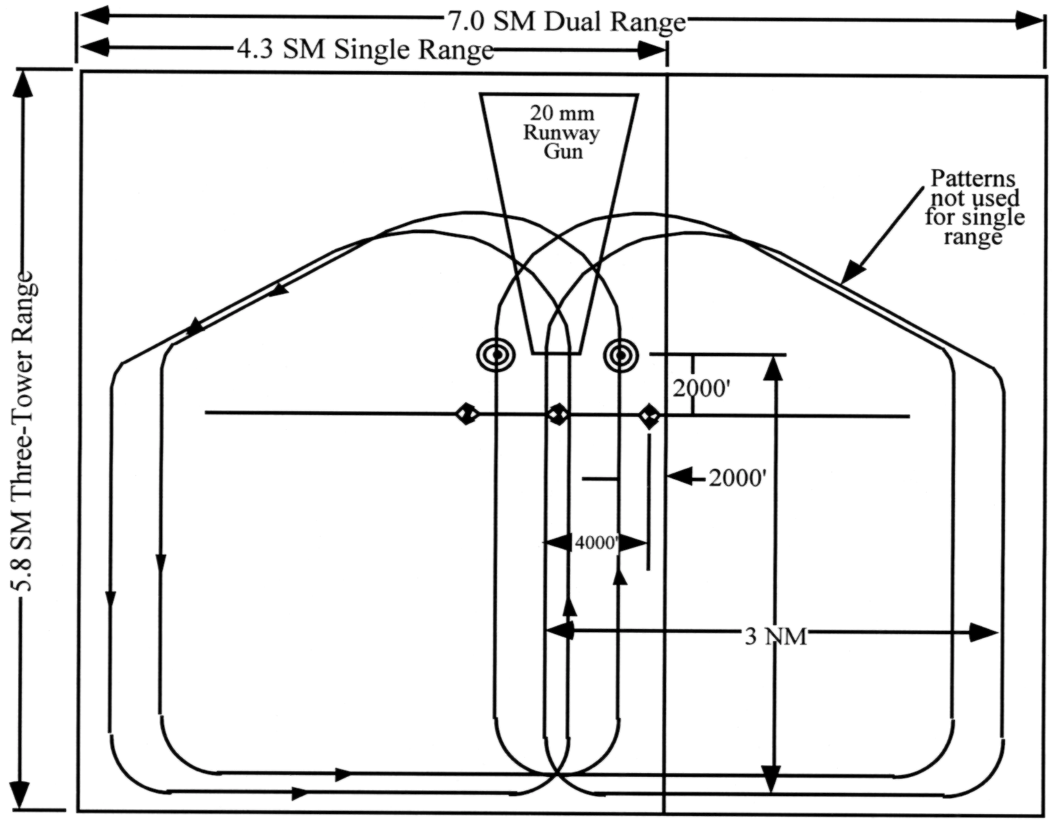


Figure 1.4. Standard Patterns for Conventional Three Tower Range.



1.1.2. Tactical Air-to-Surface Ranges (Service Class A, B, and C). This type range lends itself to most types of ordnance delivery against ground targets, including air-to-surface missiles, and simulated nuclear weapons delivery. The primary advantage of a tactical range is that it gives the aircrew an opportunity to visualize enemy targets as they would appear in a combat zone. The tactical range is the transition step between the conventional range, with precisely configured targets, and combat. The type of delivery and direction of attack are limited only by the size of the range, local restrictions, and type of ordnance.

1.2. Layout Considerations. Construct tactical ranges using current intelligence threat data so that target arrays are as realistic as possible. Use airfields, Surface-to-Air Missile (SAM) systems, Anti-Aircraft Artillery (AAA) sites, industrial complexes, and Forward Edge of the Battle Area (FEBA) targets in various threat scenarios. If developing FEBA target areas, consider "friendly" targets if the mission requires target ID. Change threat scenarios and target locations as current intelligence is updated. In this manner, you present aircrews varying target scenes and minimize stereotyped training scenarios. Whenever possible, tactical ranges should include a simulation of the hostile threat environment, to include SAMs, AAA, and communications jammers. These threats, when collocated with the targets, provide a realistic range complex that trains aircrews the way they will have to fight.

1.2.1. Live Ordnance Targets. Tactical ranges offer an excellent opportunity for aircrews to train using live ordnance. Carefully locate these targets to ensure safety to ground personnel. These live ordnance target areas, within the weapon safety footprints as a minimum, must be closed to public access at all times. Locate sensitive scoring equipment, threat emitters, communications equipment, etc., outside the fragmentation area to reduce maintenance and operating costs. Before establishing crew live ordnance training target areas, the operating agency must accomplish a Test/Training Space Need Statement (T/TSNS) and comply with the National Environmental Policy Act of 1969 (NEPA). If you contemplate subsequent relocation of these target areas in order to vary training scenarios, assess the entire range during the Environmental Impact Analysis Process (EIAP). This will give the operating agency more flexibility in managing range assets and will avoid the delay and expense of subsequent EIAP actions. Whenever possible, locate targets away from environmentally sensitive areas IAW final land disposition.

1.2.2. Simulated Nuclear Weapons Delivery Target. Strategic and many current tactical aircraft have simulated nuclear weapons delivery (SNWD) requirements. They deliver ordnance by specialized systems using a variety of specialized techniques developed to deliver such weapons. The SNWD range should be capable of supporting a flight of four aircraft in the pattern and be equipped to score spotting charges associated with all types of practice bombs. Include the capability to perform multi-directional SNWDs in the range layout whenever possible. The simulated nuclear weapons target supports deliveries requiring a long, stabilized run-in. When laying out the SNWD target (if all delivery methods are to be used), determine the length of the range by the distance of the initial points (IPs) from the target, plus the Hazard Areas. Locate the IP references for training 2,134 meters (7,000 feet), 3,059 meters (10,000 feet), and 9,146 meters (30,000 feet) from the target and on the run-in line or run-in heading. **Figure 1.5.** shows the minimum size of an SNWD range. IPs should be radar reflective objects since they may be used for radar Offset Aim Points (OAP). One of the best radar reflectors is the omni-directional type. This type allows altitude and heading deviations, thereby increasing training mission effectiveness and realism. Obtain optimum results by proceeding carefully in the construction phase, testing the pattern for optimum radar return, and experimenting with reflector positioning as necessary. If possible, position multiple reflectors to replicate cultural or other features of the potential target areas. Offset radar IPs should be approximately 3,059 meters (10,000 feet) to 9,146 meters (30,000 feet) from the target and offset from the run-in line by about 2,134 meters (7,000 feet). This offset varies depending on the size of the range area. If range space permits a variable run-in heading, use the reflectors placed on the run-in line for offset radar IPs. Radar reflectors must be oriented to each approach or reflect in all directions. The most probable areas of gross-error impacts can be predicted and are depicted by the shaded areas in **Figure 1.5.** Precise SNWD patterns are not shown because of the wide latitude of delivery parameters possible. However, to minimize the possibility of an off-range impact, orient the direction of approach to coincide with the length of the range property. In order to lessen the chance of off-range impacts, consider the following:

> If the range is larger than the dimensions depicted in **Figure 1.5.**, available lands must include the Hazard Areas for modified flight patterns.
>
> The 9,146-meter (30,000 foot) range extensions in front of and beyond the target accommodate inadvertent low-angle releases when bomb doors or dispenser doors are opened at the 9,146 meter IP. These areas give the range the capability of supporting deliveries in two directions.

The recommended range tower layout (see **Figure 1.6.**) consists of two towers 2,439 meters (8,000 feet) apart with lines-of-sight intersecting the SNWD circle at an angle of 60 degrees. In some cases, the SNWD circle may be moved closer to the towers (45 degree angle lines) to a minimum of 1,723 meters (5,650 feet). The advantage of this layout is the possibility of collocating it with a conventional air-to-surface range, negating the need of a separate range or building more towers. A layout similar to the one in **Figure 1.7.** is recommended. The distance between towers should always remain 2,439 meters (8,000 feet).

Figure 1.5. Simulated Nuclear Weapons Range Layout.

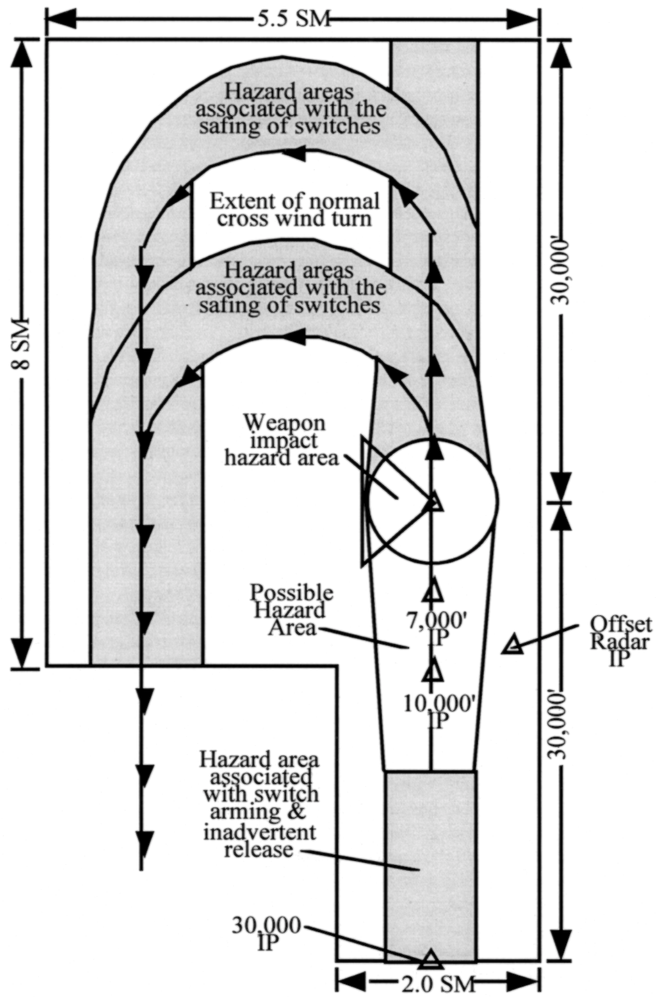


Figure 1.6. Simulated Nuclear Range Tower Arrangement.

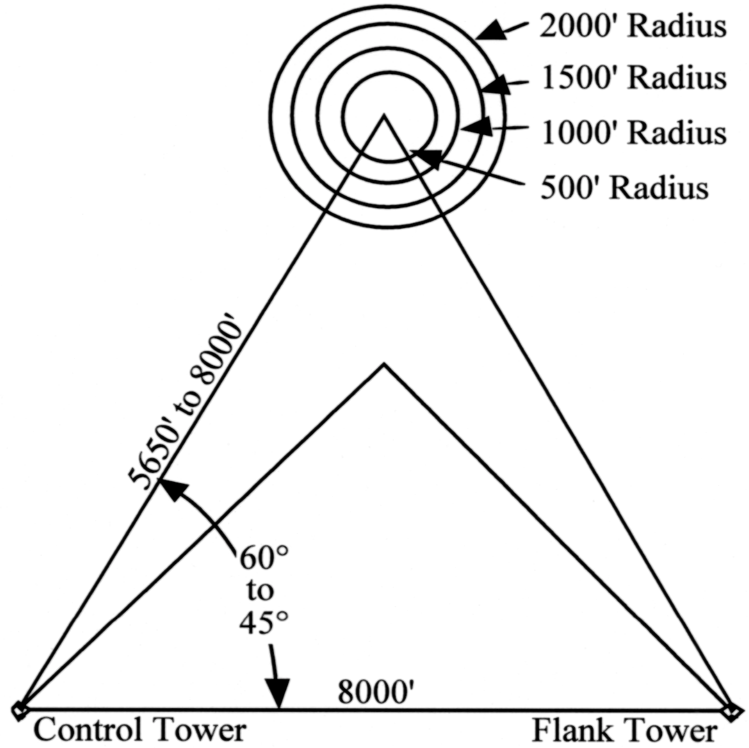
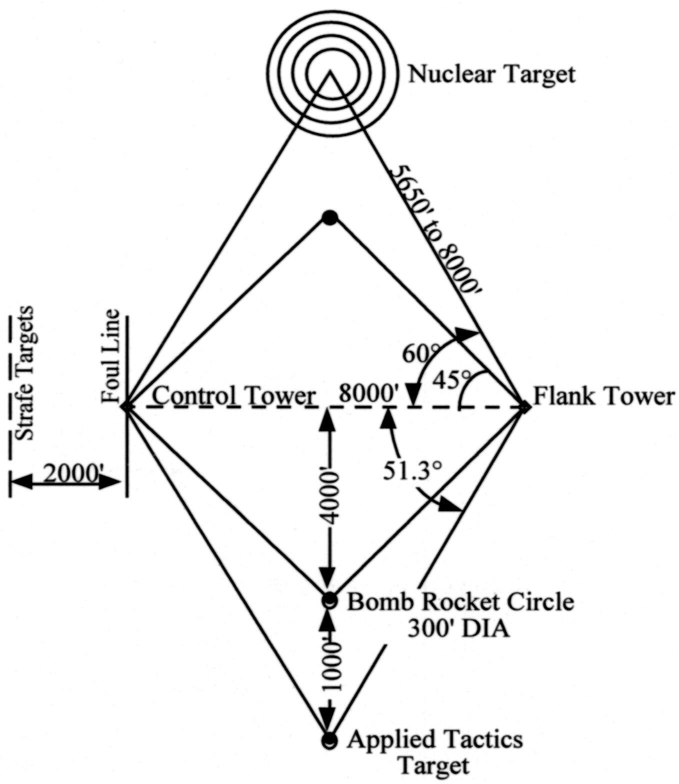


Figure 1.7. Simulated Nuclear Weapons Target Collocated with Conventional Range.



1.2.3. Other Air-to-Surface Ranges. There are other types of ranges that may be developed as part of existing air-to-surface ranges or as stand alone ranges.

1.2.4. Night Photography Range. A night photography range has facilities of known dimensions that, when photographed, reveal details regarding height, depth, size, and image definition for the evaluation of photography. The range usually has a series of photo-resolution targets installed in an area that has been cleared for night operations. In the interest of economy, night photography ranges are usually superimposed on air-to-surface ranges. The photo-resolution targets are built to permit an assessment of the quality of photographic exposures taken at night. To allow photographs at night, photo-flash devices illuminate the target. Photography ranges must have sufficient radar returns to allow the crew to position the aircraft to effectively illuminate resolution targets. Radar returns (natural or manmade) should be of an intensity sufficient to present a usable scope presentation in relation to the surrounding environment. The distance and direction of radar returns to the resolution targets must be known for flight planning purposes. This type range requires neither a RCO nor ground scoring capability as nothing is dropped (other than photo cartridges) from the aircraft and scoring is done through photo analysis. For night photography on tactical ranges, establish positive location features for photo interpreter's identification while viewing imagery. A radar return from natural terrain features or reflectors is also required to establish timing for cartridge expenditures and may be obtained through the use of an offset aiming point. The air-to-surface tactical range with realistic targets provides the best photography range for photo cartridge deliveries. Photo cartridges will be dropped only when impact will occur on government controlled land designated during EIAP. Public annoyance from cartridge flashes may be a factor; however, explosion noises and shock waves are not a factor outside the range area. The airspace reservation for a night photography range should cover the entire range area up to the maximum flight altitude.

