

UNIFIED FACILITIES CRITERIA (UFC)

SMALL ARMS RANGES



APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UNIFIED FACILITIES CRITERIA (UFC)

SMALL ARMS RANGES

Any copyrighted material included in this UFC is identified at its point of use. Use of the copyrighted material apart from this UFC must have the permission of the copyright holder.

Indicate the preparing activity beside the Service responsible for preparing the document.

U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER CENTER

Record of Changes (changes are indicated by \1\ ... /1/)

Change No.	Date	Location

FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with [USD \(AT&L\) Memorandum](#) dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA). Therefore, the acquisition team must ensure compliance with the most stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

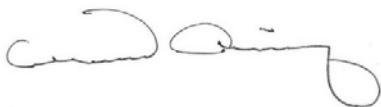
UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Civil Engineer Center (AFCEC) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: [Criteria Change Request](#). The form is also accessible from the Internet sites listed below.

UFC are effective upon issuance and are distributed only in electronic media from the following source:

- Whole Building Design Guide website <http://dod.wbdg.org/>.

Refer to UFC 1-200-01, *DoD Building Code*, for implementation of new issuances on projects.

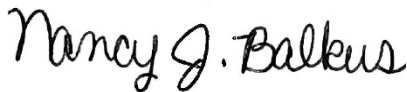
AUTHORIZED BY:



CHRISTINE T. ALTENDORF, PhD,
P.E., SES
Chief, Engineering and Construction
U.S. Army Corps of Engineers



R. DAVID CURFMAN, P.E.
Chief Engineer
Naval Facilities Engineering Command



NANCY J. BALKUS, P.E., SES
Deputy Director of Civil Engineers
DCS/Logistics, Engineering &
Force Protection (HAF/A4C)
HQ United States Air Force



MICHAEL McANDREW
Deputy Assistant Secretary of Defense
(Facilities Management)
Office of the Assistant Secretary of Defense
(Sustainment)

UNIFIED FACILITIES CRITERIA (UFC)

NEW SUMMARY SHEET

Document: UFC 4-179-02, Small Arms Range Criteria.

Superseding: Navy MIL HNDBK 1027/3B and Air Force ETL 11-18.

Description: This UFC-4-179-021 replaces the superseded documents above and provides Tri Service criteria applicable all new DoD indoor, outdoor, and steel close quarter combat small arms range facilities. This UFC establishes existing Army and USMC Surface Danger Zone criteria as Tri Service criteria and references other Department of Defense (DoD) range criteria where appropriate.

Reasons for Document:

- The new UFC updates and consolidates various service range guidance into one Tri Service document and addresses many areas not covered in existing DoD range criteria.
- The superseded documents included requirements that were inconsistent between each other and other service practices.

Impact:

This unification effort will result in more consistent requirements across DoD and will increase DoD range safety, improve training, and reduce costs in the following ways:

- Provides new and updated criteria that is consistent throughout DoD and a centralized source to share and apply lessons learned.
- Improves indoor range ventilation designs which in turn reduces the chance of overexposure to airborne contaminants.
- Improves indoor range noise attenuation designs which in turn reduces the impacts of harmful noise to personnel at the range.
- Highlights exterior noise concerns and thus reduces noise to neighboring areas.
- Increases awareness of indoor range options and capabilities. This allows for facilities that improve training to warfighters.
- Provides criteria on steel CQC facilities which is currently absent in DoD.
- Provides suppliers with consistent standards thus simplifying procurement of range equipment for both DoD and contractors.

Unification Issues:

General:

Several service specific planning and layout requirements are included since:

- The Army has extensive planning criteria for outdoor ranges. The Air Force has detailed planning requirements for the indirect support area of indoor ranges. The Navy has no separate range planning criteria.
- Training requirements vary between the services, and this dictates different range requirements and layouts.

Outdoor ranges:

The Army, Navy, and USMC use DA PAM 385-63 and MCO 3570 for SDZ criteria. The Air Force uses horizontal distances listed in these criteria but different distances for the vertical component of the Surface Danger Zone. A separate table with vertical components is included for Air Force use.

Services have different access, signage, and marking requirements. A statement is made to use service installation guidance.

The Army, USMC, and Air Force allow machine gun training on tube ranges. These tube ranges do not support traverse firing that is required for maritime machine gun training. A statement is made not to use tube ranges for Navy machine gun qualifications.

Indoor Ranges:

The Navy and Air Force do not use rubber traps on new ranges due to fire and maintenance issues experienced with rubber traps on several existing ranges. The Army and USMC use rubber traps as an option. Service specific guidance is provided.

The Air Force requires a raised floor in the range control booth. The other services do not. A note is included to use raised floors on Air Force projects.

CQC Facilities and Shoothouses:

The Army allows an option to glue splatter protection directly to the ballistic panels in steel shoothouses. The Navy requires an air gap between steel panels and the splatter protection to facilitate inspections and to increase the life of the splatter protection. Service specific guidance is provided.

The Army uses Shock Absorbing Concrete (SACON) as an option for ballistic walls, and does not require a ballistic roof when an SDZ waiver is obtained. The Navy only uses steel shoothouses with steel ballistic panels and overhead ballistic containment. This criteria only covers steel shoothouses with a ballistic roof and refers to Army when designing SACON shoothouses.

This Page Intentionally Left Blank

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION	1
1-1 PURPOSE AND SCOPE	1
1-2 APPLICABILITY	1
1-3 OTHER CRITERIA	1
1-3.1 General Building Requirements.....	1
1-3.2 Antiterrorism and Security.....	1
1-3.3 Sustainability.....	1
1-3.4 Service Specific DoD Range Criteria.....	2
1-3.5 Army Ranges.....	2
1-3.6 Non-Standard Ranges.....	2
1-4 CYBERSECURITY	2
1-5 BEST PRACTICES	2
1-6 WEAPONS AND AMMUNITION	2
1-7 GLOSSARY	2
1-8 REFERENCES	2
CHAPTER 2 GENERAL	3
2-1 PLANNING	3
2-2 BASIS OF DESIGN	3
2-3 MATERIAL	4
2-3.1 Concrete.....	4
2-3.2 Ballistic and AR500 Steel Plate.....	4
2-3.3 Splatter Protection for Overhead Baffles and Safety Ceiling.....	4
2-3.4 Splatter Protection for Steel CQC Facilities.....	5
2-4 AIR FORCE RANGES	5
2-4.1 Firing Line Positions and Platforms.....	5
2-4.2 Position Numbering.....	5
2-4.3 Position Barricades.....	6
2-4.4 Firing Line.....	6
2-4.5 Light Anti-Tank Weapons (LAW) and 40 mm Grenades.....	6
2-5 ARMY AND USMC RANGES	6
CHAPTER 3 OUTDOOR RANGES	7
3-1 PLANNING AND DESIGN	7

3-2	SURFACE DANGER ZONES.....	7
3-2.1	Air Force Ranges.....	7
3-2.2	Access Restrictions, Warning Signs, Markers, and Flags.....	10
3-2.3	Surface Danger Zones Over Navigable Water.....	10
3-2.4	Baffled Ranges.	10
3-3	TYPES OF OUTDOOR RANGES.	10
3-3.1	Single Fixed Firing Line.	10
3-3.2	Multiple Firing Lines.....	11
3-3.3	Maneuver Areas.	11
3-3.4	Skeet and Trap Ranges.....	11
3-4	SITING.....	11
3-4.1	Mandatory Requirements and Issues to Address.	11
3-4.2	Considerations.....	11
3-5	SUPPORT FACILITIES.....	12
3-5.1	Roads and Parking.	12
3-5.2	Utilities.	12
3-6	GEOMETRY FOR NAVY AND AIR FORCE RANGES.....	13
3-6.1	Measurement Control.	13
3-6.2	Target Centers.....	13
3-6.3	Lanes.....	13
3-6.4	Range Length.	13
3-7	GEOMETRY FOR ARMY RANGES.....	14
3-8	RANGE COMPONENTS.....	14
3-8.1	Drainage.....	14
3-8.2	Floor Surface.....	14
3-8.3	Benches.....	14
3-8.4	Bleachers.....	14
3-8.5	Obstacles.....	14
3-8.6	Range Safety Officer Position.....	15
3-8.7	Towers.....	15
3-8.8	Overhead Cover.	15
3-8.9	Lateral Limit Markers.	15
3-9	IMPACT BERMS.....	15

3-9.1	Geometry.....	15
3-9.2	Berm Material.....	16
3-9.3	Berm Construction.....	17
3-10	TARGET SYSTEMS.....	17
3-10.1	Target Systems for Army Ranges.....	18
3-10.2	Target Line Grading and Protection.....	18
3-10.3	Target Supports and Berms.....	18
3-10.4	Butt Target System.....	18
3-11	PARALLEL RANGES.....	19
3-12	MACHINE GUN TUBE RANGE.....	19
3-12.1	Surface Danger Zone.....	20
3-12.2	Machine Gun Tubes.....	20
3-12.3	Drainage.....	20
3-12.4	Firing Platform.....	20
3-12.5	Berm Backstops.....	20
3-12.6	Noise.....	21
CHAPTER 4	INDOOR RANGES.....	23
4-1	GENERAL.....	23
4-1.1	Coverage.....	23
4-1.2	Range Areas.....	23
4-2	TRAINING AREA.....	23
4-3	DIRECT SUPPORT AREA.....	24
4-3.1	Range Control Booth.....	24
4-3.2	Airlock Vestibules.....	25
4-3.3	Vacuum Storage.....	25
4-3.4	Brass Storage.....	25
4-4	TRAINING AND DIRECT SUPPORT AREA LAYOUT.....	25
4-5	INDIRECT SUPPORT AREAS.....	29
4-5.1	Required Indirect Support Area.....	29
4-5.2	Other Indirect Support Areas.....	29
4-6	FIRE PROTECTION.....	30
4-7	COLLECTION, TEMPORARY STORAGE, AND DISPOSAL.....	30
4-8	STANDARD INDOOR RANGE FEATURES.....	30