1.3. Range Infrastructure.

1.3.1. Requirements. The design of a range that accommodates near and long term realistic training has associated with it a substantial list of infrastructure requirements to accommodate access to the range by personnel and store equipment to support range operation and maintenance activities. The infrastructure includes: buildings necessary to house personnel and equipment; complexes for storing materials for building or rehabilitating targets; roads and a helicopter pad to allow access to the range; improved areas for the location and support of radars and communication equipment; marshalling areas for storage of fire-fighting equipment and personnel; wells and water storage facilities for personnel and fire fighting; waste disposal areas for sanitary purposes and target residue; and fences, gates, alarms, and intrusion detection systems as appropriate for range security. The anticipated intensity of use, the substantial facilities required to support realistic training, and the necessity for safety, security, and fire fighting result in extensive range operation and maintenance requirements. Daily access to the range by maintenance personnel, operations personnel, fire-fighting personnel, and non-participating personnel (involved in joint use activities) creates requirements for positive control of range access. Frequent reconfiguration of the range for realism creates special range design requirements in terms of road quality, bridge loads, and infrastructure support. Furthermore, the presence of hazardous activities, hazardous materials, and possible conduct of classified missions creates requirements for restricting access and enforcing the security of certain parts of the range. All of these requirements have associated design criteria for the range.

1.3.2. Range Towers. Range towers are grouped into two basic types: control towers and flank towers. Requirements for each type differ; however, the cab of each type should be of adequate height to permit unobstructed observation of targets and aircraft patterns. Both types of towers must have lightning protection installed, and obstruction lighting is required for night operation. Because of the noise from aircraft operating at low altitude and the need for uninterrupted communications between towers or between the control tower and aircraft, the towers must be soundproofed to appropriately safe levels. Heating and air conditioning must also be provided, depending on climatic conditions. The control tower is the hub from which most range ground activities emanate. Clearances and instructions to aircraft flying on the range and control of all ground personnel working on the range originate from there.

1.3.2.1. Control Towers. A typical control tower's base legs are approximately 50 feet tall with a cab measuring approximately 3.05 by 3.05 meters (10 X 10 feet) to 4.6 by 4.6 meters (15 x 15 feet) sitting atop the legs. The cab is glassed (canted no less than 15 degrees) on four sides with heat-absorbing, shatter-resistant, laminated safety glass or heat-absorbing, shatter-resistant glass. The roof, or a portion of the roof, should be glassed, and a walkway built around the outside of the cab to ensure maximum visibility. The roof glass will be tinted, or shades will be provided to prevent excess heat build-up inside the cab. A guardrail must be provided around the walkway. Control towers must be equipped with either outside radiophone jacks or long cords for headsets and microphones to allow communications with the aircraft from outside the tower cab. The floor plan and instrument layout inside the cab are extremely important from the efficiency of operation standpoint. Many variations are possible depending on the type and amount of instrumentation used. Regardless of the layout used, there are some basic considerations that should be included. For example, a compact console arrangement gives the RCO ready access to necessary instrument and radio controls. Also, an unrestricted, 360-degree field of view is a must for all types of scoring facilities. The layout must provide the RCO with free movement to all sides of the cab to observe flight patterns.

1.3.2.2. Flank Towers. A flank tower normally serves as a scoring tower only. It houses scorers who have primary and backup communications with other range towers. It too should have an unrestricted field of view. Flank tower cabs are usually smaller than control tower cabs, measuring only 2.5 by 2.5 meters (8 X 8 feet) and have no requirement for glass roofs or walkways. The cab layout is simpler because there is less equipment.

1.4. Maintenance Areas.

1.4.1. Vehicle and Heavy Equipment Maintenance Facility. The numbers and types of vehicles and heavy equipment needed for range maintenance, as well as how much will actually remain at the range on a day-to-day basis, depend on range size, terrain, soil composition, and distance from the main support base. These will also determine, along with the weather in that local area, the type and number of maintenance buildings required, how they should be constructed, and the type of built-in equipment required. Normally, at a minimum, the equipment and maintenance building should be an enclosed space encompassing approximately 1,500 square feet to permit indoor work on heavy equipment and vehicles in inclement weather. It should have a high ceiling and large doors to accommodate the largest piece of equipment programmed for the range. The building should also have space for a tool storage area, a spare parts storage area, an air compressor with plumbing for multiple outlets, a paved floor, workbenches, and a room for an electronic equipment test bench. Outside, there should be a fuel storage and dispensing area and several outbuildings for storage of paints and thinners, cleaning solvents, oils and lubricants, and other combustible or hazardous materials. In addition to the buildings, a large storage lot with compacted gravel surface should be planned for vehicle, equipment, and bulky material storage.

1.4.2. Electronic Equipment Maintenance Facility. As more and more ranges have the scoring functions enhanced by electronic equipment, it may become useful to repair and recondition this equipment at the range. This may be especially true if the main base is located a significant distance from the range. Range facilities should then include space to house the electronic repair equipment and provide a proper work area for its use.

1.4.3. Target Fabrication Area. An outdoor area should be improved with gravel or other material to provide a firm, dry work area to build up or repair targets. It should be near the range maintenance building, if possible, to share assets such as compressed air, electrical power, tools and equipment, and washroom facilities.

1.4.4. Administrative and Support Facility. As well as having facilities to work on vehicles and equipment, ranges should be designed with a facility to accommodate the needs of the personnel manning the range. Although the size of the facility may vary from range to range, approximately 2,000 square feet is an initial base to scale up or down from. The following are some ideas for areas that should be incorporated into the design. Offices should be provided for all Class A ranges and considered for Class B and C ranges any time personnel spend extensive time at the range performing administrative functions. Range towers should not be used as administrative areas. These offices also provide a place to receive and brief visitors to the range.

1.4.5. Scoring Facility. Some scoring equipment, such as the scoring console for the Television Ordnance Scoring System (TOSS), requires considerable floor space for each console. Some ranges might require several consoles. Locating the consoles within a dedicated area would allow for easier installation and maintenance of the equipment and provide better climate control for computer associated equipment. The addition of several consoles could require several hundred square feet of space and could be a separate facility or be part of the operations building. Locate the M-2 Aiming Circle and the strafe scoring equipment in the tower.

1.4.6. Amenities. For manned ranges, the addition of septic tank or other latrine facilities is required, and provisions for snack bar-type equipment would enhance conditions for those required to spend extended time there. In addition, for those ranges where people are required to remain overnight due to inclement weather or multiple-day work shifts, provide a bunk room and shower facilities.

1.4.7. Vehicle and Equipment Parking Area. Provide a parking area for personal vehicles and daily-use range vehicles. The parking area should be an improved surface of at least compacted gravel.

1.4.8. Target and Construction Material. At least one site for target and other materials of construction should be provided. This site should include a storage building for materials susceptible to moisture, sunlight, or other outdoor conditions. It should consist of an area of several acres of unimproved lot for storage of salvaged vehicles, aircraft, and other materials awaiting use.

1.4.9. Visitor Facilities. Visitor facilities, while not required, are beneficial in promoting community relations. These facilities need not be expensive or elaborate, but should provide basic comforts such as latrine facilities and drinking water. Bleachers or some other seating arrangement will be located outside the Hazard Area and should provide a good view of the main bombing and strafing targets. Some sort of physical barrier, even if just a rope strung between posts, should indicate the limits of movement around the viewing area.

1.4.10. Utilities Easements. Utilities serving the range should be routed along the primary range access road, if practical, for ease of maintenance and to minimize impact on operations. Also, ranges cover an extensive area and are usually located away from populated areas. This is the same criteria used by utility companies when looking for land over which they would like to string power or communications lines, or under which they would like to lay pipelines. As the introduction of these elements can be of benefit to large numbers of the public at large, every effort should be made to accommodate the easement requests. However, the primary purpose of the range must be the primary consideration, not only as it is used now, but for future requirements. Remember that the ranges in use today will probably be the same ones in use for years to come. Do not compromise flexibility in operation and capability for changes and expansion.

1.5. Airspace Design. Although the focus of previous sections has been on the acquiring and use of land and facilities, the acquiring and use of airspace is just as critical. Also, just as environmental pollution of the surface has become an intense subject of debate, noise pollution and use of airspace by the military is becoming an increasingly contentious issue in some areas. For these reasons, a thorough knowledge of types of airspace, their proper uses, the procedures for obtaining the airspace (to include environmental aspects), and how to fully integrate airspace and range land space is required. This knowledge can be found with the unit airspace manager, who must be involved in planning from the start, and AFI 13-201, *Air Force Airspace Management*.

1.6. Construction Alternatives and Considerations.

1.6.1. Military. During the range planning process, consider construction by military civil engineering or construction units. If the proposal is an addition to an existing range or construction of a small range, this may be a viable alternative. Depending on the amount of construction to be done and land to be cleared, it may be possible for a large range as well. However, most units do not have the people or equipment to put against a long term and/or massive construction project. Additionally, consider the use of active duty or Reserve RED HORSE units. Since active duty RED HORSE units are usually heavily committed, your project must be approved and placed on their long range construction planning schedule as soon as possible. If you are unable to get on their schedule until after approval is secured to start your initiative, it may be a considerable amount of time before construction can begin. Reserve units are constrained by time. If your project cannot be completed within their active duty training period, you will have to attempt to use multiple units during the same year or the same unit over several years. It is advisable to establish your range design as early as possible and coordinate with Civil Engineering to determine the extent of construction effort required. They should also be able to help you determine if or how much of the effort military construction units could accomplish.

1.6.2. Contractor. If military construction is not feasible, the alternative is a civilian contract construction company. A cooperative effort among the working group can provide the Civil Engineer with specifications as to what exactly is to be accomplished. These specifications form the basis for the contract bidding process. Since any changes that occur after the contract award normally involve additional cost, the information must be as complete and accurate as possible. Contracting for construction has the advantage of a firm start date in line with Air Force needs. Even though most of the heavy construction may be contracted out, much of the equipment (radios, scoring systems, etc.) may still be provided and installed by military resources.

1.6.3. Construction Considerations. If the total land required for the range cannot be acquired at one time, acquisition should be planned so that construction can progress efficiently and an initial operational capability (IOC) established as early as possible. Range construction should start as soon as possible after acquisition begins. Range design and construction should not vary significantly from that evaluated under NEPA. Any mitigation measures identified for implementation during the Environmental Assessment process must be included in the final construction.

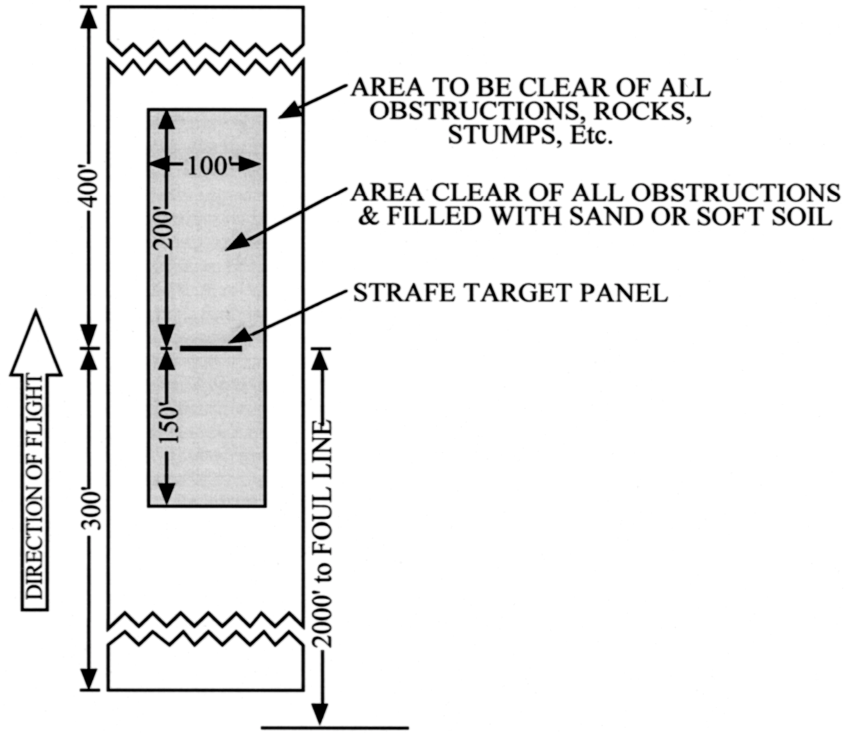
1.6.4. Oversight Responsibility. The designated civil engineering agency is responsible for overseeing range construction. Supplement this agency with an operations representative to assist with technical issues. Oversight will ensure that range construction is consistent with original range design, that facilities meet specifications, and that requirements specified in this instruction are met. As part of the developmental process in planning for a range, plans for the range had to be evaluated under the EIAP. Comply with the design analyzed during EIAP. Deviation from the approved design could stop construction and result in another EIAP requirement. Any mitigation measures identified in the EIAP must be included in final construction. If changes are contemplated for specific reasons, consult with the Civil Engineer to determine if additional analyses are required. Also, MAJCOMs must coordinate this action with AF/XOOR for Air Staff review IAW AFI 13-212, Volume 1, *Range Planning and Operations*.

1.7. Target Construction. Target construction should avoid Federally-listed threatened and endangered species and their habitat, historic and archeological sites, and wetlands. If during target construction archeological sites or artifacts are discovered, construction activities should be halted and the base environmental management flight should be contacted.

1.7.1. Strafe Targets.

1.7.1.1. Conventional Range Strafe Beds. Construct strafe beds to reduce the ricochet hazard to a minimum. An area 30 meters (100 feet) wide, 46 meters (150 feet) in front of the target, and 61 meters (200 feet) behind the target should be filled with sandy soil or soft loam to a depth of at least 12 inches (see **Figure 1.8.**). Fine, loose sand has proven to be the best type of soil for this area; however, a soft loam or other type soil that remains soft after disk harrowing or chisel plowing is acceptable. Sand should not be imported into the strafe target area unless the native soil is hard and difficult to work, such as clay or calcite. The total strafe bed area covers 46 meters (150 feet) wide, 91 meters (300 feet) in front of the target, and 122 meters (400 feet) behind the target. This area should be cleared of all foreign objects such as rocks, stumps, and other obstructions. The strafe bed area should be level around the strafe targets, and all depressions and embankments (except the protective berm for the scoring transducer) should be eliminated.

Figure 1.8. Low Angle Conventional Range Strafe Bed Layout.



1.7.1.2. Drag Chute Target. The preferred low-angle strafe target is constructed from a salvaged aircraft drag chute and MA1A barrier webbing. This target requires two utility poles mounted about 21 meters (70 feet) apart and set in the ground 10 to 15 degrees from the vertical (leaning away from the foul line). See **Figure 1.9.** and **Figure 1.10.** Paint the bullseye and outer panels of the target to contrast with range terrain color. To ease replacing and hoisting the target in place, attach pulleys, eyes, or hooks to the rear of the poles. Route nylon rope, nylon strap, or armored cable through the pulleys, eyes, or hooks to a winch or cleat located at the rear of the poles. Support the top corner of each target with lines to separate winches or cleats. This feature provides a backup in the event one support line is shot away. This type of target may also be used for high angle strafe as long as the berm protecting the electronic scoring device is modified for the higher firing angle. Due to the different configuration of the protective berm, the low and high angle acoustically scored targets cannot be interchanged.

Figure 1.9. Drag Chute Target.

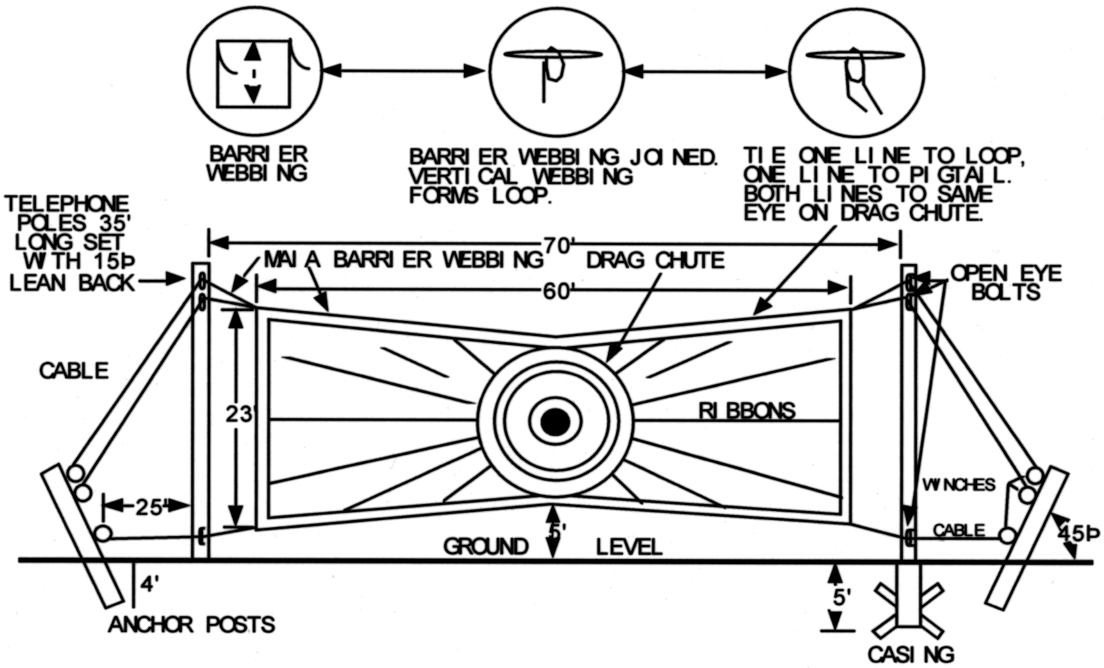
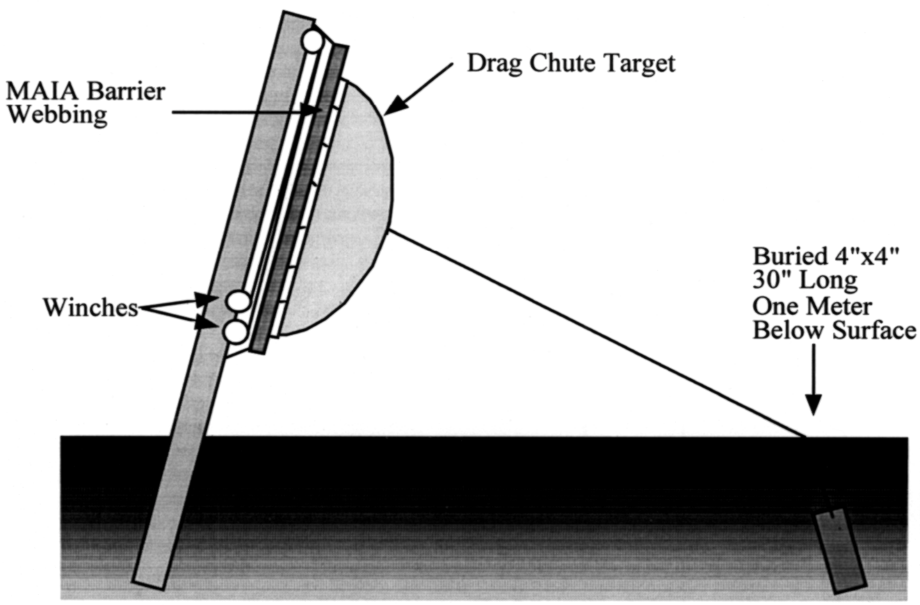


Figure 1.10. Side View of Drag Chute Target.



1.7.1.3. Other Strafe Targets. Panel strafe targets built of target cloth may be used for manual scoring if the electronic scoring system fails. Refer to the aircraft specific AFI 11-XXX series for target size and foul line distance criteria. Salvaged aircraft, vehicles (engine and transmission removed), or mock aircraft and tanks may be used for high-angle strafe targets. Do not use salvaged vehicles and aircraft as strafe targets when they are scored by the DA3/H/J acoustical scoring systems because debris from the target may damage the transducers.

1.7.1.4. Berm Construction. For DA3/H systems, place a berm approximately 8-9 feet long, approximately 4 feet wide, and 30 inches high in front of the target to protect the acoustic transducer. The aft side of the berm is approximately 80 to 104 inches from the target, if the target is in a vertical position. To construct the berm, railroad ties or 8 inch by 8 inch posts should be anchored and faced with 1/2 inch (or greater) plywood, 1 inch by 8 inch lumber, or other 8 inch by 8 inch posts to establish the berm bulkhead. Next, salvaged tires are stacked in front of the bulkhead and tied together to stabilize the berm construction. Then clean, loose sand or soil will be filled in over the stacked tires as shown in **Figure 1.11. Figure 1.12.** shows the position of the berm in relation to the target. For ease in maintenance, sides or wings may be fixed at a 30-degree angle to the bulkhead to prevent sand from spilling down the sides of the berm.

Figure 1.11. Top View of Strafe Berm.

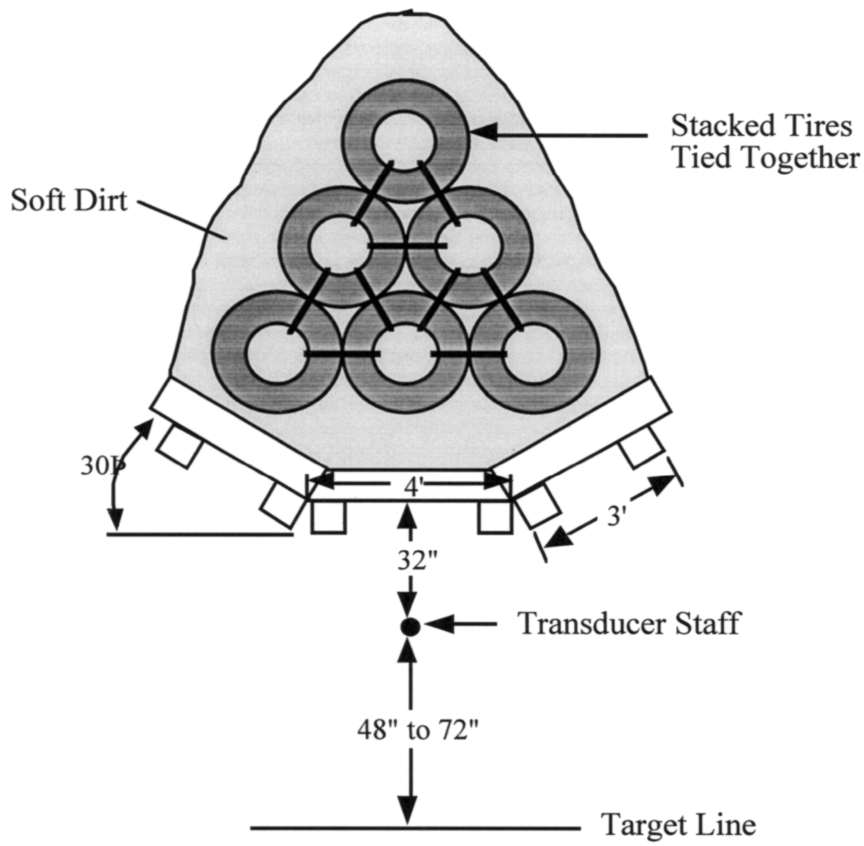
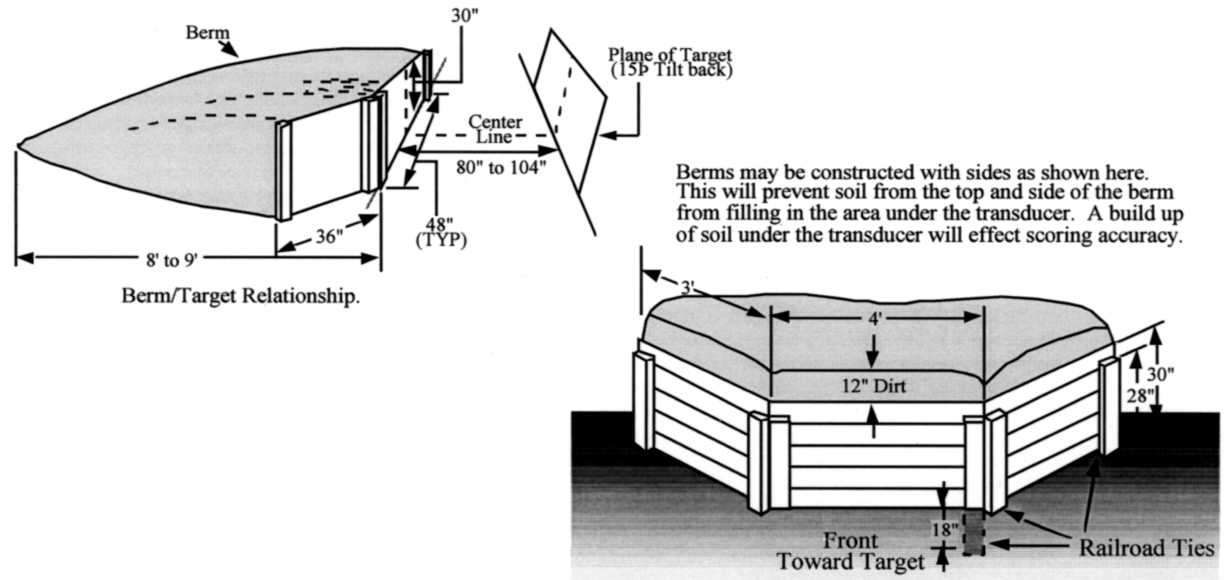


Figure 1.12. Berm/Target Relationship and View of Strafe Berm with Wings.



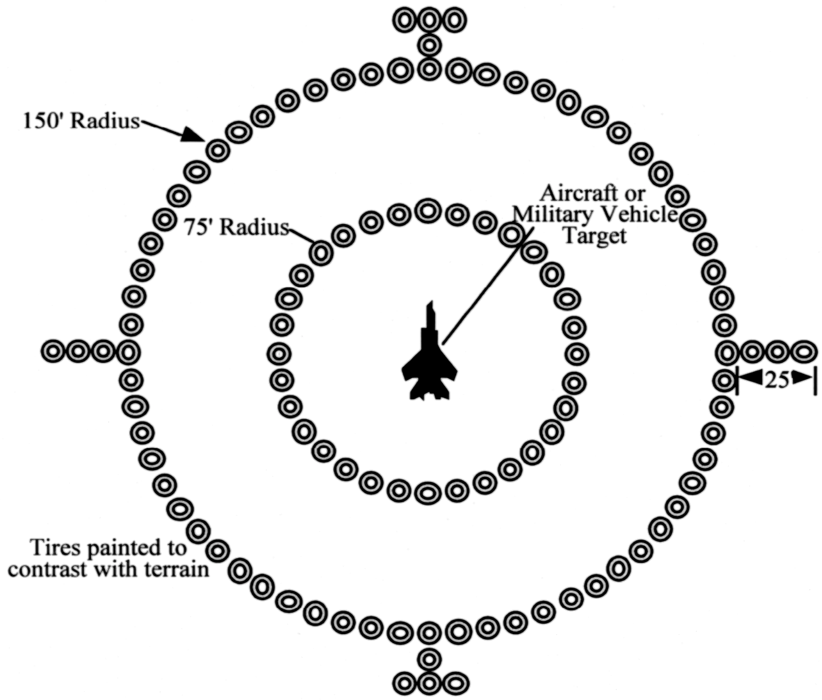
1.7.1.5. Run-in and Foul Lines. Construction techniques vary, depending on range conditions. Where practical, clearing and mowing normally provides sufficient contrast for run-in lines. If the run-in line is over forested area, the line must be wide enough to prevent the tops of trees from subsequently merging and obscuring it. Strafe run-in may require clearing to the same width as the entire strafe bed, depending on the height of trees, since targets are only 150 feet apart. In arid areas with little or no vegetation, run-in lines may be graded to a width of 4.5 meters (15 feet) to provide contrast. Also, tires (not preferred), barrels, or other items may be placed along the run-in line to eliminate the need for periodic grading. These items may be painted, if necessary, for contrast. In swampy areas where clearing and mowing is impractical, and where tires or other items would be overgrown, telephone poles with cleaned and painted 55 gallon drums mounted on top are viable alternatives. The same construction techniques work for foul lines. They also must be of high contrast, both from the air and from the control tower. If the foul lines are mowed or graded, create a definitive line with tires, barrels, etc., painted to contrast with terrain lines.

1.7.2. Conventional Bomb Target.

1.7.2.1. Layout. The placement of bomb targets on a conventional range is shown on the range layout diagrams found in this chapter. These targets can be used for dive bomb, low-angle bomb, high-angle bomb, high-angle strafe, and rocket events.

1.7.2.2. Construction. This target is normally outlined by two concentric circles constructed from large aircraft or truck tires, painted to contrast with the terrain (see **Figure 1.13.**). Reference lines of equal length, representing 3, 6, 9, and 12 o'clock, may be added. These lines should be oriented to the aircraft flight path and extend 7.6 meters (25 feet) beyond the outer edges of the large circle. Distances can be modified to coincide with qualification criteria as stated in the aircraft specific AFI 11-XXX series. The target circles may be bladed out with a bulldozer if the resulting cut affords a sufficient contrast with surrounding terrain. However, experience has shown that circles outlined with tires are superior from the standpoint of visibility and durability.

Figure 1.13. Conventional Target Layout.



1.7.2.3. Targets. The impact point is usually enhanced by using salvaged vehicles, aircraft, or joint modular ground targets. In some cases, pylon targets are used when vehicle targets are not available. The pylon targets are built using three salvaged telephone poles, 3 meters (10 feet) high, placed 3 meters apart, and in an equilateral triangle with the base of the triangle perpendicular to the normal run-in line. Salvaged automobile or aircraft tires are placed over the poles and painted to contrast with the terrain color.

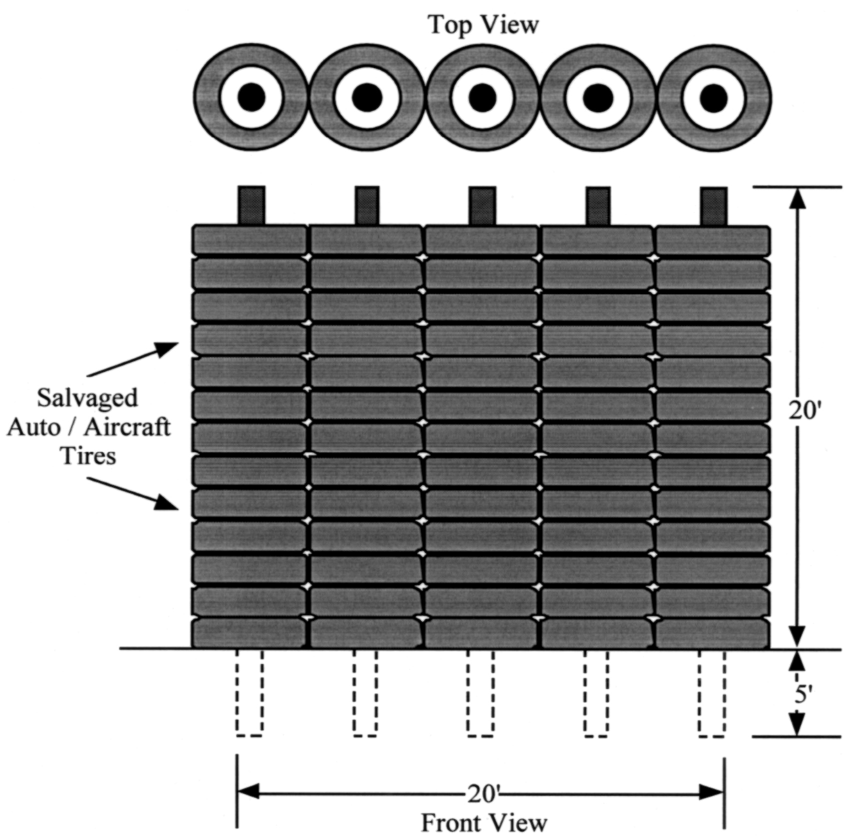
1.7.3. Tactical Targets.