4-9	MULTIPLE BAYS.....	31
4-10	CEILING, WALLS, AND DOORS.....	31
4-10.1	Uprange Ceiling and Wall Behind Firing Line.	31
4-10.2	Ballistic Side and Downrange Walls.	31
4-10.3	Wall Joints.	32
4-10.4	Downrange Doors.....	32
4-10.5	Maintenance and Vehicle Entrance.	32
4-11	FLOORS.....	32
4-12	RANGE MARKINGS.	33
4-13	TARGET SYSTEMS.....	33
4-13.1	Static Target Stands.	34
4-13.2	Overhead Target Rail System.....	34
4-13.3	Running Man Targets.	34
4-13.4	Fixed Turning Targets System.....	34
4-14	SHOOTING STALLS.....	35
4-15	BARRIERS AND BARRICADES.	35
4-16	OVERHEAD BAFFLES AND SAFETY CEILING.....	35
4-17	BULLET TRAPS.	36
4-17.1	Cantilevered Upper Ramp Support.....	37
4-17.2	Dust Collection System.....	37
4-17.3	Spent Round Collection System.	37
4-17.4	Granular Rubber Trap Option.	38
4-18	COMMUNICATIONS.	39
4-19	LIGHTING.....	39
4-19.1	Range In Use Lights.	40
4-19.2	Security Training Lights.	40
4-19.3	Emergency Lighting.	40
4-20	NOISE.....	40
4-20.1	Noise to Adjacent Land.....	41
4-20.2	Noise Inside the Training Area.....	41
4-20.3	Acoustical Treatment Locations.....	41
4-20.4	Acoustic Panels.	41
4-20.5	Acceptance Testing.	42

4-21	RANGE VENTILATION.....	43
4-21.1	General Ventilation Requirements.....	43
4-21.2	Climate Control.....	44
4-21.3	Supply Distribution System.....	45
4-21.4	Exhaust System.....	45
4-21.5	Controls.....	46
4-21.6	Acceptance Testing.....	47
4-22	RANGE OPTIONS.....	48
4-22.1	Relocatable Ranges.....	48
4-22.2	Combination Fixed and Tactical Range.....	49
4-22.3	Steel Reactive Range.....	50
4-22.4	Wide Angle Shooting.....	51
CHAPTER 5	STEEL CLOSE QUARTER FACILITIES.....	53
5-1	GENERAL.....	53
5-1.1	Applicability.....	53
5-1.2	Items Not Addressed.....	54
5-1.3	Design.....	54
5-2	RANGE AREAS.....	54
5-2.1	Live Fire Area.....	54
5-2.2	Direct Support Areas.....	55
5-3	EQUIPMENT AND SPECIAL EFFECTS.....	55
5-4	TARGET SYSTEMS.....	55
5-5	ALARMS.....	56
5-6	FIRE PROTECTION.....	56
5-7	LIGHTING AND ILLUMINATION.....	56
5-8	NOISE.....	56
5-9	LASERS.....	56
5-10	BALLISTIC PROTECTON.....	57
5-10.1	Ballistic Walls.....	57
5-10.2	Ballistic Roofs and Decking.....	57
5-10.3	Exterior Openings.....	57
5-10.4	Army Shootouses.....	58
5-11	CATWALKS.....	58

5-12	VENTILATION.....	58
5-12.1	Air Flow Requirements.	59
5-12.2	Design Documents.	59
5-12.3	HEPA Filters.	59
5-12.4	Contractor Experience.	60
5-12.5	Acceptance Tests.	60
5-13	ENCLOSED CQC FACILITIES.	60
5-13.1	Top to Bottom Ventilation System.....	60
5-13.2	Across-the-Top Ventilation System.....	61
5-14	CQC FACILITIES WITH OPEN EAVES.....	61
5-14.1	Minimum Distances.	62
5-14.2	Ventilation.	62
APPENDIX A BEST PRACTICES		63
A-1	INDOOR RANGE VENTILATION CONTRACTING STRATEGY.....	63
A-1.1	Phase 1 – Requirement Development.	63
A-1.2	Phase 2 - Ventilation Contractor Requirements.....	65
APPENDIX B DOD WEAPONS AND AMMUNITION		67
B-1	WEAPONS.....	67
B-2	CATEGORIES OF SMALL ARMS AMMUNITION.....	67
APPENDIX C GLOSSARY		69
C-1	ACRONYMS.....	69
C-2	DEFINITION OF TERMS.....	71
APPENDIX D REFERENCES.....		74

FIGURES

Figure 3-1	Impact Berm.....	16
Figure 3-2	Butt Target System.....	19
Figure 3-3	Machine Gun 10-Meter Tube Range Layout	22
Figure 3-4	Machine Gun 10-Meter Tube Range Section	22
Figure 4-1	Standard Range Layout.....	27
Figure 4-2	Standard Range Section.	28
Figure 4-3	Overhead Baffles.....	36
Figure 4-4	Range Ventilation Schematic.....	44

Figure 4-5 Range with Ballistic Divider Walls 50
Figure 4-6 Steel Reactive Range..... 51
Figure 5-1 Top to Bottom Ventilation System Schematic. 61
Figure 5-2 Across-The-Top Ventilation System Schematics. 61
Figure 5-3 Ventilation System Supplemented with Natural Airflow..... 62

TABLES

Table 3-1 Air Force Minimum VDZ Height Requirements 8
Table 4-1 Range Heights and Get Ready Area Distances..... 29
Table 4-2 Lighting Requirements..... 40
Table 4-3 Maximum Noise Levels 43

This Page Intentionally Left Blank

CHAPTER 1 INTRODUCTION

1-1 PURPOSE AND SCOPE.

This Unified Facility Criteria (UFC) provides requirements for DoD small arms range facilities.

1-2 APPLICABILITY.

This UFC applies to the planning, design, and construction of DoD indoor, outdoor, and steel Close Quarter Combat (CQC) small arms range facilities worldwide. CQC facilities are also known as shoothouses.

1-3 OTHER CRITERIA.

1-3.1 General Building Requirements.

Comply with UFC 1-200-01, DoD Building Code. UFC 1-200-01 provides applicability of model building codes and government unique criteria for typical design disciplines and building systems, as well as for accessibility, antiterrorism, security, high performance and sustainability requirements, and safety. Use this UFC in addition to UFC 1-200-01 and government criteria referenced therein.

1-3.2 Antiterrorism and Security.

UFC 4-020-01 supports the planning of DoD facilities that include requirements for security and antiterrorism. Use UFC 4-020-01 in conjunction with UFC 4-010-01 to establish the security and antiterrorism design criteria that will be the basis for DoD facility designs. All DoD facilities must also comply with Geographic Combatant Commander antiterrorism construction standards for antiterrorism requirements.

1-3.3 Sustainability.

For indoor ranges, the indirect support areas must meet UFC 1-200-02. The design of the training and direct support areas is driven by containment and ventilation criteria and must meet UFC 1-200-02 to the extent practical.

1-3.4 Service Specific DoD Range Criteria.

- AR 350-19.
- AR 350-52.
- DA PAM 385-63.
- TC-25-8.
- MCO 3570.1.
- FC 4-179-03F.
- AF 36-2654.

1-3.5 Army Ranges.

Range layouts, target distances, lane widths, target systems, and baffle effects are standard and defined by the Training Circular TC 25-8. Specific range design requirements are as defined in the Range Design Guide (RDG).

1-3.6 Non-Standard Ranges.

For non-standard ranges that do not have applicable criteria in this UFC, consult with the specific service range subject matter expert.

1-4 CYBERSECURITY.

All control systems (including systems separate from an energy management control system) must be planned, designed, acquired, executed, and maintained in accordance with UFC 4-010-06, and as required by individual Service Implementation Policy.

1-5 BEST PRACTICES.

Appendix A contains best practices.

1-6 WEAPONS AND AMMUNITION.

Appendix B contains a general description of common weapons and ammunition used by DoD.

1-7 GLOSSARY.

Appendix C contains acronyms, abbreviations, and terms.

1-8 REFERENCES.

Appendix D contains a list of references used in this document. The publication date of the code or standard is not included in this document. In general, the latest available issuance of the reference is used.

CHAPTER 2 GENERAL

2-1 PLANNING.