1.7.3.1. Scenario Layout. Tactical ranges should be constructed using current intelligence threat data so that target arrays are realistic. Airfields, SAMs, AAA sites, industrial complexes, and FEBA targets can be used in various scenarios. As current intelligence is updated, threat scenarios and target locations can be changed. In this manner, aircrews are presented varying target scenes, and stereotyped training scenarios are minimized. To adequately replicate this threat would take a range with appropriate land and air space, ground targets, and simulated threats representing the different levels and types that would be faced in an actual situation. This might involve three different levels: a FEBA, the battlefield air interdiction area, and a strategic threat or deep interdiction area. Airspace in front of the FEBA should allow use of standoff aircraft such as AWACS, COMPASS CALL, etc.

1.7.3.2. Construction. Comply with the design analyzed during EIAP. Roads and airfields are simulated by the blading action of a bulldozer or grader, or by disk harrowing. The airfield may be outlined with industrial black tint mixed with water. The exact mixture ratio depends on the color and consistency of the soil. Salvaged or mock aircraft should be placed in bladed revetments around the airfield, on the taxiways, and on the runways. Command posts; supply installations; petroleum, oil, and lubricants (POL) storage areas; ammunition storage areas; and buildings may be simulated by bulldozing up mounds of earth, by using any type of available boxes, crates, or salvaged vans, or by building metal or wood frames that can be covered with old tent canvas, camouflage netting, or target cloth. Convoys may be simulated by salvaged vehicles or by constructing metal or wood-frame structures. Tracks with ties can be simulated by pouring industrial black tint mixed with water on a bladed roadbed. Missiles and guns can be simulated by using wooden poles of various diameter, plywood fins, or platforms. Where possible, collocate a simulation of the hostile threat environment (Smokey SAMs, simulated AAA, and communications jammers) with tactical ranges.

1.7.4. Simulated Nuclear Bombing Target. The SNWD target is normally 6 to 9 meters (20 to 30 feet) high and painted to contrast with the surrounding terrain to make it easy to see. The target is built using five salvaged telephone poles placed 1.52 meters (5 feet) apart, perpendicular to the normal run-in line. Salvaged auto or aircraft tires are placed over the poles. **Figure 1.14.** depicts a representative non-radar target that is satisfactory for SNWD ranges. The SNWD target circles should be plainly visible for airborne scoring purposes. The circles should be bladed at radii of 152 meters (500 feet), 305 meters (1,000 feet), 457 meters (1,500 feet), and 610 meters (2,000 feet). In some areas, these circles can be made by marking the circles with a one to two meter circle of lime.

Figure 1.14. Simulated Nuclear Target Construction.



1.7.4.1. Run-in Line. The run-in line should be bladed out to a width of about 4.5 meters (15 feet), and the IPs should be clearly visible from the aircraft. If the range is used for initial training in SNWD techniques, run-in lines and lateral offset lines are necessary. See **paragraph 1.7.1.5.** for construction techniques. However, if there are no run-in lines, more realistic training for experienced aircrews is achieved.

1.7.5. Applied Tactics Target. Another type of target found on conventional ranges is the applied tactics target. These targets are salvaged military vehicles and aircraft and are placed to provide an accurate scoring capability. The intent is to give more realistic training; therefore, no circles, run-in lines, or other markings are provided around the target, consistent with the need for fire breaks and scoring accessibility. The actual location of the applied tactics target on the range varies depending on range layout and ability to score, although the normal position is approximately 300 meters (1,000 feet) outboard of the conventional bombing circle. On dual ranges, this target could be the second conventional target if no circles, run-in lines, or other unnecessary markings outline the target.

1.7.6. Laser Targets. Any object discernible from the air can be used as a laser target. Salvaged vehicles, aircraft, heavy equipment, CONEX containers, and fabricated targets are all satisfactory. Prior to installing the target, it must be despecularized by removing all reflective or refractive materials. This can be done by removing glass, chrome and shiny metals. When removal is impractical, an alternative is to paint these surfaces with non-reflective paint. Laser targets should not be located near standing water or used if standing water is present, such as after a heavy rainfall.

1.7.7. Photo-Resolution Target. Photo-resolution targets are alternating black and white rectangles and are laid out on a range as depicted in **Figure 1.15.** The black rectangles are usually asphalt. The white rectangles are usually made of crushed rock, target cloth, painted asphalt, or painted concrete. These targets are normally used only to test or verify the performance of the photography equipment and aircrew proficiency.

Figure 1.15. Photo Resolution Target.

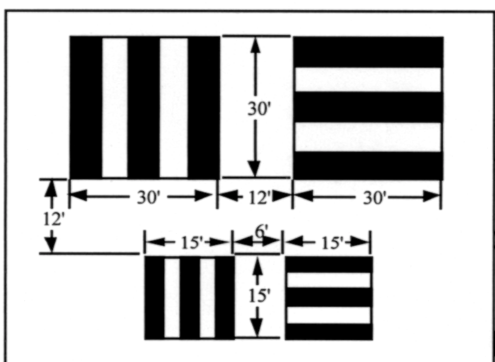


Photo-Resolution Target.

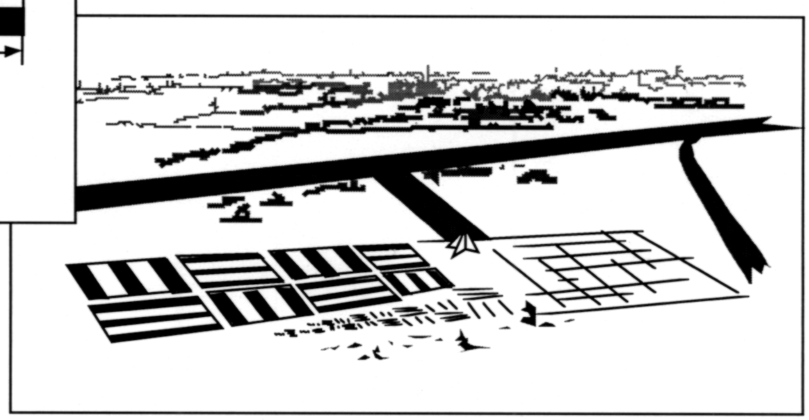
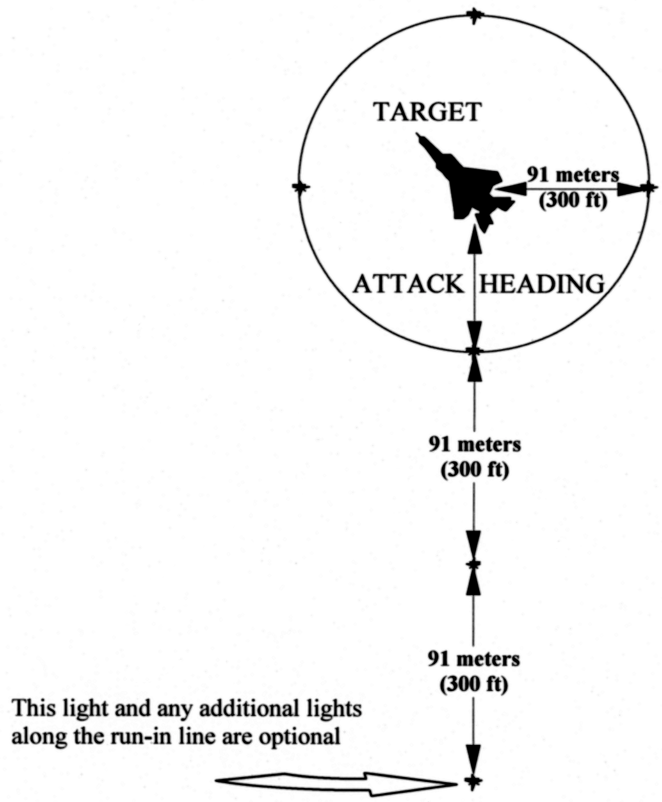


Photo-Resolution Target as Seen From the Air.

1.7.8. Night Lighting. The optimum ground marker arrangement for night weapons delivery is four lights placed 46 meters (150 feet) to 91 meters (300 feet) from the target at the 3, 6, 9, and 12 o’clock positions, plus one or more lights along the run-in line at the 6 o’clock position at 91-meter intervals (see **Figure 1.16.**). Night lighting can be done with propane lanterns or incandescent lamps. Incandescent lighting systems are efficient and simple to use; however, they require line and fixture installation plus additional power requirements. Bulbs of 50 to 75 watts give the required illumination when placed in weatherproof fixtures mounted on short posts and controlled by a rheostat. Propane lanterns may be used if incandescent lighting or electrical power is not available. Propane lanterns can supply the required illumination, but require increased maintenance and handling.

Figure 1.16. Night Lighting.



1.7.9. Targets for Side-firing Aircraft. As side-firing aircraft use the same ranges as other aircraft, targets are often the same. However, due to the accuracy and size of some weapons used (40 and 105 MM), it is often best to have certain targets designated as side-firing targets. These targets should be easy to construct and replace. For example, it may be possible to construct targets by bulldozing dirt into piles to resemble buildings or vehicles. Salvaged vehicles, particularly tanks, are excellent targets. Air-dropped smoke markers are used for targets on large water ranges; however, only minimum mission requirements are achieved on a water range. **Figure 1.17.** through **Figure 1.19.** illustrate target and flight pattern relationship.

Figure 1.17. Typical Fixed Wing Close Air Support Pattern.

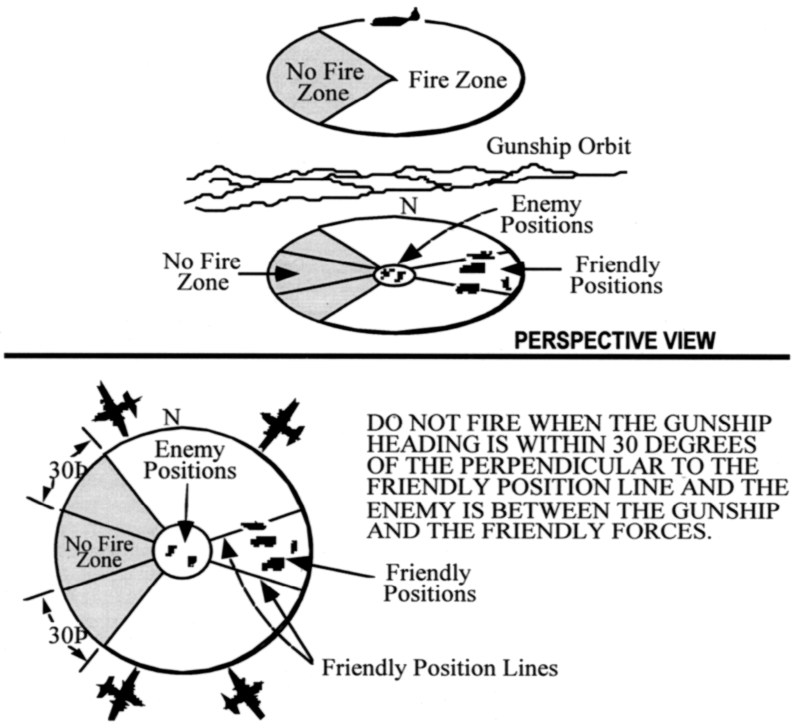


Figure 1.18. Typical Rotary Wing Box Pattern.

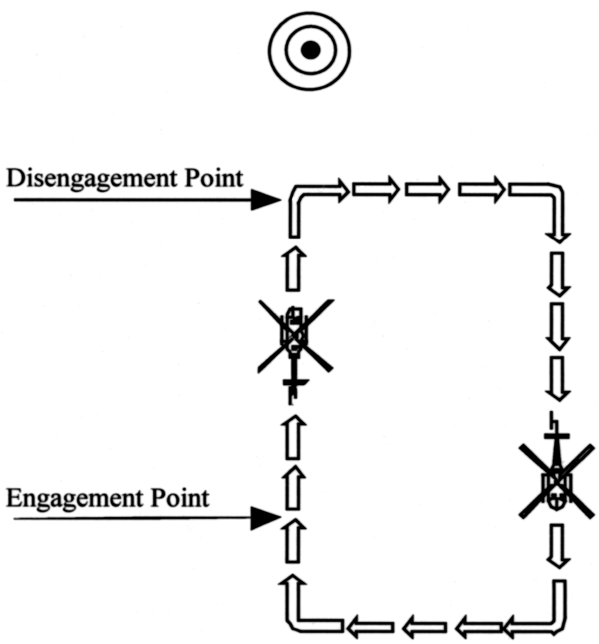
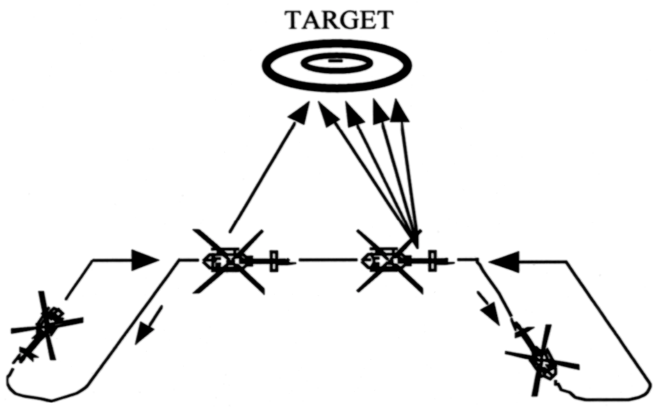


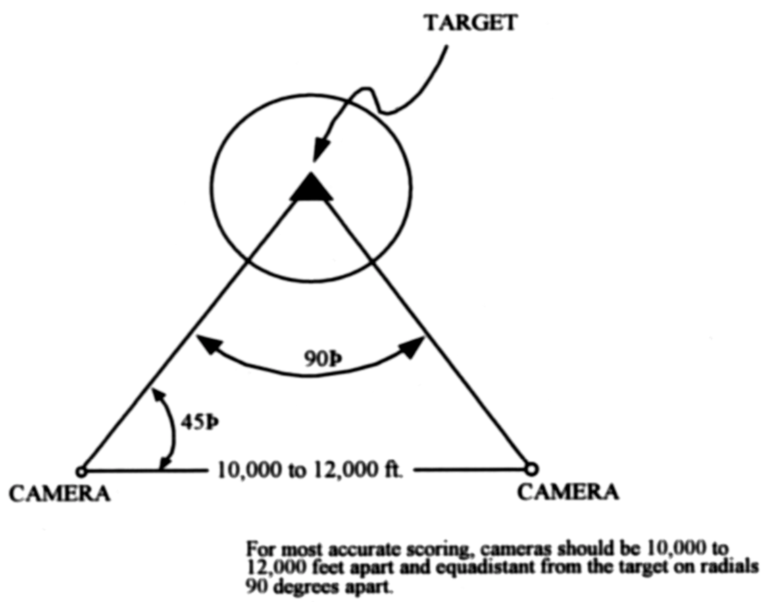
Figure 1.19. Typical Rotary Wing Dogbone Pattern.



1.8. Installation of Scoring Equipment .

1.8.1. Television Ordnance Scoring System (TOSS). The general layout of the TOSS is shown in **Figure 1.20.** It is recommended that the cameras be installed approximately two miles from the center of the scoring zone. A unique configuration of four types of support structures is required for each range. These include targets, calibration markers, surveyed aiming points (SAPs), and SAP markers.

Figure 1.20. TOSS Camera Arrangement.

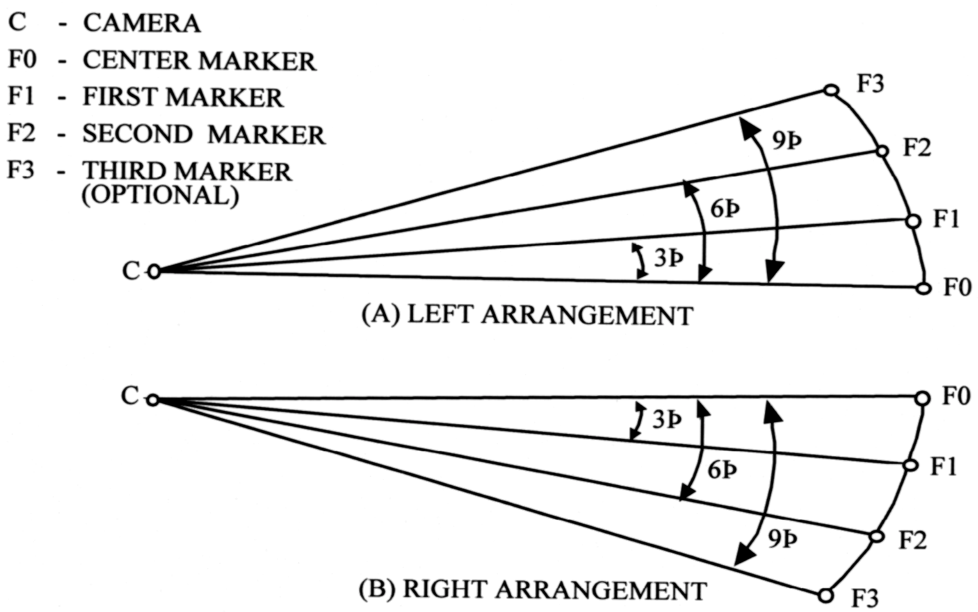


1.8.2. Surveyed Aiming Points (SAPs). SAPs are precisely surveyed points located within the field of view of each target area. Each SAP is marked by a flat, circular survey bench marker to accurately position targets, calibration markers, and SAP markers. Each SAP is assigned a target number that is greater than 100. These target numbers are listed in tabular format on the range map along with an X-Y coordinate of each SAP. The X-Y coordinates can then be used to locate a specific SAP on the range map.

1.8.3. Targets. Each target is assigned a number. Line targets, runways, and convoys are assigned target numbers from 1 to 15. Point targets, missiles, and tanks are assigned target numbers from 16 to 100. The target numbers are listed in tabular form on the range map along with an X-Y coordinate for each one. These coordinates can be input to the graphic calculator to locate specific targets on the range map.

1.8.4. Calibration Markers. Each camera is provided with three or four calibration markers (see **Figure 1.21.**) that are used to calibrate the camera's zoom lens. These markers include a center marker (F0) and two other markers (F1 and F2). Some sites may be provided a fourth marker (F3). Markers are installed between the camera and target area at locations that are site dependent. The angle between any two adjacent markers is 3 degrees when viewed from the camera. At some ranges, a calibration marker may also be used as a SAP marker.

Figure 1.21. Typical Calibration Marker Arrangement.



1.8.5. SAP Markers. Construct and install SAP markers so they can be easily recognized on the video monitor display at the control site. The television cameras are aimed at these markers while missions are being scored. Some markers are painted so the left half is black and the right half is white when viewed from the camera. The left edge of the white half is the center of the marker. Other markers are painted with a single black line to denote the center of the marker, which is used to align the scoring cursor during camera relocation or calibration procedures.

1.8.6. Equipment Locations. TOSS equipment may be located at four types of sites: main camera sites, flank camera sites, microwave repeater sites, and a control site. The number and locations of the equipment sites vary among ranges. The terrain, size, and physical layout of each range is used to determine how many of each type camera and microwave repeater sites will be required to support proper operation.

1.8.7. Camera Site. The main and flank camera sites contain the equipment required to relay a video image of the target area to the control site and provide remote control for the video cameras from the control site operator's console.

1.8.8. Control Site. The control site contains all the equipment necessary to control the operation of the TOSS and receive and display video from remote camera sites.

1.8.9. Repeater Site. Only install a microwave repeater site when required. Repeater sites may be required when the camera sites and the control site do not have line-of-site communications paths with each other. Additionally, they may be required when obstructions or great distances interfere with microwave data transmission and reception.

1.8.10. M-2 Aiming Circle. The M-2 should be mounted in the scoring towers on a rigid stand with a flat plate welded on the top of the stand. The flat plate should be slightly larger in diameter than the instrument base. A threaded receptacle in the base of the instrument allows firm attachment to the plate. An additional hole should be drilled through the instrument base and the stand plate to maintain alignment of the instrument with the target. A metal cover is provided with the aiming circle and should be used to protect the instrument when not in use. If used during laser operations, the M-2 should be equipped with a laser eye protection (LEP) filter, or personnel should wear a LEP. This is required even if the aiming circle is located outside the Nominal Ocular Hazard Distance (NOHD) as the magnification power of the aiming circle can significantly increase the NOHD. See **paragraph 2.4.5.1.** for information on plotting boards, scoring tables, and scoring drums that can be constructed for use with the M-2, if desired.

1.8.11. Transducer Installations for Acoustical Scoring Systems. **Figure 1.22.** shows a typical DA3H setup. If the range is to be equipped with an acoustical scoring system, proper installation is very important for protection of the system and to obtain accurate scores. **Figure 1.23.** shows a typical installation including dimensions. Installation and quality control checks can be facilitated if a template is used to assure proper placement. A diagram of the template is found at **Figure 1.24.** Once installed, and periodically thereafter, the accuracy of transducer placement should be checked and validated. This can be done by using a piece of target cloth measuring 12.2 by 7.6 meters (40 feet by 25 feet) with the scoring panel painted on it. See **paragraph 3.1.7.2.** for details on the scoring panel.

Figure 1.22. DA3H Typical Setup.

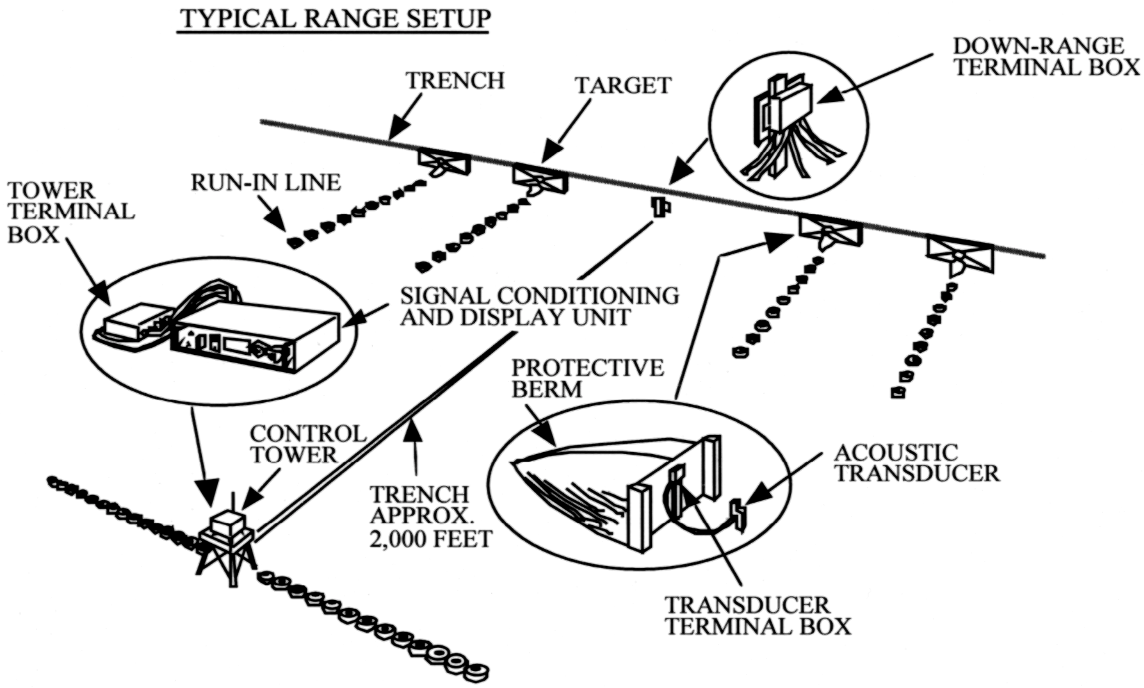


Figure 1.23. Typical Transducer Installation.

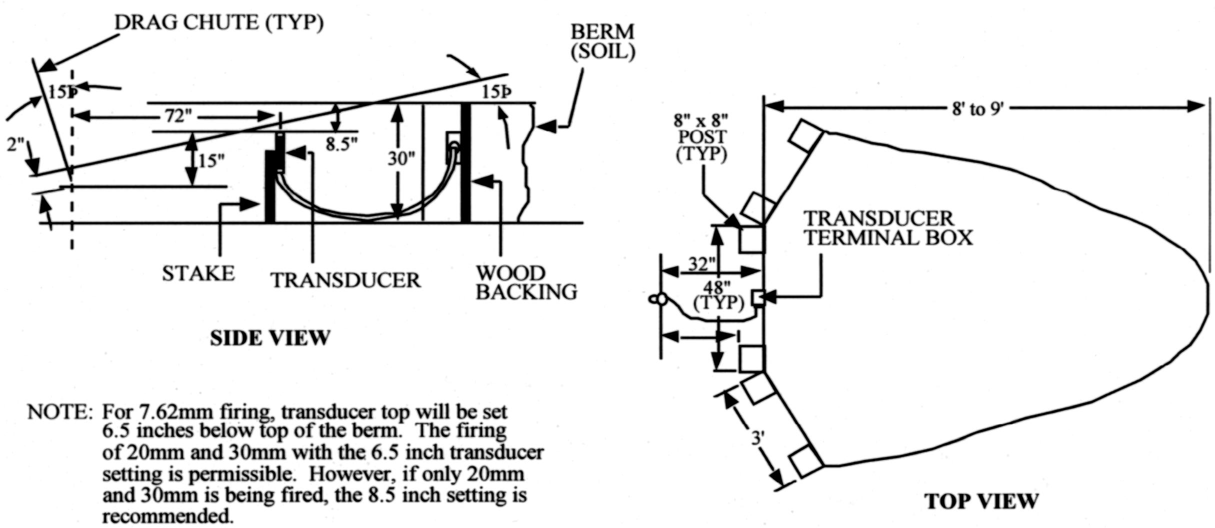
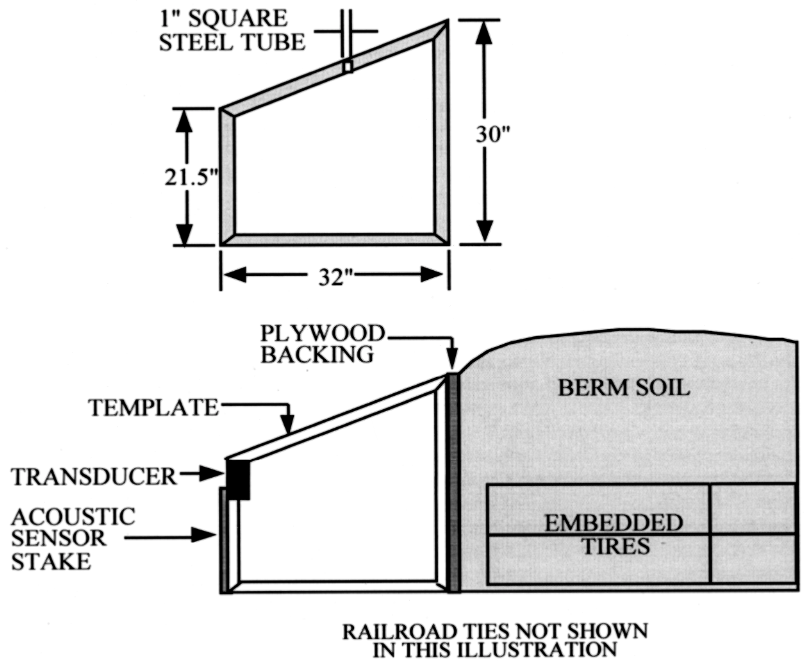


Figure 1.24. Transducer Template.



Chapter 2

SPECIALIZED EQUIPMENT AND SYSTEMS

2.1. Equipment To Simulate Enemy Threats.

2.1.1. Electronic Threat Emitters. Electronic threat emitters simulate certain enemy air defenses aircrews might face. They are intended to produce appropriate signals on aircraft detection and warning systems. Aircrews may then take appropriate evasive maneuvers or use other countermeasures, such as chaff, flares, or electronic signals. Threat emitters may be on a range near target arrays, on approach routes to ranges, or located to support a specific training scenario. Many of the threat emitters are mounted on vehicles so they may be relocated on a specific range or another range, if needed. They may also be used with visual threats and communications jamming. The use of threat emitters and countermeasures requires prior coordination and should be scheduled along with other range requirements.

2.1.2. Bombable Threat Emitters. Bombable threat emitters are usually smaller, self-contained units placed close to targets or used as targets. These units normally have a programmed signal they emit when turned on. Unless they are remotely activated, they are normally turned on and left on for the duration of the range period(s). They lack the flexibility of the staffed emitters but have the advantage of being able to be used where staffed emitters can not. This type emitter provides aircrews having a defense suppression mission more realistic training. These systems are lower in cost and emit a signal that is usually representative of a threat type, rather than a specific enemy threat. Limited measures, such as sandbagging or installation in hardened bunkers, may be taken to protect certain components of these systems to prolong their life and reduce costs.

2.1.3. Staffing. The largest number of threat emitters, simulating the widest variety of threats, are normally found with the staffed emitters. These are usually more adaptable in that signal strength, duration, and type may be changed by the controller. Often, ranges with these emitters have a scoring system built in that allows a measure of the effectiveness of some of the countermeasures used by the aircrews. These emitters are normally under command of a central controlling authority, and aircrews may request starting and stopping of the signals. These emitters vary in cost and sophistication. Low cost units, such as the Sentry Dawg, are directed optically. Others use radar, infrared, or other system direction. Some are designed to simulate a very specific threat, while others are designed to simulate general types of threats such as SAMs and AAA. Some emitters are self-contained and easily moved around the range, as previously mentioned. They require a minimum amount of site preparation and no external electrical power. Other systems are less mobile and need level, prepared sites capable of supporting considerable weight. These sites (or pads) may be concrete, crushed gravel, or compacted soil, as appropriate. These systems may also need external electrical power, communications and data links, and other utilities. Planners should keep these issues in mind when developing cost, staffing, and support needs.

2.1.4. Location. Choose emitter sites carefully. Locate them so that they can contribute to realistic training scenarios as much as possible. Also, locate them to ensure the emitter operator's safety and avoid equipment damage from ordnance deliveries. The sites must be reasonably accessible to transport emitters and provide utilities as needed. Include security measures such as fencing, surveillance cameras, alarms, and signs in the planning process.