Design ranges to meet the need of the intended training. Consider the number of shooters and firing lanes, anticipated weapons and ammunition, target systems, target distances, scoring accuracy required, shooting directions and angles, and components necessary to maintain and support the range. Establish a team to review range requirements and develop the project. The team composition will depend on the service but in general should include service range experts, weapons and range safety officers, organizational range safety personnel, trainers, industrial hygienists, activity planners, project managers, fire protection and environmental personnel, and others that will be involved in operations and maintenance of the facility. For outdoor ranges plot the proposed Surface Danger Zone (SDZ) and check for conflicts early in the planning phase. Check aircraft operations and contact the Federal Aviation Administration (FAA) if there is a vertical weapon component that could endanger aircraft.

2-2 BASIS OF DESIGN.

For the initial design submittal include a separate document outlining the parameters and assumptions on which the range design is based. All range design parameters should be provided or verified by the service's range safety program. This information will help ensure the range is operated and maintained with appropriate restrictions and should include:

All Ranges:

- The most powerful rounds in terms of energy and maximum distance.
- A sketch for indoor ranges and a Geographic Information System (GIS) map for outdoor ranges showing location of all firing lines, target lines, direction of fire, and left and right limits.
- Maximum target distance provided.
- Target systems.
- Assumptions used for sizing range support areas including the number of targets, weapons, and students.

Outdoor Ranges:

- A Surface Danger Zone (SDZ) map provided by the government annotated to show the location of SDZ enforcement features including topography, range fencing, base limits, signage, and road barriers.
- A list of recommended best management practices.

Indoor Ranges and CQC Facilities:

- A sketch showing the location and maintenance access to all range equipment and controls including targeting systems, ventilation

equipment, filters, trap equipment, dust collection system, bullet collection components, and lighting controls.

- A floor plan showing live fire areas with direction of fire and any limitations imposed such as areas or walls not designed for live fire.
- A floor plan showing range support functions such as classrooms armories, offices, simulators etc.
- Bullet trap and ventilation operation and maintenance manuals provided at end of project.

2-3 MATERIAL.

2-3.1 Concrete.

All concrete that may receive bullet strikes must be minimum 3500 psi (24 MPa). Structural design may require higher strengths.

2-3.2 Ballistic and AR500 Steel Plate.

Ballistic steel plate and AR500 Steel Plate must be tested in accordance with ASTM E10-08, meet MIL-A-46100, and certified as having the following Brinell Hardness (HBW):

- AR500: HBW between 470 and 544.
- AR525: HBW between 500 and 544.

In addition, require:

- Certifications for all ballistic steel plates.
- Connection made in such a manner as to maintain ballistic properties.
- All cuts made in a manner that does not alter or reduce hardness.
- Ballistic integrity maintained across all joints.

2-3.3 Splatter Protection for Overhead Baffles and Safety Ceiling.

Splatter protection must have spacers providing minimum 1-1/2" (38 mm) air gap between splatter protection and the underlying material with the exception that Army ranges may have splatter protection glued directly to the underlying material. Splatter protection material must be fire resistant and must not contain any metal or metal fibers, excluding fasteners. Design splatter protection to allow for removal and replacement without damage to the splatter protection, spacers, or underlying material. Choose from among the following:

- 0.375 in. (9.5 mm) two-ply rubber conveyor belt material. Must not contain any metal.
- 2 in. (50 mm) thick vulcanized rubber.

- 2 in. (50 mm) cold-pressed ballistic rubber.
- Minimum 0.75 in. (19 mm) fire-retardant plywood.
- Other material may be used when approved.
- Acoustic material with tests results showing material can stop splatter from rifle rounds after striking underlying steel plates.
- Spacer material may be wood, light-gauge steel channels, or recycled plastic lumber.

2-3.4 Splatter Protection for Steel CQC Facilities.

Choose splatter protection options that provide:

- Containment of splatter within wall.
- Capability to easily remove and replace to allow inspection of ballistic steel.
- Ease of maintenance.
- Fire resistance.

For Navy projects, use spacers that provide a 1.5-in. (37 mm) air gap between steel and splatter protection to reduce damage to backside of splatter protection and simplify removal for routine inspection of ballistic steel panels. Army facilities may have splatter protection glued directly to the ballistic panels.

2-4 AIR FORCE RANGES.

The Air Force allows only outdoor non-contained, machine gun tube, or fully enclosed indoor ranges for new construction. The following applies to Air Force indoor and outdoor small arms ranges.

2-4.1 Firing Line Positions and Platforms.

All small arms ranges should have a minimum of seven positions at the firing line. Additional positions may be added in increments of seven. The width of the firing position must be at least 5 ft. (1.5 m) center-to-center. The firing line must be located on a stable horizontal surface with a clear distance that is at least 14 ft. (4.3 m) in depth for the length of the firing line. For most ranges, the firing platform is a concrete slab on grade. For ranges that have fighting positions dug in the ground, sandbags, or other definite structures to identify the firing line, the firing platform can be an earth surface. For special weapons, Combat Arms (CA) personnel will specify the number of firing positions and the widths of each position based on training requirements.

2-4.2 Position Numbering.

Number each firing position beginning from the left when facing the target line. The numbers must be at least 8 in. (200 mm) tall and displayed on rectangular backgrounds

attached to the position barricade or other location that is clearly visible to all shooters and range officials. Mark odd-numbered positions with white numbers on a black background. Mark even-numbered positions with black numbers on a white background.

2-4.3 Position Barricades.

Install a wooden barricade, or equivalent, in the form of a cross at the left edge of each firing position with the following requirements:

- The nominal dimensions of the wood horizontal member must be the 2 in. (50 mm) by 6 in. (150 mm).
- The top surface of the horizontal member must be 48 in. (1220 mm) above the floor with a 12 in. (300 mm) resting surface on each side of the post.
- Post member may be nominal 2 in. (50 mm) by 6 in. (150 mm) or 4 in. (100 mm) by 4 in. (100 mm) wood.

2-4.4 Firing Line.

Paint a red line a minimum of 4 in. (100 mm) wide on the leading edge of the firing line on the target side. For ranges without firing line platforms or concrete floor, a firing line may be marked in red on the downrange side of the firing positions with treated timber embedded along the firing line. If not painted in red, this can also be a line of safety cones or other method that clearly marks the location. This is the stationary firing line and must be continuous for the full length of all firing positions. For move and shoot courses, the firing line is relocated downrange as appropriate for the training scenarios.

2-4.5 Light Anti-Tank Weapons (LAW) and 40 mm Grenades.

See Chapter 3 paragraphs on "Surface Danger Zones".

2-5 ARMY AND USMC RANGES.

For planning Army ranges follow AR 350-19. Army ranges must be approved and included on the installations Range Complex Master Plan (RCMP).

- Use US Army TC 25-8 and DA PAM 385-63 for range layout.
- Use the RDG for range design details, standard features, and target system interface.

CHAPTER 3 OUTDOOR RANGES

3-1 PLANNING AND DESIGN.

Safety is the primary concern when selecting a site for an outdoor small arms range. Other critical concerns include training capability, compatible use, travel distance, location of utilities, and unexploded ordinance (UXO) risk assessment.

3-2 SURFACE DANGER ZONES.

Surface Danger Zones (SDZs) include both horizontal and vertical components and will be developed by the Government during the planning phase in accordance with DA PAM 385-63/MCO 3570. The designer should familiarize themselves with the SDZ as it impacts the location and layout of the firing lines, target lines, berms, supporting features, and downrange features. Orient the SDZ horizontal and vertical components to minimize the effect of range operations on populated areas, watercraft operations, public waterways, aircraft ground and air operations, and land uses within the maximum range of the ammunition. Available land for the SDZ controls the type and size of the range. Consider future expansion when choosing the site and developing SDZs. As weapons and ammunition improve, they are often more powerful than their replacements and therefore require larger SDZs. All mapping must be done using a geographic information system (GIS).

3-2.1 Air Force Ranges.

The Vertical Danger Zone (VDZ) component of the SDZ will be developed using Table 3-1. For VDZ in excess of 200 ft. (61 m) in height, coordinate with the local airfield manager. In some cases, Light Anti-Tank Weapons (LAW) and 40 mm grenade launchers are employed adjacent to, or overlapping, the small arms range footprint. For specialized weapons such as the LAW and 40 mm grenades on outdoor non-contained small arms ranges, DA PAM 385-63 will be used to develop surface danger zone and range design criteria.