2.1.5. Planning. In planning for these systems, the ROA must know the requirements of each range user. It is the responsibility of each user to notify the ROA when requirements change, but the ROA should periodically request users to forecast needs. Since there is a significant investment involved in procuring and operating threat systems, allow sufficient lead-time to establish priority (with other ranges), funding, procurement, and staffing. Estimates on priority and procurement lead-time can be obtained from HQ ACC/DOR, who is the executive agent of Combat Air Forces (CAF) range improvement requirements.

2.2. Ground Launched Visual Threats.

2.2.1. GTR-18A. The GTR-18A ground-launched rocket, SMOKEY SAM simulator (SSS), is used to simulate the actual launch of a SAM. The propellant produces a thick white plume of smoke as it propels the rocket to an altitude of 1200 to 1800 feet AGL before falling back to the ground. For optimum visual effect, the SSS should be launched in the pilot's 10-2 o'clock position. For safety, launch should occur 3-6 miles (depending on aircraft speed) in front of the aircraft. If fired when the aircraft is overhead, the aircraft must be at 2000 feet AGL or higher. The aircraft should never under-fly the rockets as the rockets may take 25-30 seconds to return to ground. ROAs must set up positive control procedures for qualified operators, and specify when these visual threat simulators can be fired.

2.2.2. PJU-7. The PJU-7 projectile is launched to simulate AAA air bursts against an aircraft. When fired, the charge propels the projectile to approximately 500 feet AGL where it separates into five segments. Each segment then ignites, producing a flash and smoke similar to AAA bursts. The AAA simulators are launched from the same four bay multiple launchers as the SSS. Both the Smokey Sam and AAA simulators are often used in concert to produce maximum visual simulation. The AAA simulators and Smokey SAMs are both explosives and require specific instructions for handling, storing, and transporting.

2.3. Communications. Communications jamming against aircrews is simulated to provide realistic training by disrupting communications between aircraft and between aircraft and the ground. Communications jamming equipment may be ground-based on the range or provided by aircraft specifically designed for that role. Regardless of the system used, establish procedures so that safety of flight communications are not jeopardized. Procedures must be established before take-off to allow certain radio frequencies to remain free of jamming, to allow essential communications or "Stop Buzzer" calls to be made and heard. Communications jamming will often be used with other types of simulated enemy threats to enhance training.

2.4. Scoring and Feedback Systems. Over the years, a number of methods have been developed to score targets. The method used depends on the type of target or weapon used and ranges from simple (counting holes in a strafe target), to complex (television cameras with microwave relays).

2.4.1. Air-to-Surface Targets. Air-to-surface targets may be scored by triangulation, with airborne scoring (mainly on unmanned ranges), or with electronics (optical or acoustical systems). Some of the more common systems are described in more detail below.

2.4.2. Mission Debriefing System. This is a sophisticated communications and telemetry system that is an air-to-surface enhancement to the ACMI system. This system provides a three-dimensional ground display that presents real-time aircraft maneuvers, systems employment, delivery parameters, and other critical information. Debriefing, performance measurement, and learning are significantly increased through real-time control and accurate recording of the mission. Due to the cost and geographic area needed for ground based systems, they are not cost effective for most ranges. The Air Force is moving toward rangeless/untethered instrumentation systems that do not require an extensive ground infrastructure. This will allow a greater proliferation of this type of training throughout the Air Force. Units with a projected need for instrumentation systems should submit the requirement through the MAJCOM for inclusion in the CTR program IAW AFI 13-212, Volume 1, *Range Planning and Operations*.

2.4.3. Joint Advanced Weapon Scoring System (JAWSS). This system upgrades the TOSS with a joint Air Force/Navy system and provides new night and laser scoring capabilities. JAWSS uses commercial, off-the-shelf technology to replace TOSS on air-to-surface ranges. Upgrade will provide greater accuracy, night and day scoring capabilities, laser scoring, strafe scoring, virtual reality Imaging Weapons Training System (IWTS), no-drop weapon scoring (NDWS), and automated remote feedback for home station debrief. JAWSS consists of five systems: Weapon Impact Scoring System (WISS), Laser Evaluation System - Mobile (LES-M), Large Scale Target Sensor System (LSTSS), Remote Strafe Scoring System (RSSS), and the Imaging Weapons Training System (IWTS).

2.4.3.1. Weapon Impact Scoring System (WISS): Tower mounted cameras capable of automatically scoring day/night weapon impacts to within three feet of accuracy. Operational control of WISS is via a Remote Operations Console that has connectivity via standard T-1 communication lines.

2.4.3.2. Laser Evaluation System - Mobile (LES-M): This system provides real-time, closed-loop feedback to aircrews to calibrate airborne laser designators with video crosshairs displayed in the cockpit. It provides real-time training feedback to the aircrew on the effectiveness of their crosshair placement on the target. LES-M transmits an UHF tone to the aircrew whenever the laser sensors on the ground are illuminated by a laser designator. This allows the aircrew to verify laser/crosshair boresight accuracy while airborne.

2.4.3.3. Large Scale Target Sensor System (LSTSS): Configuration consists of an actual laser seeker head, mounted in front of a simulated group of targets, which records actual laser spot during periods of laser designation and provides laser spot accuracy to within three inches. System will merge data with existing ACTS debrief stations to provide comprehensive feedback to the aircrew on their performance of using simulated laser guided munitions by providing no-drop weapon scoring.

2.4.3.4. Remote Strafe Scoring System (RSSS): Layers of acoustic sensors record the sonic wave of each supersonic projectile fired above the RSSS array to provide aircrew feedback on their strafe scoring attacks. RSSS provides data feedback on each round fired to include velocity, trajectory, and impact point to within three feet - hit or miss.

2.4.3.5. Imaging Weapons Training System (IWTS): Transceiver array on the range effectively emulates precision optically guided munitions flyouts from F-15Es, F-16s, and B-52s by emulating/manipulating the weapons data-link between the simulated weapon and controlling aircraft. Integration of weapon simulation models, digital terrain, and virtual reality targets provides a dynamic training environment to the aircrew. Day/night/weather conditions can be software controlled to meet evolving aircrew proficiency using optically guided munitions. Video monitor data is recorded for aircrew debrief which can be merged with comprehensive ACTS debrief monitors and displays.

2.4.4. TOSS. TOSS is a weapons delivery scoring system used on air-to-surface ranges. The system provides remote video scoring for single or multiple airborne ordnance deliveries against pre-placed ground targets. The bombing range target area is monitored by two or more precisely aimed and controlled television cameras. The cameras can tilt and pan, can be adjusted for varying light conditions, and can be focused by the operator from a remote location. The cameras may be installed up to several miles from the targets, depending on local environmental conditions. Besides the cameras, TOSS is made up of data transmission equipment (microwave, fiber optic, or coax cable) and the scoring console which consists of television monitors, a computer, and recording system. Because of the features listed below, TOSS is an excellent addition to any bombing range:

Uses off-the-shelf equipment

Real time scoring

Automatic computer scoring

Accuracy of 10 feet or less

Selectable target scoring

Aircrew debriefing provided via video cassette or hard copy print-outs

Only two people required to provide real time scoring or one person for delayed scoring

Remote site (cameras) power may be provided by solar power

Can be used for range security purposes as an adjunct to roving security patrols or other methods

2.4.4.1. TOSS Operations. TOSS uses simple geometry to compute scores. By using simple arithmetic functions and precisely measured angles and distances between the target and target complex cameras and designated mean points of impact (DMPIs), the computer will automatically calculate the miss distance and angle from the target. They accomplish this by superimposing a moveable, system-generated cursor over the picture on the monitor at the point where the flash from the spotting charge is seen. A scoring button is pushed, and the computer calculates the score. This is done using the pictures from at least two different cameras, giving the computer the angles needed to calculate the location of the impact. Operator technique is important to get consistently accurate scores. To reduce parallax, the operator should maintain the same position relative to the monitor when positioning the cursor. Contrast and brightness controls should be continually adjusted to produce the best picture possible, particularly when sun angles are troublesome. When grease pencils are used to mark bomb spots on the monitor screen, prior to moving the cursor, the operator should make light marks and keep the grease pencil as sharp as possible.

2.4.5. M-2 Aiming Circle. This is the most commonly used device for scoring on conventional ranges. The M-2 has many of the characteristics of a surveyor's transit. It is a precision-measuring instrument using a four-power, fixed-focus telescope. An M-2 is mounted on a rigid stand in the main and flank towers. The operator rotates the instrument to align the reference mark with the bomb flash or smoke and then reads the angle off from the target. The readings obtained from each M-2 are then used to calculate the score.

2.4.5.1. Scoring Computations. The development of the current computer-scoring program has allowed scoring with the M-2 to equal or exceed the accuracy of other scoring systems. This is due to the interpolation (up to 15 mils) necessary with plotting boards, scoring tables and charts, and scoring drums. The M-2 can be used to accurately measure to at least 1/2 mil which, when combined with the precise calculations of the scoring program, results in highly accurate scores. On a conventional range with the bomb circle located approximately 5000 feet from the towers, scores accurate to 2.5 feet, or approximately .75 meter, can be obtained. A plotting board for use with triangulation devices can be built using a scale of one inch equal to 30.5 meters (100 feet). This scale allows adequate accuracy in plotting. A plotting board is built by locating two tower positions at the top of the board and attaching a string to each tower position. The target is then drawn on the board with concentric circles out to the required distance listed below. From each tower position, arcs are then swung outside the largest diameter circle. Each arc is marked off in increments corresponding to the mil scale on the aiming circle with the target center (bullseye). A metal strip approximately three-quarters of an inch wide should be mounted along the outer edge of each arc. The string for each tower is attached to a magnet and held in position on the metal strip. This feature allows the scorer to readily align the strings with the corresponding tower plots. The primary limitation is the accuracy with which the plotting board can be engineered and drawn. Clock positions may also be shown around the larger circle. Plotting boards should be designed to give the following capabilities:

Conventional target scores, in 1.52 meter (5-foot) increments, from the center to a distance of 91 meters (300 feet).

Simulated nuclear target scores, in 3.05 meter (10 foot) increments, from the center to a distance of 152 meters (500 feet); and scores, in 9.1 meter (30-foot) increments between 152 and 608 meters (500 and 2,000 feet) from the target.

Scoring tables can be developed using the plotting boards, or can be computer-generated. The tables can then be placed under Plexiglas and a slide can be mounted on the Plexiglas face. With one tower's reading horizontally across the top and the other tower's reading vertically on the slide, the scoring crew merely moves the slide to the reading at the top and then looks vertically on the slide to find the score. Scoring drums are scoring tables glued to a large rotating drum. The drum is then covered, except for a narrow horizontal slit. The mil readings for one tower are across the face of the slit and the other tower's readings are on the edge of the table. The drum is then turned until the tower reading is on the left or right and the other tower reading is located on the face of the slit, thus obtaining a score. Computers can be used on-site to score and develop scoring tables, which use the inputs of distance between the towers and mil angle readings to the target from each tower. The score is then computed and printed for various mil increments. The score can be related to any clock position or related to a fixed run-in heading. This feature is beneficial for scoring tables on staffed Class B ranges. The ease with which the computer calculates and prints scoring tables enables the repositioning of the applied tactics targets without the drudgery of manually constructing boards on scoring tables. Calculators can also be used to score. A machine that prints the input information and the score is desirable. These programs have the position of each target as a function of the distance between scoring towers and mil angles to the target. Tower personnel insert the mil readings of the bomb impact and read the score. The calculator has an accuracy advantage because the bomb impact angle is entered to the nearest mil, as opposed to the 5- to 15-mil tolerances on the scoring charts.

2.5. Other Scoring Systems.

2.5.1. Airborne Scoring. Airborne scoring consists of the aircrew estimating the miss distance of the weapon from the target. Airborne scoring is facilitated if the aircrews have some type of ranging marks around the target or have information concerning various dimensions on the range about the target. For example, if a target is centered on a 61 meter (200 feet) wide runway, a hit half way between the runway center and edge results in a score of approximately 15 meters (50 feet).

2.5.2. Electronic Scoring. Electronic scoring of simulated bomb releases and impacts is done by computer calculations. An electronic tone is transmitted by the aircraft at the time of simulated weapon release. The computer uses the precise aircraft position, release parameters, and weapon ballistics to compute where the bomb would have impacted.

2.5.3. Sensor Scoring. Sensors implanted in the surface can register weapons impacts and provide a miss distance in relation to the target. For strafing, acoustical sensors located near the targets register the sound of the projectile passing through a prescribed area of space and record hits on what would have been a target. See **paragraph 1.8.11.** for construction and installation techniques for scoring equipment.

Chapter 3

RANGE MAINTENANCE

3.1. Target Maintenance.

3.1.1. Conventional Targets. The plowed or graded area around a conventional target must periodically be maintained to ensure contrast with the surrounding area. Prior to maintenance, the area must be cleared of expended weapons using normal decontamination procedures. After decontamination, the area should be cleaned of all vegetation. Tires (not preferred) should be painted and repositioned if required, and the area inside the 75 foot and 150 foot target circles should be bladed smooth. If salvaged vehicles or joint modular ground targets are used as targets, they should be replaced with newer vehicles as they become depleted from constant hits. If the target is the pylon type, they should be inspected each week to assure the tires do not need to be repainted or replaced. In addition, if any tire shows a high number of hits or is severely damaged, the pole under the tire should be evaluated for serviceability and need for replacement.

3.1.2. Simulated Nuclear Target (Class A Conventional Range). Simulated nuclear target areas need the same type maintenance as conventional targets. There are four different concentric target circles that must be marked in 500 foot increments starting at a radius of 152 meters (500 feet) and extending out to a radius of 610 meters (2,000 feet). Each circle may be outlined with two rows of tires (one black and one white), or if conditions permit, construct two approximately three feet wide circles (one with industrial black tint and one with lime). At some locations, blading alone may provide sufficient contrast to allow aircrews proper visual cues. The simulated nuclear target described under **paragraph 1.7.4.** requires little maintenance due to its construction and due to the weapons dropped on it. The tires may require periodic repainting or replacement due to hits by the smaller simulated weapons. Direct hits by heavy weight weapons may necessitate the occasional replacement of both tires and poles. Run-in lines must be cleared of vegetation and/or bladed to provide contrast with surrounding ground. IPs should be sufficiently marked to be readily identifiable from the air. Radar reflectors should be inspected on a regular basis to make sure they have not been damaged by premature weapon releases or normal deterioration, or become misaligned with the run-in heading.

3.1.3. Tactical Targets. Since the purpose of a tactical range is to give the aircrews realistic training, bomb circles, run-in lines, etc., are not required. However, the targets themselves, as they become severely damaged or destroyed, need to be repaired or replaced periodically to continue to provide appearance realism. Although the target area is not marked the same as a conventional range, it should still be maintained in appearance to look like the real target that it is supposed to simulate. Therefore, flat areas such as simulated roads and airfields will have to be kept clear of vegetation and bladed. Simulated SAM sites, AAA sites, and buildings will have to be straightened and the area around them cleared to appear as they should.

3.1.4. Photo Resolution Target. This type of target is a low maintenance target as the only wear and tear should be from nature or possibly vandalism. It will require clearing of brush or other vegetative growth; sweeping if dirt, leaves, or other trash is blown onto it by the wind; and a schedule for periodic repainting to provide the appropriate contrast. Over long periods of time the asphalt, concrete, or other construction material may deteriorate to the point where it may require patching or replacement, but this should be an infrequent task.