Table 3-1 Air Force Minimum VDZ Height Requirements

Weapon/Caliber	DOD Identification Code (DODIC)	Ammunition Nomenclature	Minimum VDZ Height⁵ Feet (Meters)
Pistol, 9 mm (M9, M11, GLOCK 19) and Submachine Gun, 9 mm (MP5 and UZI)	A363, A360	Cartridge (Ctg), 9 mm Ball NATO and Cartridge 9 mm Ball Parabellum (M882, M1)	2215 (675)
Pistol, 9 mm (M9, M11, GLOCK 19)	AA16	9 mm Ctg Frangible (MK254-0)	2215 (675) ¹
Pistol, 9 mm (M9, M11, GLOCK 19)	AB13, AB14	9 mm Blue (Red) Marking Ctg (M1041)	328 (100) ⁴
Handgun, .44 magnum		Commercial Local Purchase	2965 (904) ²
Shotgun, 12 Gauge	A011, AA51, AA82	Ctg 12 Gauge (GA) Shotgun 00 Buckshot, Frangible, Non-Lethal Fin Stabilized (M19/M162, M1012)	1083 (330)
Shotgun, 12 Gauge	A023	Ctg 12 GA 1 OZ Slug	2706 (825) ²
Shotgun, 12 Gauge	AA52	Ctg 12 GA Non-Lethal Crowd Control (M1013)	328 (100)
Rifle/Carbine, 5.56 mm (M4, M4A1 and all M16 series weapons)	A071, A068	Ctg 5.56 mm Ball, Ctg 5.56 mm Tracer (M193, M196)	3347 (1020)
Rifle/Carbine/Automatic Rifle, 5.56 mm (M4, M4A1, all M16 series weapons and M249)	A059, A063/Linked A062, A064, AA01	Ctg 5.56 mm Ball, Ctg 5.56 mm Tracer (includes ball, tracer, armor piercing [AP] and AP tracer linked) (M855, M856, M995)	3674 (1120)
Rifle/Carbine, 5.56 mm (M4, M4A1 and all M16 series weapons)	AA68	5.56 mm Plastic (M862)	328 (100) ⁴
Rifle/Carbine/Automatic Rifle, 5.56 mm (M4, M4A1, all M16 series weapons and M249)	AA40/Linked AA85	Ctg 5.56 mm Frangible Ball and Ctg 5.56 mm Frangible Linked	3347 (1020) ¹
Rifle/Carbine/Automatic Rifle, 5.56 mm (M4, M4A1, all M16 series weapons and M249)	AB09, AB10/Linked AA85	5.56 mm Blue (Red) Marking Ctg/Blue (Red) Linked Marking Ctg (M1042)	328 (100) ⁴
Rifle/Carbine/Automatic Rifle, 5.56 mm (M4, M4A1, all M16 series weapons and M249)	AB67, AB66	5.56 mm, XM1037 Short Range Training Ammunition (SRTA) (Includes Single Round and Linked) (M1037)	656 (200) ⁴

Weapon/Caliber	DOD Identification Code (DODIC)	Ammunition Nomenclature	Minimum VDZ Height⁵ Feet (Meters)
Rifle/Machine Gun, 7.62 mm (M110, M14, MK14 EBR, M21, M24 and M240)	A122, A130, A140, A146, AB50/ Linked A168, A127, A128, A131, A143, A151, A164, A165, A168, A257	Ctg 7.62 mm Ball (M80) and Ctg 7.62 mm Tracer (M62) (Includes Linked and Ball/Tracer Linked) (M80, M62, M276, MK319-0)	4478 (1365)
Rifle/Machine Gun, 7.62 mm (M110, M14, MK14 EBR, M21, M24 and M240)	AA11	Ctg 7.62 mm NATO M118 Special Ball (M118)	4856 (1480)
Machine Gun, 7.62 mm (M240)	AA37, AB60	7.62 mm, M973/M974 Short Range Training Ammunition (SRTA) 4/1 and (Includes Ball Linked) (M973 and M974)	656 (200) ⁴
Rifle, .50 caliber (M107)	A525, A552, A571, AA50, A606, A605	Ctg Cal .50 Ball, Tracer, Armor Piercing (AP), AP Incendiary (I) and API Tracer (Mark 211 Mod O, M2, M1, M10, M33, M17, M8, M20)	6365 (1940)
Machine Gun/Rifle, .50 caliber (M2)	A530, A532, A533, A543, A545, A546, A555, A557, A564, A575, A576, A584, A602, A606, A641, AA06	Ctg Cal .50 Ball, Tracer, AP, Incendiary (I), API and API Tracer Linked (M8 API, M2 AP, M20, M1, M33 Ball, M2 Ball, M17, M10, M17, Spotter Tracer)	6365 (1940)
Grenade Launcher, 40mm (M203, M320)	B470, B472, B506, B508, B509, B519, B535, B536, B537, B538, B542, B546, B568, B576, B584	40mm Ctg, HE, HEDP, TP, Practice, Smoke, Illumination (M381, M384, M385, M386, M406, M407A1, M430, M433, M441, M661, M662, M583A1, M992, M713, M715, M716, M781, M918)	708 (216) ³
Grenade Launcher, 40mm (M203, M320)	BA06	40mm Ctg Non-Lethal Sponge (M1006)	328 (100)
Grenade Launcher, 40mm (M203, M320)	B534	40mm Ctg, Multi Projectile (M576)	246 (75)
Machine Gun, 40mm Linked (MK19)	BA30, B542, B576, B584, BA32, BA21, BA12	Ctg 40mm Linked HEDP, TP, Practice, Mixed (M430/M918/M385/M385A1/M918 & M385/ MK281)	1565 (477) ³
Light Anti-armor Weapon (LAW), 35mm Sub-Caliber (M72-Series LAW)	H708	Rocket, 35mm, Practice (M73)	666 (203) ³

Weapon/Caliber	DOD Identification Code (DODIC)	Ammunition Nomenclature	Minimum VDZ Height⁵ Feet (Meters)
LAW, 66mm RKT HEAT (M72-Series LAW)	HX01	Launcher, Rocket, 66mm (M72 Series)	3116 (950) ³
LAW, 84mm RKT HEAT (M136 [AT-4])	C995	Rocket, HE 84mm M136 AT-4 (M136)	3116 (950) ³

¹ same as ball

² calculated plus 1.25 safety factor

³ From DA PAM 385-63

⁴ From SRTA ballistic graph - General Dynamics Ordinance

⁵ Historical data based on 30° projectile trajectory plus safety factor

3-2.2 Access Restrictions, Warning Signs, Markers, and Flags.

Use service specific installation criteria.

3-2.3 Surface Danger Zones Over Navigable Water.

Use DA PAM 385-63/MCO 3570.1 when shooting over navigable water. A U.S. Army Corps of Engineers permit and citation in 33 CFR Part 334 are required.

3-2.4 Baffled Ranges.

When approved, overhead baffles can reduce the size of the SDZ but require special consideration that are not addressed in this UFC:

- **Containment:** Baffles designed to completely block line of sight out of the range may be used to eliminate direct fire from leaving the range but may not necessarily contain ricochets, ground skips, and splatter from leaving the range.
- **Surface Danger Zone:** The size and shape of the SDZ will need to be established on a case by case basis by the Government.
- **Air movement:** Baffles can significantly block natural air flow and increase potential for exposure to lead and other airborne contaminants. Unlike indoor ranges where negative pressure can be achieved, any ventilation system on baffled ranges will be influenced by outdoor air movement.

3-3 TYPES OF OUTDOOR RANGES.

Outdoor ranges may be configured in various ways to accomplish training goals.

3-3.1 Single Fixed Firing Line.

These ranges have one fixed firing line with targets placed along one or more target lines downrange. A moving target system may also be provided to vary target distance.

3-3.2 Multiple Firing Lines.

These ranges vary target distances using multiple firing lines used for shooting at one target line at the end of the range.

3-3.3 Maneuver Areas.

Maneuver ranges allow fire and movement in multiple directions. These ranges may or may not have permanent firing positions or firing trails. They may have single or multiple targets or target arrays. The complexity of maneuver ranges varies significantly. Simple maneuver ranges train movement and firing while moving techniques to individuals and teams. Complex maneuver ranges train movement, engagement, and support techniques to larger, or multiple, maneuver elements using a variety of weapons and weapon systems. Maneuver ranges often use Short Range Training Ammunition (SRTA), Standard Operating Procedures (SOPs) or Observer/Controllers to limit the firing locations and target engagement in order to limit SDZs.

3-3.4 Skeet and Trap Ranges.

Skeet and trap ranges are a type of outdoor recreational range that are typically limited to shot size Number 7.5 and smaller. Follow the United States Army Corps of Engineers (USACE) Centers of Standardization (CoS) Outdoor Sports Facility Standard.

3-4 SITING.

3-4.1 Mandatory Requirements and Issues to Address.

- The range must be accessible by road. Vehicle access is required to the range area for maintenance, grass mowing, emergencies, and delivery of weapons and ammunition.
- Travel distance to the range.
- Storm water management.
- Protection of wetlands, ground water, and surface water.
- Suitability of terrain.
- Historical and archaeological features.
- Previously contaminated sites, including unexploded ordnance contamination.
- Endangered species habitat.

3-4.2 Considerations.

When siting and orienting the range consider:

- Allowing for future expansion.

- Orienting north to south to minimize glare for the shooters.
- Orienting the firing away from sensitive and inhabited areas.
- Taking advantage of existing impact areas and natural backstops.
- Eliminating drainage structures on the range surface whenever possible.
- Using natural drainage with no flowing water courses near the range floor or impact berm.
- Avoiding areas that are subject to flooding.
- Minimizing noise to surrounding areas both on and off the installation. Noise models such as those provided in the Army's Range Management Toolkit (RMTK) may be used to develop potential noise contours.
- Taking advantage of any natural barriers and base restricted areas to prevent access by personnel and animals to the SDZ.
- Taking advantage of any natural topography such as hills and mountains to help contain rounds.
- Selecting site to minimize grading of range surface to produce a smooth surface of homogeneous material. A rocky surface will increase ricochets.
- For areas where wind predominantly blows in one direction, orienting with wind blowing downrange.
- Taking advantage of local topography to assist with runoff removal.
- In cold climates minimizing snow drifts and ice buildup and facilitating snow removal on range.

3-5 SUPPORT FACILITIES.

Supporting facilities include roads, drainage structures, and utilities. Design and locate these features to protect them from direct fire.

3-5.1 Roads and Parking.

Design for access by all vehicles that will use the range. Provide surfaced all-weather connector roads from the installation road network to the range complex. Provide range access roads that approach the range complex from behind the firing line and outside the SDZ.

3-5.2 Utilities.

3-5.2.1 Electricity.

Size service to accommodate power requirements for target systems, lighting, support facilities, and range maintenance.

3-5.2.2 Telephone and Radio Communication.

Include two forms of communication between the Range Control Facility, Range Safety Officer (RSO), instructors, beach guards, and any others involved in the operations of the range and security of the SDZ. For Army, follow DA PAM 385-63 and installation's SOPs.

3-5.2.3 Water.

Coordinate with the local utility and Designated Fire Protection Engineer (DFPE), as defined in UFC 3-600-01 to determine requirements. Consider fire protection, drinking, hand washing, and sanitary uses. If a water system is not feasible, consider a well and tank system. If this is not feasible, consider portable fire protection such as fire extinguishers or tanker trucks as required by the DFPE in collaboration with the installation fire department.

3-5.2.4 Restroom Facilities.

Restroom facilities are required adjacent to or within a reasonable distance from the range. Where sewage and running water are not feasible, other options such as composting or commercial portable latrines may be used.

3-6 GEOMETRY FOR NAVY AND AIR FORCE RANGES.

Typical geometry for a flat rectangular outdoor range may be adjusted when necessary to accommodate different types of training.

3-6.1 Measurement Control.

For vertical control define the firing line floor surface (FLFS) elevation as 0.00 and set other features based on this. Base horizontal control on measurements taken from the rearmost firing line (FL).

3-6.2 Target Centers.

Locate the center of the target at an elevation between the upper limit of fire (ULF) equal to 6 ft. (1.8 m) above FLFS for standing shooting and lower limit of fire (LLF) equal to 6 in. (152 mm) above FLFS for prone shooting.

3-6.3 Lanes.

Lane widths vary depending on weapons and training requirements. Establish lane width as necessary to safely support intended training.

3-6.4 Range Length.

Locate target lines as necessary to accommodate intended weapons and training.

3-7 GEOMETRY FOR ARMY RANGES.

Refer to TC 25-8 and the RDG for standard Army range layouts.

3-8 RANGE COMPONENTS.

Locate and design components to avoid direct fire and the creation of potential ricochet hazards.

3-8.1 Drainage.

Design positive grading to direct runoff away from the firing lines and prevent flooding at the target line(s) and access roads. Avoid using drainage structures on the range surface when possible. When the length of the slope or natural terrain require using drains between target lines and firing lines, trench drains or subsurface gravel drains should be located on the forward edge of the impact berm or bullet trap. Design inlets so that no hard-flat surface will be exposed to shooters and provide enough protection to account for heavy bullet impacts and erosion.

3-8.2 Floor Surface.

Design the surface to be smooth and graded to drain away from targets. Side to side grading should be minimal except on ranges where defilade or obstructions are desired for training. Transverse firing line grading should match target line transverse grading. Allow enough fore and aft distance to support the type of training conducted. Clearly mark firing lanes on the surface to match the targets. Depending on the number of personnel to be supported, the following surfaces may be considered at the firing line:

- Ground firmly compacted with mown grasses.
- Sand or fine gravel, with shooting mats for prone shooting.
- Wood decking of enough thickness and supporting members to avoid deck movement.
- Concrete pad topped with cushioning material.

3-8.3 Benches.

Continuous benches or individual trays may be provided to hold ammunition and weapons. Place trays to allow safe weapons handling.

3-8.4 Bleachers.

Bleachers and covered shelters may be provided outside the SDZ behind the firing line for training and briefings.

3-8.5 Obstacles.

Mock-up roofs, windows, doors, and other training structures may be provided at the firing line to meet training requirements.

3-8.6 Range Safety Officer Position.

Where possible, provide the Range Safety Officer (RSO) position an unrestricted view of all firing lines and target lines from their control position.

3-8.7 Towers.

Tower requirements are service and training dependent. Elevated range towers may be necessary to provide proper visibility for the RSO.

3-8.8 Overhead Cover.

Overhead cover may be provided but is not required nor recommended in most cases. While it can provide some protection from direct sun and the elements, covering the firing line can also increase noise levels below and interfere with air movement needed to remove airborne contaminants away from shooters. When provided, design to reduce noise reflected down to the firing line and to minimize interruption of natural air movement.

3-8.9 Lateral Limit Markers.

Lateral limit markers indicate direction of fire limitations from the outmost firing and target positions. The right lateral limit is found by taking the line of sight from the right firing position at the most uprange firing line to the right most target downrange, and similarly for the left. For Army ranges, TC 25-8 and the RDG along with installation SOPs define the type, size and location of limit markers.

3-9 IMPACT BERMS.

Impact berms are required for Navy and Air Force ranges that are generally flat, fire in one direction, and have target distances of 200 yds. (182 m) or less. Impact berms:

- Capture projectiles where they can be collected and removed more efficiently compared to ranges without impact berms.
- Significantly reduce the number of projectiles spreading out and landing downrange in the SDZ.
- Will not capture all projectiles because ground skips and ricochets will continue downrange.
- Will not reduce the length of the SDZ since the controlling round is at such an angle that its trajectory is well above the impact berm.

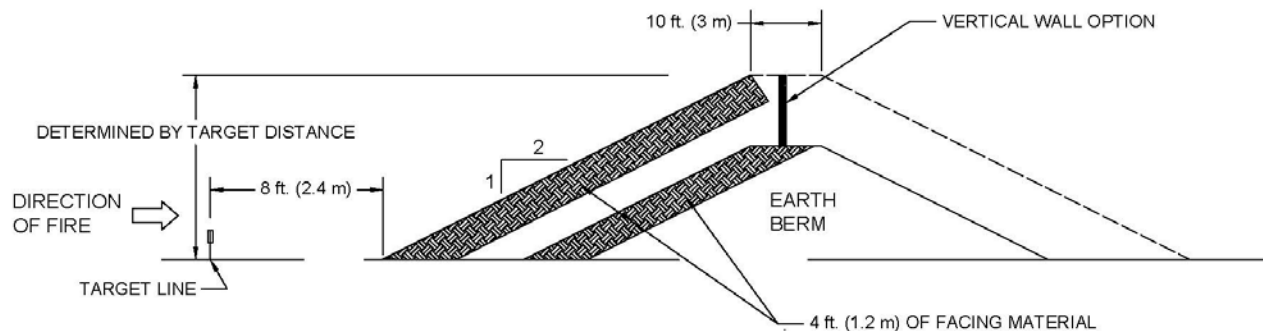
3-9.1 Geometry.

When required, design in accordance with Figure 3-1 and as follows:

- Slope: A slope of 2H:1V is recommended. A steeper slope of 1.5:1V may be used if a stable berm can be constructed that also allows future sifting of the soil.

- Width: Provide a total berm width equal to the firing line width plus the additional width necessary to cover a 5-degree dispersion angle from all firing positions.
- Top of Berm: Minimum 10 ft. (3 m) horizontal top on the berm.
- Toe of Berm: A minimum of 8 ft. (2.4 m) past the last target line.
- Minimum Height: 16 ft. (5 m) above the highest grade at the last downrange target line for ranges with target distances of 50 yd. (46 m) or less and 26 ft. (8 m) for ranges with target distances of 100 yd. (91 m) and greater. For ranges with target distances between 50 yd. (46 m) and 100 yd. (91 m), use a height that is prorated between the 50-yd. (46m) and 100-yd. (91 m) berm heights.
- Wall Option: A vertical wall may be provided on the top of the berm to reduce the berm height and footprint. The earth portion must be a minimum of 16 ft. (5 m). As a minimum, the wall should be solid 8 in. (203 mm) thick concrete. The foundation must have a minimum 4 ft. (1.2 m) of earth cover on shooting side of the berm. The direct line of fire from the prone position through the target point must impact the earth portion of the berm 3 ft. (1 m) below the exposed wall.
- See Butt Target Systems paragraphs for minimum berm height and toe of berm distance from target line when using that system.

Figure 3-1 Impact Berm



3-9.2 Berm Material.

Specify berm material in the design that will achieve and sustain a proper slope, promote vegetation growth, reduce the chance of ricochets, and allow for sifting to remove projectiles. Require the upper 4 ft. (1.2 m) of facing material on the impact side to be free from rocks and debris no greater than a No. 4 sieve – equivalent to 0.187 in. (4.76 mm) diameter mesh – that will not clog screens when sifting. A high clay content will help achieve a more stable slope, but too much clay in the upper layer will make it very difficult to sift and remove spent rounds in the future. Therefore, the facing material must not have more than 40% passing the No. 200 sieve.

3-9.3 Berm Construction.

Construct the berm in compacted horizontal lifts. Do not allow compaction up the slope of the berm face. Use benching and keying techniques to enhance slope stability when resurfacing or tying in to an existing berm.

3-10 TARGET SYSTEMS.