3.1.5. Restrictions on Target Materials. Salvaged cars, trucks, artillery pieces, tanks, aircraft, missiles, used dart targets, joint modular ground targets, or similar items add realism to the range and simplify target construction. Any military hardware (e.g. tanks, artillery, aircraft etc.) will be demilitarized before it is used as a target. Any vehicle used as a range target will have all fluids drained (except for a small amount of transmission fluid to permit the target to be dragged to the site). Batteries, hazardous materials, and radium dials (and other heavy metals present) will be removed and will be despecularized prior to its use as a target. All materials removed from potential targets will be disposed as required by local environmental procedures. All vehicles and aircraft used as strafing targets will have the dense metal portions (engines, transmissions, etc.) removed before being placed on the range. Salvaged aircraft and missiles may be obtained from the Aerospace Maintenance and Regeneration Center (AMARC).

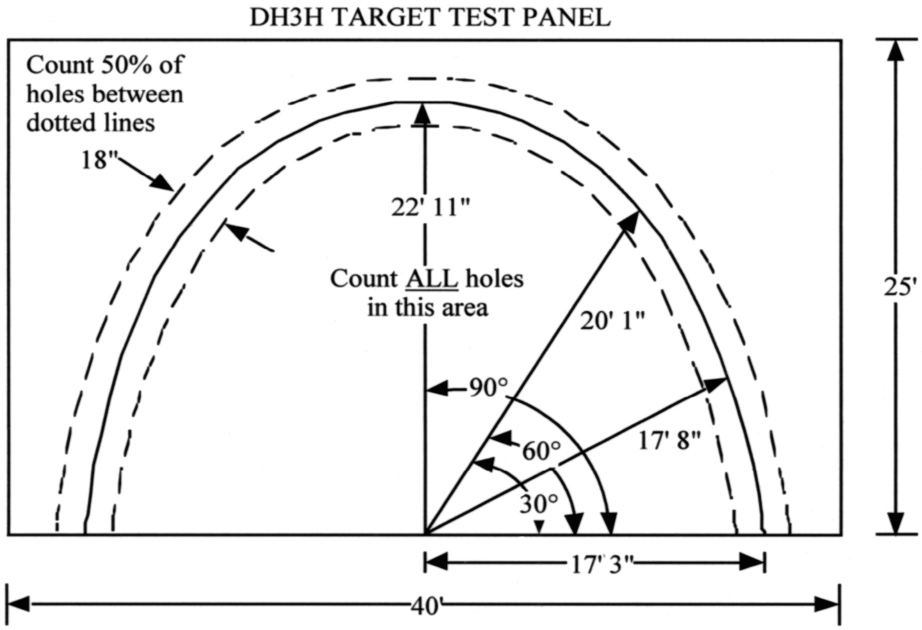
3.1.6. Salvaged Target Materials. Salvaged automobiles, trucks, tanks, artillery pieces and used dart targets can be obtained from a local source or the regional Defense Reutilization and Marketing Office (DRMO).

3.1.7. Conventional Range Strafe Beds. To reduce ricochet hazard, strafe beds require a routine maintenance schedule. The area around the strafe target should be maintained IAW AFI 13-212, Volume 1, *Range Planning and Operations*. In addition, to aid in projectile absorption in the ground, the following maintenance on the 100' by 350' strafe target area will be accomplished weekly or every 6 use-days. Disk harrow or chisel plow the area to keep the soil in a loose condition to the 12-inch depth. The disk harrow has a tendency to compress and harden the soil at maximum depth and fluff the soil on the surface. This reduces the moisture in the soil. The chisel plow will loosen the soil to the required depth without the drying effect of the disk harrow. When one pass of the chisel plow is not sufficient to loosen the soil to the 12-inch depth, the second pass should be at a 22-degree angle to the first pass, not 45 or 90 degrees. Standing water should not be allowed to gather in the strafe beds as this influences ricochets and invalidates the weapons footprints. Low spots should be filled in with loose sand or dirt. After using the disk harrow or chisel plow, use the magnetic sweeper or digger-strainer to remove subsurface debris. Other types of equipment may be used after approval is granted by the MAJCOM. To avoid settling into the soft soil, the magnetic sweeper will be equipped with wide tires. The digger-strainer operates best in fine sand and can be used even when the sand is wet. Use of the digger-strainer in loam or mixtures of sand and other soils is limited because the soil must be dry enough to sift through the holes in the conveyor belt. During periods of dry weather, this sifting action of the digger-strainer, plus the weekly disk harrowing, can rapidly turn the soil to powder, making the strafe target area unusable. Therefore, on some ranges, the use of the digger-strainer and disk harrow should be limited to those times of the year when this powdering effect will not occur. The decision to use the disk harrow, chisel plow, digger-strainer, or magnetic sweeper will be made by the ROA after considering such factors as the type of soil, condition of the soil in the strafe target area, and its moisture content. Depending on the soil condition and type of digger-strainer used, it may be more beneficial to use the digger-strainer before using the disk harrow or chisel plow. Additional inspection for debris will be necessary if the disk harrow or chisel plow is used last. In addition to the weekly maintenance, the following maintenance will be accomplished daily on the strafe bed area before the first strafe mission of the day. The area 23 meters (75 feet) in front of the target to 30 meters (100 feet) behind the target, including 15 meters (50 feet) either side of the centerline, and the areas around the berms and tops of the berms will be hand-policed. All hard objects 3" x 2" or larger, spent projectiles, and other hazardous debris will be removed. The RCO and/or range crew will inspect the target area after the hand-policing and before the first strafe mission of the day to ensure compliance with this requirement. If a scored strafe target is used only by aircraft that do not overfly the target or the target's 3 to 9 o'clock line or come closer than 500 feet horizontally to the target, then the strafe target does not have to be maintained in a level condition or require weekly loosening as described above.

3.1.7.1. Berm. A well-constructed and maintained berm is required to protect the acoustiscore transducer. The berm aids in preventing a build up of sand under the transducer that would negatively influence the acoustiscore's accuracy. The sand/dirt should be piled 12 inches above the highest part of the bulkhead (sloped away from the target toward the run-in heading) to protect the wood of the bulkhead. The bulkhead facing or at least the damaged part should be replaced anytime enough of it is shot away such that it is level with the supporting post, or deteriorates to the point that enough sand is leaking through to potentially influence transducer accuracy.

3.1.7.2. Acoustiscore. The DA3/H/J Acoustical Scoring System (acoustiscore) is a highly reliable and efficient scoring system, provided it is properly installed and maintained. Accuracy of the DA3H acoustiscore system can be checked by using a 25 X 40 foot panel made from target cloth and four inch nylon webbing (see **Figure 3.1.**). After an acoustiscore reading of at least 50 hits, count the holes in the target cloth and compare with the acoustiscore count. The acoustiscore will normally score slightly higher than actual count. A 15 percent difference is considered to be within tolerance. After installation and testing confirms proper operation, periodic maintenance and checks will confirm continued proper operation. Daily inspections for damage to the transducers, down range terminal boxes, cables, and connectors are required. The slot and microphone screen in the transducer should be inspected daily for dirt or other contamination and cleaned as necessary. After cleaning and installing the transducer at the target, the circuit continuity should be checked using the spring clip on a clipboard. Snapping the clipboard next to the transducer will record one hit on the signal conditioning display unit (SCDU). At least weekly, communications squadron personnel should check the SCDU controls for full and free movement, and use a test calibrator to perform a sensitivity test and make adjustments. At least bi-monthly, communications squadron personnel or Range Operations and Maintenance contractor personnel should check down range junction box terminal blocks for dirt, fungus, or moisture; wiring and cables for corrosion, cuts, deterioration, and signs of burning; and receptacles and connectors for damage, security of pins, contamination, and evidence of insulation breakdown. Targets and target supports will be replaced anytime more than one-fourth of the target or support is shot away. The target will also be replaced if any of the support lines has a hole that severs more than one-third of the strands on any one line. Run-in and foul line maintenance will be determined by how or what the lines are constructed of, which is determined somewhat by the terrain. Bladed lines only need occasional blading to keep them in condition. Lines formed by laying down salvaged automobile or truck tires (not preferred), salvaged 55-gallon drums, or railroad ties will need occasional straightening and painting, if contrast with the surroundings is needed. In addition, vegetation that has grown up around the railroad ties or in and around the tires will have to be removed. For those ranges in heavily forested areas, the removal of tall growth within the area of the run-in line may be sufficient. This may have to be controlled with cutting, as use of defoliants is now severely curtailed. This cutting should be done often enough to not only provide the required contrast, but to also facilitate ease of cutting.

Figure 3.1. Test Panel for Acoustiscore.



3.2. Equipment.

3.2.1. Vehicles. There are many types of vehicles required to operate and maintain the range. Some of these vehicles are used on a daily basis while others may only be used weekly, monthly, or less often. Kinds and types of maintenance required will vary with amount and conditions of use and even weather conditions. All vehicles will require the normal maintenance outlined in the service manuals. Due to dusty conditions or heavy use, more frequent oil changes, lubrications, oil and air filter changes, etc. may be required. Tires will require frequent inspection for damage and punctures. Vehicles should be covered or sheltered to protect them from environmental conditions when not in use.

3.2.2. Maintenance Equipment. Most types of equipment see regular service at ranges. Other types, such as fire fighting equipment may be infrequently used. Fire trucks require daily checkout/exercising. They and the water trailers require heated storage space to prevent freezing during cold weather. Other types of equipment should be protected from the weather and placed on a periodic maintenance schedule so that they never go for extended periods without normal preventive maintenance.

3.3. Specialized Equipment.

3.3.1. TOSS. The control site equipment for the TOSS is like any other computer/electronic equipment, it requires protection from excessive dust, heat, humidity, and vibration. Other than periodic cleaning of the videocassette recorder heads, the unit should only require maintenance when malfunctions are detected. The microwave linkage for the newer video and VHF camera control systems has proven successful and fairly trouble free. It eliminates problems associated with cables. Once camera mounting poles or towers are properly sited and unless the tower or camera is damaged, they require only periodic maintenance performed by qualified personnel. The cameras are calibrated by the operator prior to each scoring session using previously surveyed and permanently placed calibration markers. They may be reoriented between targets by focusing on strategically placed SAP markers. Both the calibration markers and SAP markers must be maintained by periodic painting, and they must not be moved or misaligned for the TOSS to retain its accuracy. If there is any doubt as to placement of a marker that has been knocked down, it should be resurveyed. Emitters and other threat simulators are normally self-contained units operated and maintained by qualified technicians or contractors. Emitters may have their own power supply and may be turned on to operate continuously or be manned and operated only upon direction. The technicians provide equipment checkout and maintenance while the RCO controls and communicates with the operators. The Smokey SAM and AAA threat simulators also come as self-contained units and are normally operated by two trained technicians. These personnel will prepare the launch site, set up the simulator, and perform the operational checks and routine in-the-field maintenance. Intermediate maintenance is usually performed in the shop back at a base. In-the-field maintenance is limited to simple cleaning of equipment and cleaning and tightening of electrical connections. Detailed operational and intermediate maintenance instructions can be found in T.O. 11L1-2-23-1, *Smokey SAM Simulator/Antiaircraft Artillery Visual Cueing System*. The RCO's primary concern should be positive communications with the crews and controlling the launch operations. Communications equipment normally consists of radios (both mounted and portable), field telephones, and regular telephones. This equipment has been time tested and is very reliable. Maintenance normally consists of performing operational checks on the system prior to use. Most maintenance, other than charging or changing batteries in portable radios and field telephones, will require services of qualified personnel. Field telephone wires can be checked for proper connection at the phones and for breakage or damage between phones. If available, spare radio power supplies, RT units, or control heads can be swapped out after external power is removed. Further maintenance requires qualified technicians.

3.3.2. Acoustiscore. Operation and maintenance of the DA3/H/J acoustiscore system is described in **paragraph 3.1.7.2.** Other, newer systems will have their own checking/testing procedures.

3.3.3. M-2 Aiming Circle. The M-2 aiming circle is a precision instrument, and if it is properly mounted, should give good performance with little maintenance required. The instrument should be covered when not in use for protection. As related equipment, such as scoring tables and drums are fairly simple to manufacture, extensive maintenance is not required. If computers or calculators are used, they should be provided the normal protection of any sensitive equipment of that type.

3.4. Facilities and Other Range Improvements.

3.4.1. Towers. Towers will be maintained to provide a safe working environment and enhance efficient operation. Windows will be kept clean and clear. If they become pitted, cracked, or broken, they should be replaced with similar glass. Environmental units must be maintained for operator comfort as well as to assure proper operation and protection of electronic equipment. Report any broken or unserviceable equipment to the responsible maintenance agency. Schedule the tower structure for routine maintenance to include inspection, repairs, and painting.

3.4.2. Maintenance and Administrative Areas. Periodic maintenance can improve productivity by helping facilities and equipment reach full service life expectancy. This includes routine exterior and interior wall repairs and painting for environmental protection and appearance enhancement. All electrical and plumbing malfunctions should be promptly isolated and repaired. Windows, doors, and environmental control systems should be maintained to protect the work area and any sensitive equipment. Repair or replace the roof to protect the structure and equipment against water leaks and damage. All workmanship should conform to established safety and building codes.

3.4.3. Storage Areas.

3.4.3.1. Vehicles and Equipment. The vehicle and equipment parking area should be improved (e.g. adding gravel over the existing ground). The area should be fenced for security. A covering of some type may be provided for the infrequently used equipment that will be kept there.

3.4.3.2. Materials. Materials used for either target construction or target and range maintenance facilities need to be protected. Material storage facilities need to be kept in good repair to prevent wind, water, or sunlight from damaging the materials. These storage facilities should be put on the same inspection and maintenance schedule as the towers and administrative buildings.

3.4.3.3. Hazardous Materials/Hazardous Waste (HM/HW). These storage facilities must be maintained to the highest standards for safety reasons and environmental protection. Depending on the hazardous material or waste amount and type, Air Force and government instructions place stringent requirements on storage containers, facilities, locks, etc. In some cases, there are maximum time limits between facility inspections and restrictions on how long materials can be stored. The ROA should contact the Base Civil Engineer to determine what can be stored on the range, how it must be marked, and any time limits associated with storage. This information will determine inspection schedules and maintenance standards. HM/HW substances are ignitable, corrosive, reactive, and/or toxic to living organisms. Examples are explosives, paint, paint thinner, petroleum products, insecticides, and herbicides. There are other materials that fall into these categories, so the ROA should request staff assistance from and maintain liaison with the base environmental office. Although the operating agency is ultimately responsible for environmental compliance at the range, it is up to the ROA to see that proper procedures are adhered to on a day-to-day basis. Personnel involved are the environmental protection committee, base civil engineer, bio-environmental engineer, environmental coordinator, staff judge advocate, and the supply, transportation, safety, and public affairs officers. Training requirements for range personnel include briefings on the type of HM/HW used and produced at the range, proper handling and storage, proper marking, and disposal procedures. Accumulation points (where HW may be stored for up to 90 days) must be established for used petroleum products generated as part of range operation and maintenance. Arrangements for periodic transportation to a permitted storage facility must be made. Build accumulation sites for expended munitions and storage facilities for pesticides and herbicides. Procedures must be established to handle and contain contaminate spills.