The type of target system used will influence significant portions of the design. Choose systems based on the type of training anticipated. See individual service policy for procuring range target system equipment. A variety of target systems are available and new systems are under constant development. Current target systems include, but not limited to:

- Paper Targets on Wooden Frames: Paper targets can be mounted on simple wooden or other non-ricochet producing stands at the target line. They are typically used for 27.3 yd. (25 m) target distances or less because the time needed to walk downrange and score the targets.
- Butt Target Systems: Butt systems use paper targets secured to cardboard or plywood frames that are raised, lowered, and scored by personnel located downrange behind a protective berm. These systems are simple, reliable, and allow the shooter to remain at the firing line while the targets are scored but are labor intensive because a downrange scorer is required for every shooter.
- LOMAH (Location of Miss And Hit) Targets: A computerized target system with sensors at the target end that detect the path of the projectile through the target and provide feedback to monitors at the firing line. These are generally very accurate but expensive and require significant maintenance to maintain calibration.
- Pop-Up Targets and Stationary Infantry Targets (SIT): These targets are raised and lowered remotely and can be either electric or pneumatic.
- Steel Targets and Knockdown Targets: Steel targets are typically used when accurate scoring within the target is not needed, only a hit or miss. Steel targets provide audible feedback and are designed to go down or spin when struck. Knockdown targets fall when struck. Knockdown targets can be steel but other versions are available. Steel targets and knockdown targets can be reset pneumatically, electrically, or by gravity. Check with service safety requirements when considering steel targets as they will impact target design, placement, and safe target distances.
- Turning Targets: These targets rotate on a vertical axis to present alternating target face and edge to initiate and cease firing. They can be designed with a friend face on one side and a foe on the back for shoot and no-shoot drills. Turning mechanism can be pneumatic or electric.
- Running Man and Moving Infantry Targets (MIT): Targets that move laterally or randomly on a track. Targets can present personnel and

vehicle silhouette including armored vehicles and tanks. These targets are typically provided to supplement other target systems.

- Stationary and Moving Armor Targets: Targets that simulate a tank or other vehicle for live fire training and qualification programs.
- Mobile and Robotic Targets: A variety of targets are available that move on remote controlled vehicles.

NOTE: When using moving targets, it is critical to incorporate all shooting positions and angles when developing the SDZ.

3-10.1 Target Systems for Army Ranges.

For Army ranges, AR 350-19, TC 25-8, and the RDG define target types, control systems, interface, emplacements, protection, and procurement processes.

3-10.2 Target Line Grading and Protection.

Match grading at target line bases with firing lines when possible. Protect target support bases from direct fire by:

- Providing a target berm on the firing side.
- Burying below ground.
- Providing a protective wall designed to stop rounds but reduce ricochet potential.

3-10.3 Target Supports and Berms.

Target holders and bases should be designed to prevent ricochets and splatter. Earth berms can be placed in front of targets to protect target base and should be constructed from the same material as the impact berm.

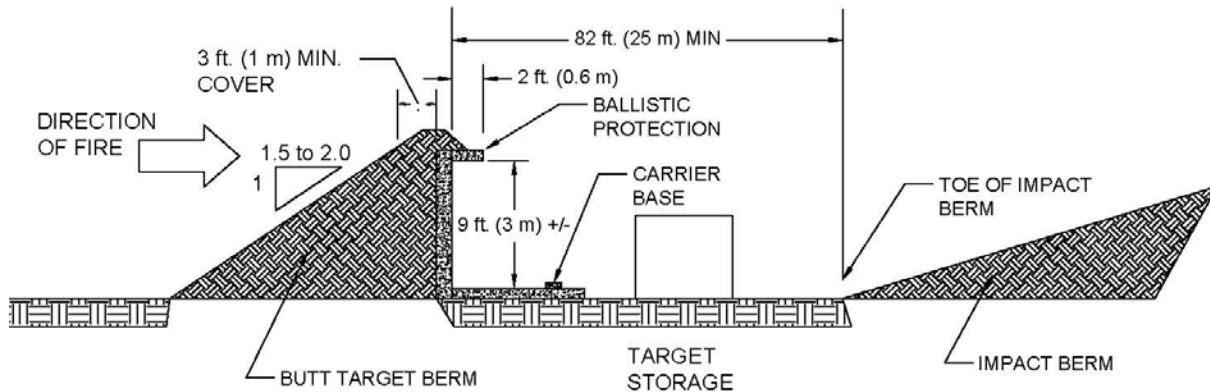
3-10.4 Butt Target System.

Butt target systems allow manual scoring of targets by personnel downrange behind the target line and protected by a berm. Design in accordance with Figure 3.2 and as follows:

- Design butt target berm with a slope that is maintainable, typically 1.5 to 2.0H:1V and 3.0 to 4.0H:1V where erosion is a major issue.
- Provide an impact berm behind the target berm with a minimum height of 26 ft. (8 m) above the carrier base elevation.
- Toe of impact berm a minimum of 82 ft. (25 m) from the butt wall.
- A target storage facility protected from direct fire may be included between the butt system and the impact berm. Top of structure must be below all direct lines of fire and the top elevation of the ballistic protection in the pit.

- For Army Ranges, use the Known Distance (KD) Range section of TC 25-8 and the RDG for the design and construction details for this type of target system.
- For pit option, see the RDG.
- For USMC, meet the requirements of MCO 3570.1.

Figure 3-2 Butt Target System



3-11 PARALLEL RANGES.

When parallel ranges have SDZs that cover the firing line of the adjacent range, the ranges may be used concurrently when side containment is provided as follows:

- Earth Berm: Require an inside slope of 1V:1.5H or flatter with a minimum horizontal 6 ft. top width. Provide same material and compaction as required for impact berms.
- Concrete Wall: Require a minimum 8 in. (203 mm) thick concrete wall with a smooth, flat surface free of irregularities, form ties, and protrusions.
- Shock Absorbing Concrete (SACON): Design based on type of weapons and ammunition used.
- Wood and Gravel Walls: Timber and gravel filled wooden walls on new ranges are not recommended because of maintenance and integrity issues.
- Height: Require a minimum height of 10 ft. (3 m) above the highest elevation on either side where personnel could potentially be standing while either range is in use.
- Army ranges may require an SDZ deviation to allow concurrent use.

3-12 MACHINE GUN TUBE RANGE.

Training on machine guns up to 7.62 mm caliber may be provided using a 10-meter tube range. See Figures 3-3 and 3-4. These ranges incorporate range tubes that

function as baffles to reduce the size and shape of the SDZ. Army ranges of this type require the same approval as other baffled ranges. Tube ranges are not suitable for:

- Machine guns over 7.62 mm caliber.
- Navy OPNAV 3591 machine gun training since they do not support the training requirements for traverse firing.

3-12.1 Surface Danger Zone.

The machine gun tube SDZ for all ammunition types less than 7.62 mm is 2296 ft (700 m) and the VDZ for all ammunition types less than 7.62 mm is 1640 ft (500 m). The reduction in the SDZ for 7.62 mm and greater ammunition will be determined by the Government. Army ranges require a deviation IAW AR 385-63.

3-12.2 Machine Gun Tubes.

For 10-meter machine gun tube ranges use concrete pipe with a minimum length of 24 ft. (7.3 m) and either round with a minimum 5 ft. (1.52 m) inside diameter or square with a minimum 5 ft. (1.52 m) inside dimension. Provide a reinforced concrete slab the length of the tubes to maintain joint integrity. The tubes may be constructed of sectional pieces if the spigot end of the bell spigot joint is pointed downrange. Tubes may be made of ASTM C75, Class V reinforced concrete pipe (RCP) requirements, or may be steel pipe of suitable thickness fabricated from rolled plates. The interior of the tubes must have a smooth continuous surface. Repair any lifting lugs or holes so the tube interior is smooth and does not produce erratic ricochets.

3-12.3 Drainage.

Slope the tubes approximately 6 in. (150 mm) towards the target line. Firing positions must be at least 12 ft. (3.7 m) apart, measured center-to-center. The end of the tube toward the shooter should touch the firing line.

3-12.4 Firing Platform.

Ensure that the firing tube placement and the firing platform height will place the muzzle of the machine gun at the approximate center of the tube height and at least 6 in. (150 mm) inside the tube. To achieve this, the platform may need to extend inside the tube approximately 3 in. (76 mm) depending on the tripod and weapon dimensions.

3-12.5 Berm Backstops.

For berm backstops, locate the berm no more than 150 ft. (45.7 m) from the firing line to the centerline of the berm. The minimum height of the backstop is established by determining where the highest point that a bullet could exit the target end of the tube and impact the berm. This line must intersect the berm no less than 6.5 ft. (2 m) from the top. Use same material as required for impact berms.

3-12.5.1 Optional Deflector Plate.

Locate the deflector plate at least 2 ft. (0.6 m) above the highest bullet impact point on the berm. The deflector plate may be either angled or vertical which will influence the reduction in the SDZ.

3-12.5.2 Optional Steel Traps.

Locate the trap at least 50 ft. (15m) away from the firing line. The line drawn from the firing point to the highest point that a bullet could exit the target end of the tube must intersect the top plate of the trap not less than 12 in. (300 mm) from the top, measured along the slope of the trap.

3-12.6 Noise.