3.4.3.4. Roads and Grounds. Minimize range roads to the maximum extent possible. They should be kept free of all ordnance and other debris. Paved roads should be maintained to be free of potholes and other types of deterioration. Road shoulders should be maintained slightly below the pavement and sloped to drain water away from the road surface. Unimproved surfaces should be graded to maintain a relatively smooth surface free of potholes, washouts, and "washboard", and should support all weather traffic. If repair is beyond the capability of the range personnel or equipment, agreements should be arranged with the Base Civil Engineer to provide the maintenance or arrange for it to be performed under civilian contract. Inhabited areas of the range should be scheduled for periodic "policing" to remove unwanted debris and general clearing or mowing of excess vegetation. Debris should be collected and properly disposed of in accordance with local procedures. Excess vegetation may be removed by any approved method to include cutting, controlled burning, or environmentally approved defoliants. When unimproved surface roads are no longer required for range activities, they should be closed and restored to their natural habitat as much as possible.

3.4.3.5. Signs and Fences. Signs and fences provide demarcation lines between government and other land and provide warnings of unsafe conditions. Signs should be made of weather resistant material and paints, and lettering should be of suitable quality to resist fading, weathering, or other degradation. Signs should be consistent in size and appearance and have crisp, clear lettering that is clearly legible from a reasonable distance. When signs no longer meet these criteria, they should be replaced. Fences prevent large domesticated animals from straying onto the range, but should not jeopardize wild animal safety. Fences should receive routine inspection and maintenance. Any break should be promptly repaired with material consistent with the initial construction. Gates and locks should be continually inspected and repaired or replaced as required. To prevent sign or fence degradation, keep vegetation from overgrowing them so they can perform their intended purpose.

3.4.3.6. Fire Breaks. Fire breaks provide three way protection; they help keep fire from coming off the range onto the range, they help keep fires that start on the range from burning property off the range, and they can provide separation between portions of the range to help contain a fire. However, firebreaks only provide protection if they are maintained. Close watch must be maintained on the breaks to schedule clearing of vegetation before it becomes a hazard. Clearing involves removal of green, as well as dead, grass, leaves, limbs, and other combustible debris. Extra vigilance must be maintained during drought or extremely dry periods. Consult with installation, local, state, or federal fire experts to ensure the fire breaks provide appropriate protection.

Chapter 4

EQUIPMENT USED IN MAINTENANCE AND AEDA/RANGE RESIDUE CLEARANCE/DECONTAMINATION

4.1. Maintenance and AEDA/Range Residue Clearance/Decontamination Equipment. The type of equipment used for range maintenance and clearance/decontamination will depend on location and surface of the range. Some ranges are on desert soil while others may be on swamp land. The following are suggested ideas for ranges constructed on normal soil.

4.1.1. Practice Ordnance Targets. Equipment used to maintain and decontaminate these types of targets are normally standard vehicles found at any military base. Primary vehicles will be a front-end loader and a dump truck. The front-end loader "bucket" should be placed at a height so that workers have to reach up to drop debris into it. This will help protect the workers if any of the practice munitions go off as they are placed into the bucket. As the bucket is filled, it will be emptied into the dump truck for transport to an appropriate site. If reclamation/salvage operations are also being conducted, a heavy duty all terrain vehicle (ATV) pulling a modified utility trailer, containing skid boxes for separating scrap, is also very useful. ATVs with trailers are also useful when doing the complete range clearance described in AFI 13-212, Volume 1, *Range Planning and Operations*.

4.1.2. Conventional Range Strafe Beds. For strafe bed maintenance, a heavy tractor pulling a chisel plow or scarifying plow should be used to loosen the soil. A disk harrow may be used to supplement the process but should not be used as the primary device as it has a tendency to compress and harden the soil. After the chisel plow and/or disk harrow are used, the strafe target area should be swept with a magnetic sweeper equipped with wide tires to avoid settling into the soft soil. A digger strainer should be used periodically, when soil moisture content permits, to remove subsurface debris and rocks from the plowed soil. The digger strainer works well in loose soil and effectively cleans the strafe bed to a depth of 8 to 10 inches.

4.1.3. Live and Heavy Inert Ordnance. After these items have been declared safe or inert by the EOD supervisor, various equipment may be used to extract, load and transport them to salvage processing or disposal areas. Chains for dragging ordnance out, front-end loaders, tractors, trailers, dump trucks and other equipment may be used as required, depending on what is available.

Chapter 5

EQUIPMENT USED FOR ELECTRONIC WARFARE AND RADAR BOMB SCORING

5.1. ECR/ESS Equipment. Electronic Combat Ranges (ECRs) and Electronic Scoring Sites (ESSs) provide a means for training military aircrews in precision bombing, navigation, and electronic combat (EC). This includes passive/electronic equipment used for combat training in an Integrated Air Defense System (IADS) environment.

5.1.1. (RIIS). A secure communications system used to transmit real time mission information. to the RIIS Operations Center.

5.1.2. AN/TPQ-43 (SEEK-SCORE). An "I" band system that scores navigation and radar bomb scoring (RBS).

5.1.3. AN/MLQ-T4 (Ground Jammer). Simulates a radar jamming environment. It intercepts aircraft bombing, navigation, terrain avoidance, and terrain following radar (TFR) signals in "I" and "J" bands, and radiates selected countermeasures.

5.1.4. AN/MST-T1A (Multiple Threat Emitter System {MUTES}). MUTES provides Surface-to-Air Missile (SAM), Anti-Aircraft Artillery (AAA), and Airborne Intercept radar simulations.

5.1.5. AN/MSR-T4 (Threat Reaction Analysis and Indicator System {TRAINS}). A receiver that captures, records, and analyzes ECM.

5.1.6. AN/MST-T1V (Mini-MUTES). Mini-MUTES is a smaller, remotely located version of MUTES. One Master Control Group operates five Remote Emitter Units (REUs).

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Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

NOTE:
The user of this instruction is responsible for verifying the currency of the cited documents.

US Government Agency Publications

Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Terms*

Air Force Publications

AFDD 1-2, *Air Force Glossary*

Aircraft specific AFI 11-XXX series

AFPD 13-2, *Air Traffic Control, Airspace, Airfield, and Range Management*

AFI 13-201, *Air Force Airspace Management*

AFI 13-212, Volume 1, *Range Planning and Operations*

AFI 13-212, Volume 3, *SAFE-RANGE Program Methodology*

AFMAN 37-139, *Records Disposition Schedule*

T.O. 11L1-2-23-1, *Smokey SAM Simulator/Antiaircraft Artillery Visual Cueing System*

Abbreviations and Acronyms

AAA—Anti-Aircraft Artillery

ACC—Air Combat Command

ACMI—Air Combat Maneuvering Instrumentation System

ACTS—Air Combat Training Systems

AEDA—Ammunition, Explosives, and Other Dangerous Articles

AFI—Air Force Instruction

AFMAN—Air Force Manual

AFPD—Air Force Policy Directive

AFRC—Air Force Reserve Command

AFSOC—Air Force Special Operations Command

AGL—Above Ground Level

AMARC—Aerospace Maintenance and Regeneration Center

ANG—Air National Guard

ANGRC—Air National Guard Readiness Center

ATV—All Terrain Vehicle

CAF—Combat Air Forces

CTR—Combat Training Range

DMPI—Designated Mean Point(s) of Impact

DoD—Department of Defense

DRMO—Defense Reutilization and Marketing Office

EC—Electronic Combat

ECM—Electronic Counter-Measures

ECR—Electronic Combat Range

EIAP—Environmental Impact Analysis Process

EOD—Explosive Ordnance Disposal

ESS—Electronic Scoring Site

EW—Electronic Warfare

FAA—Federal Aviation Administration

FAC—Forward Air Controller

FEBA—Forward Edge of Battle Area

HM/HW—Hazardous Materials/Hazardous Waste

IADS—Integrated Air Defense System

IAW—In Accordance With

IOC—Initial Operational Capability

IWTS—Imaging Weapons Training System

JAWSS—Joint Advanced Weapon Scoring System

LEP—Laser Eye Protection

LES-M—Laser Evaluation System - Mobile

LSTSS—Large Scale Target Sensor System

MAJCOM—Major Command

MSL—Mean Sea Level

MUTES—Multiple Threat Emitter System

NEPA—National Environmental Policy Act of 1969

NDWS—No-Drop Weapon Scoring

NGB—National Guard Bureau

NOHD—Nominal Ocular Hazard Distance

OAP—Offset Aim Point

OPR—Office of Primary Responsibility

PDO—Publishing Distribution Office

POL—Petroleum, Oil, and Lubricants

RBS—Radar Bomb Scoring

RCO—Range Control Officer

REU—Remote Emitter Unit

RIIS—Range Integration Instrumentation System

ROA—Range Operating Agency

RSSS—Remote Strafe Scoring System

RTO—Range Training Officer

SAF—Secretary of the Air Force

SAM—Surface-to-Air Missile

SAP—Surveyed Aiming Point

SCDU—Signal Conditioning Display Unit

SECDEF—Secretary of Defense

SNWD—Simulated Nuclear Weapons Delivery

SSS—Smokey Sam Simulator

TFR—Terrain Following Radar

TIS—Tracking Instrumentation Subsystem

T.O.—Technical Order

TOSS—Television Ordnance Scoring System

TP—Training Projectile

TRAINS—Threat Reaction Analysis and Indicator System

T/TSNS—Test/Training Space Need Statement

UHF—Ultra-High Frequency

VHF—Very-High Frequency

WISS—Weapon Impact Scoring System

Terms

NOTE:
The purpose of this glossary is to help the reader understand the terms used in this publication. It does not encompass all pertinent terms. Joint Publication 1-02, *DoD Dictionary of Military and Associated Terms*, and AFDD 1-2, *Air Force Glossary*, contain standardized terms and definitions for DoD and USAF use.

Ammunition, Explosives, and other Dangerous Articles (AEDA) —Any substance that: by its composition or chemical characteristics, alone or when combined with other substance(s), is or becomes an explosive or a propellant; or is hazardous or dangerous to personnel, animal, or plant life, structures, equipment, or the environment as a result of blast fire, fragmentation, radiological or toxic effects.

Emitter, Simulator —Generic terms used to describe threat equipment operated at Electronic Combat Ranges (ECR) and Electronic Scoring Sites (ESS). However, ACC operates a variety of equipment including, but not limited to: Emitter only systems, Emitter-Receiver-Processors, and replica type systems. Carefully compare the similarities and features of different systems and consider operational requirements. Surface-to-Air Missile (SAM) and Anti-Aircraft Artillery (AAA) simulators include all manned and unmanned threat emitters.

Environmental Impact Analysis Process (EIAP) —The formal process, as outlined in the National Environmental Policy Act (NEPA), used to assess environmental impacts resulting from a proposed action.

Explosive Ordnance Disposal (EOD) —The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal or unexploded explosive ordnance. It may also include explosive ordnance that has become hazardous by damage or deterioration.

Government Controlled —Control exercised by any agency of the federal government, not just USAF or DoD.

Hazard Area —The area of a range defined by a composite of all weapon safety footprints for all authorized weapon delivery events, against targets located in a given sub-range or target complex. They encompass Target Areas, but do not include them.

Joint Use —With respect to ranges, Joint Use means other MAJCOMs or services may use, as long as they conduct operations IAW this instruction, as supplemented. With respect to range airspace, it means the use by civil or other military aviation when it is not active.

Major Command (MAJCOM) —A major subdivision of USAF assigned a major part of the Air Force mission. Major commands report directly to Headquarters United States Air Force (HQ USAF). The ANGRC/DO serves as the MAJCOM for Air National Guard ranges.

Ordnance

Training:

Boosted Munitions (forward firing)—Munitions such as the AGM-65 Maverick missile and the 2.75 folding fin rocket driven by propellant.

Full-scale Inert—Concrete-filled training bombs that match the full size and weight of the actual bomb. These bombs contain no explosives, pyrotechnics, or chemical agents.

Practice Bombs—Practice bombs may be full scale or miniature. Some practice bombs contain a small explosive charge or pyrotechnic that marks the point of impact with a small cloud of smoke or flash. For example, BDU-33 practice bombs contain a MK 4 spotting charge, and MK 82 practice bombs may contain 6.25 pounds of composition C-4 high explosive. British 1,000-pound class practice bombs may contain 50 pounds of TORPEX. These bombs normally use a fuse to initiate the high explosive fillers.

Training Projectile (TP)—Ammunition Ball projectile gun ammunition that has no explosive in the projectile.

Live Munitions:—Munitions containing a fuse and high explosive material designed to detonate either prior to or upon impact with the Target Area. Munitions range from bombs, to missiles, rockets, and bullets.

Radar Bomb Scoring (RBS) System —ECR/ESS equipment used to provide no-drop bomb scoring.

Range-Active —A military range that is currently in service and is being regularly used for range activities.

Range-ANG —For ANG ranges, the term range pertains to all buildings and property that is established by the lease, license, permit or other written agreement, for either exclusive or joint use by the ANG for weapons delivery operations.

Range-Inactive —A military range that is not currently being used, but that is still considered by the military to be a potential range area, and that has not been put to a new use incompatible with range activities.

Range-Military —Designated land, and water areas set aside, managed, and used to research, develop, test, and evaluate military munitions, other ordnance, or weapons systems, or to train military personnel in their use and handling. Ranges include firing lines and positions, maneuver areas, firing lanes, test pads, detonation pads, Target Areas, and Hazard areas. It includes the airspace above the range.

Range Control Officer (RCO) —The person responsible for range operations and safety. Except in situations where the RCO delegates weapons release clearance to a qualified flight lead, individual pilot or Forward Air Controller, or other briefed person.

Range Operating Agency (ROA) —The agency designated to operate and maintain the range. The ROA may delegate the daily scheduling, management, and maintenance of the range to any appropriate subordinate unit.

Range Residue —Material including, but not limited to: practice bombs; expended artillery; small arms and mortar projectiles; bombs and missiles; rockets and rocket motors; hard targets; grenades; incendiary devices; experimental items; demolition devices; berms; and any other material fired on, or upon a military range.

Range Service:

Class A—Range is manned, has a ground-based scoring capability, and has a Range Control Officer (RCO) on the ground who controls aircraft using the range.

Class B—Range is either manned or unmanned, has a ground-based scoring capability, but does not have a RCO on the ground controlling aircraft. The flight lead, individual pilot, FAC, or other briefed person performs the RCO function.

Class C—Range is unmanned, with no scoring or aircraft control from the ground. The flight lead, individual pilot, FAC, or other briefed person performs the RCO function.

Class D—An instrumented air-to-air range. It is manned by a Range Training Officer (RTO) who maintains radio contact with aircraft on the range during air combat training as required.

Range Training Officer (RTO) —The person responsible for monitoring ACMI/ACTS, passing kill removal, and providing debriefs. The RTO will establish communications with aircraft entering the range.

Residue Clearance —The removal or disposal of unexploded ordnance, classified ordnance, inert ordnance residue, training projectile debris, and other debris.

Restrictive Safety Easement —An agreement whereby USAF purchases the right to place restrictions on types and/or times of the landowner use.

Range Integration Instrumentation System (RIIS) —The primary mission of the RIIS is to support the ACC policy of sustained combat readiness by providing feedback in the form of graphic debriefing products. RIIS integrates all ESSs as well as some ECRs.

Shared Use —When participating (as defined by the using agency) and non- participating (civil or military) users share designated land and/or airspace areas on a noninterference basis.

Target Area —Target Area is the area on a range complex that immediately surrounds the target or designated mean point of impact. The Target Area demarcation should normally be no less than 1000 feet from the center of the target or designated mean point of impact.

Weapon Safety Footprint Area —A closed contour that defines the land area containing 99.99 percent (at a 95 percent confidence level) of all initial impacts and ricochets, resulting from the release of a specified weapon type during air-to-surface weapon delivery events.