Engineering solutions to reduce the noise levels from tube ranges are limited and may consist of sand bags along the bottom of the tube. Cement-based acoustical treatment may also be used. Additional sound attenuating materials can also be added to the interior surfaces of square tubes. Appropriate operational mitigation must be established to reduce the high impact noise exposure. For Air Force ranges, the impact of hazardous noise levels for tube ranges must be evaluated by the local Bioenvironmental Engineering (BE) and Civil Engineering (CE) offices.

Figure 3-3 Machine Gun 10-Meter Tube Range Layout

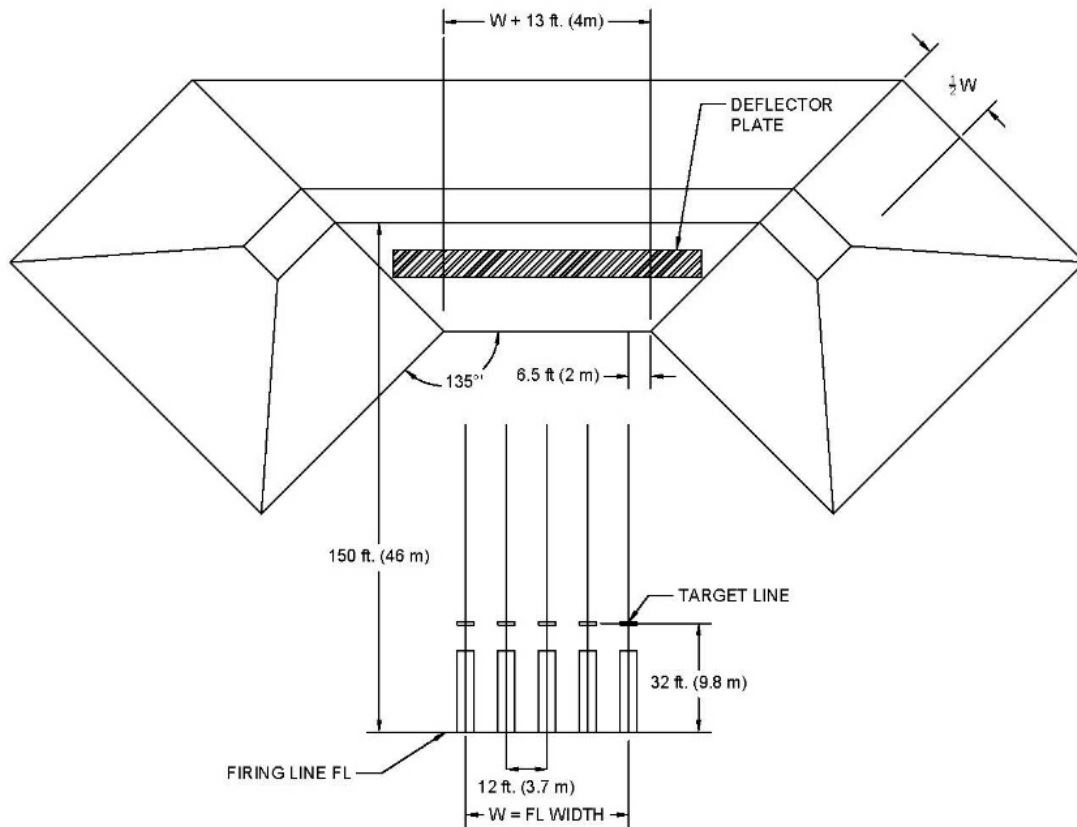
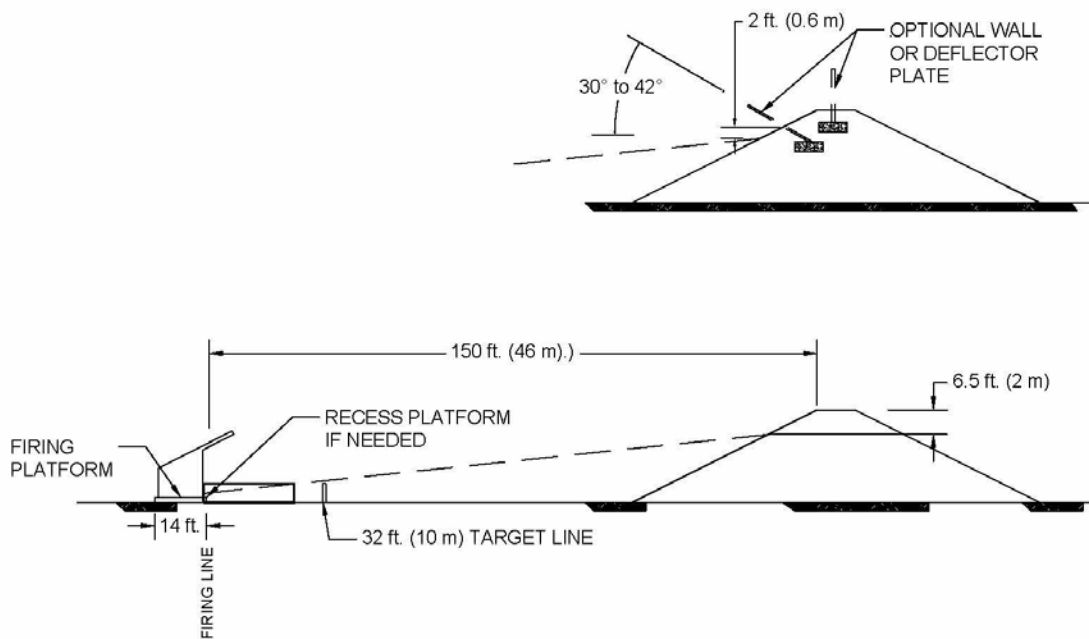


Figure 3-4 Machine Gun 10-Meter Tube Range Section



CHAPTER 4 INDOOR RANGES

4-1 GENERAL.

Indoor ranges have open bays with shooting generally straight downrange into a bullet trap. Ballistic containment is provided by ballistic side walls, overhead baffles, and a bullet trap. Indoor ranges can be built using conventional or modular construction methods. A push-pull ventilation system supplies air from behind the firing line and exhausts at the trap end to move airborne contaminants downrange and away from personnel inside the range. Design and construct Army and Marine Corp indoor ranges IAW applicable portions of this UFC and the design and safety requirements found in DA Pam 385-63; the DA PAM controls in case of conflict.

4-1.1 Coverage.

The ballistic containment criteria in this chapter is intended for indoor ranges that support weapons and ammunition with energy up to 2,500 foot-pounds (3,390 Newton-meters) including handguns, 5.56 mm rifles, and 7.62 mm rifles. It does not support:

- Tracers, explosives or incendiary rounds.
- Armor Piercing (AP) rounds.
- 5.56 mm or 7.62 mm Enhanced performance rounds (EPR), (M855A1 or M80A1).

Design the range systems for the specific, worst-case rounds for these or other higher-powered weapons. The ballistic containment system includes baffles, floors, walls, splatter protection, and bullet trap.

4-1.2 Range Areas.

An indoor range facility can be divided into three functional areas:

- The training area between the rear uprange wall and the bullet trap where live fire occurs. The training area requires a ballistic envelope to contain rounds within the facility.
- The direct support area that includes the range safety officer's office, entrance vestibules, storage areas immediately off the training area, and the area behind the bullet trap.
- The indirect support area and all other spaces including administrative, restrooms, classrooms, hallways, and other storage areas.

4-2 TRAINING AREA.

Define training requirements, ammunition, target distances, and maintenance issues prior to developing a floor plan. For ranges approaching 100 ft. (30.5 m) width and wider, the cost and size of structural components can increase significantly and should

be taken into consideration when determining number of lanes and range width. Consider multiple bays to provide flexibility and reduce structural loads.

- Navy: The Navy standard qualification range has an 82 ft. (25 m) target distance with 4 ft. (1.2 m) lane widths. Note that while some Navy training only requires a 25-yard target distances, a 25-meter range provides additional capability and safety. For Naval Special Warfare indoor ranges, the layout is not standard and will vary depending on type of training supported.
- Air Force: Use Air Force Facility Criteria FC 4-179-03 for planning and layout of indoor ranges along with general requirements provided in Chapter 1. This Air Force FC provides general guidance on lanes and detailed planning requirements for the indirect support areas.
- USMC: Typical indoor ranges have either 82 ft. (25 m) or 164 ft. (50 m) target distances.
- Army: Base layout on training and installation specific requirements.

4-3 DIRECT SUPPORT AREA.

4-3.1 Range Control Booth.

4-3.1.1 Ventilation, Layout, and Sound Attenuation.

Include a ventilation system independent of the training area range ventilation system and a 2 ft. (0.8 m) wide, full-length work counter at the base of the window. Locate all range controls and utility panels in this area. Locate lighting and communications controls to allow adjustments while maintaining clear visibility downrange. Provide sound attenuation to allow personnel in the booth during live fire without the need of hearing protection as described by the noise paragraphs in this chapter.

4-3.1.2 Visibility.

Design range control booth to provide full line-of-sight visibility from a center seated position 4 ft. (1.2 m) behind a 4 ft. (1.2 m) high window to 4 ft. (1.2 m) behind the firing line on both sides and extending downrange to the target area. See Figure Fig 4-1. Coordinate window level with that of the ventilation supply diffuser so the downrange view is not blocked by the diffuser when standing. Windows and doors within the booth must not restrict or distort the view downrange. Closed-circuit television monitors may be used to enhance, but will not replace, this requirement. Provide windows with views into the hallway behind and vestibules to the sides that allow monitoring of movement in and out of the training area. Use sliding closures or other method on the windows into hallways and vestibules that can be used to completely block light from coming into the range control booth during low light conditions. For Air Force ranges, raise floor in booth a minimum 2 ft. (0.6 m) minimum above the range floor to promote visibility downrange and to all range entry points.

4-3.2 Airlock Vestibules.

Entrance vestibules with doors at either end are required to allow movement in and out of the range without disturbing the air balance of the range. A minimum of one vestibule for ranges with seven lanes or less, and two vestibules for ranges with more than seven lanes is required. Place vestibules adjacent to the Range Control Booth with windows to allow monitoring of movement from the booth. All doors into the training area must swing outward from range to help seal doors under negative pressure. Seal around doors and place sweeps at bottom to provide an airtight closure.

4-3.3 Vacuum Storage.

Include a storage area with direct access to the training area for portable High Efficiency Particulate Air (HEPA) vacuum and equipment storage.

4-3.4 Brass Storage.

A 55-gallon drum may be placed next to side wall behind firing line for brass storage immediately after collection.

4-4 TRAINING AND DIRECT SUPPORT AREA LAYOUT.

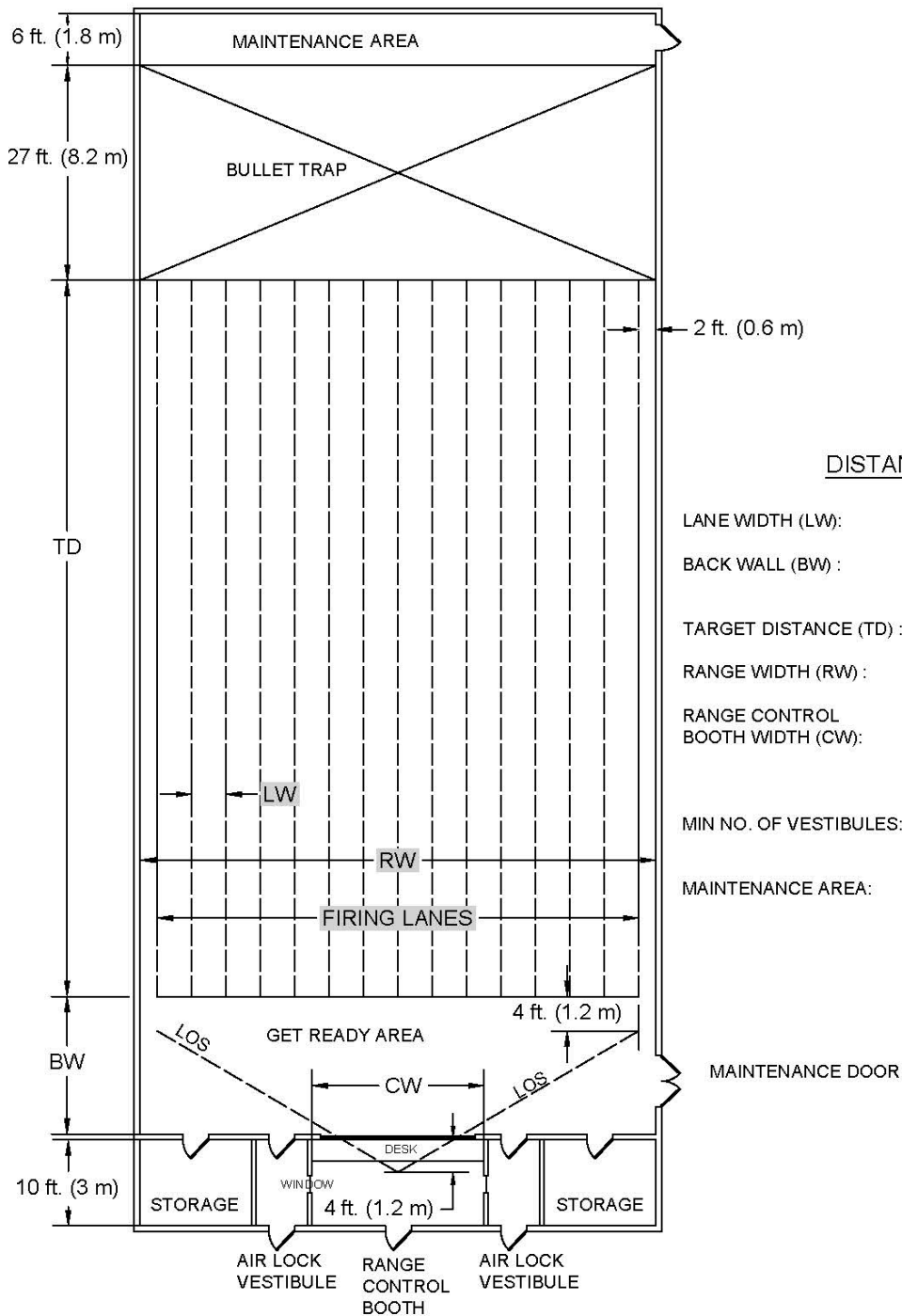
The width of the range is determined by the number of lanes, width of lanes, and the space provided against each side wall. The length of the range is determined by the distance behind the firing line, the target distance, the depth of the bullet trap, and the space behind the bullet trap. The height of the range is determined by the clear height between floor and bottom of the ceiling baffles, the ceiling baffle height, and the distance above the baffles needed for structural and mechanical systems. Make all surfaces downrange in direct line of fire non-reflective when lasers are allowed in training.

Use Figures 4-1, 4-2, and the following minimum distances:

- Range Control Booth: 10 ft. (3 m) front to back.
- Get Ready Area: Table 4-1.
- Target Distance: As required for training. Do not extend target system into the trap.
- Bullet trap: Approximately 27 ft. (8.2 m) – coordinate with trap manufacturer.
- Maintenance Area: Minimum 6 ft. (1.8 m) behind bullet trap. Verify there is enough space in maintenance area for all trap components, compressors, and other hardware. This is area must not be used for storage.
- Clear Height: Table 4-1 for minimum distance. May need higher ceilings if vehicles are used in training.

- Distance between top of baffles and bottom of roof: As needed, including space for structural components and ventilation ductwork.
- Distance between edge lanes and side walls: Minimum 2 ft. (0.6 m). This distance is needed to help achieve proper airflow and prevent shooting near side walls.
- Lane Width: Minimum 4 ft. (1.2 m). Service and training requirements may dictate wider lanes.
- Avoid interior columns when possible. If provided, include a 2 ft. (0.6 m) buffer between column and lanes.
- Safety Ceiling: Extend ballistic coverage to 4 ft. (1.2 m) behind firing line.

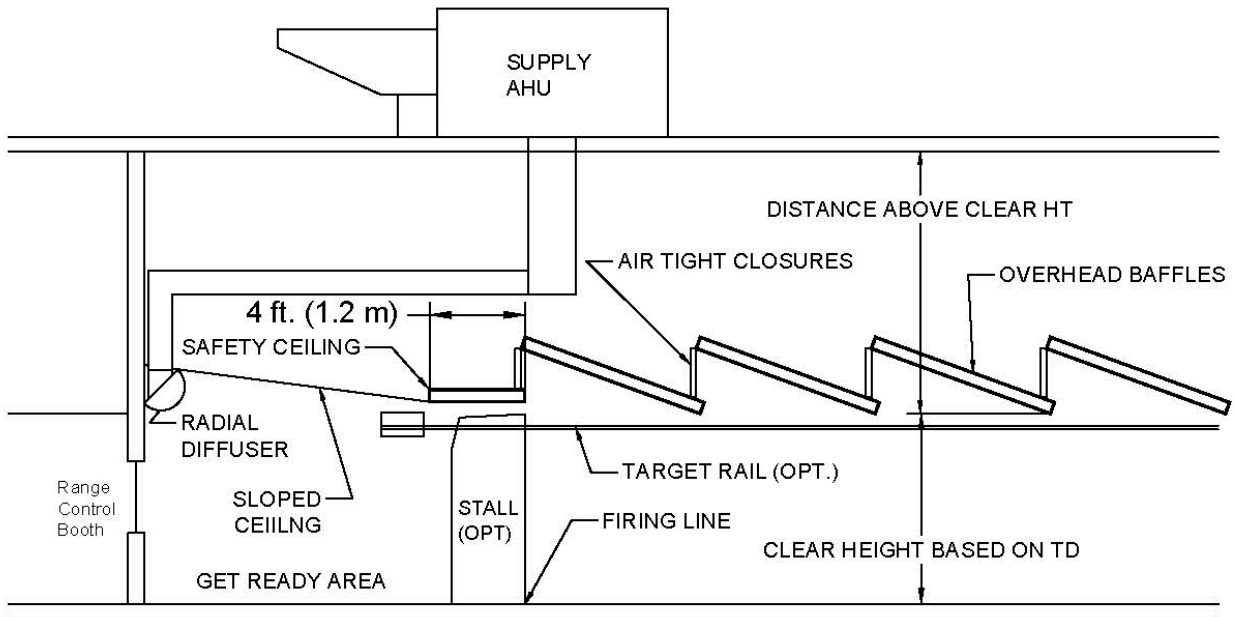
Figure 4-1 Standard Range Layout



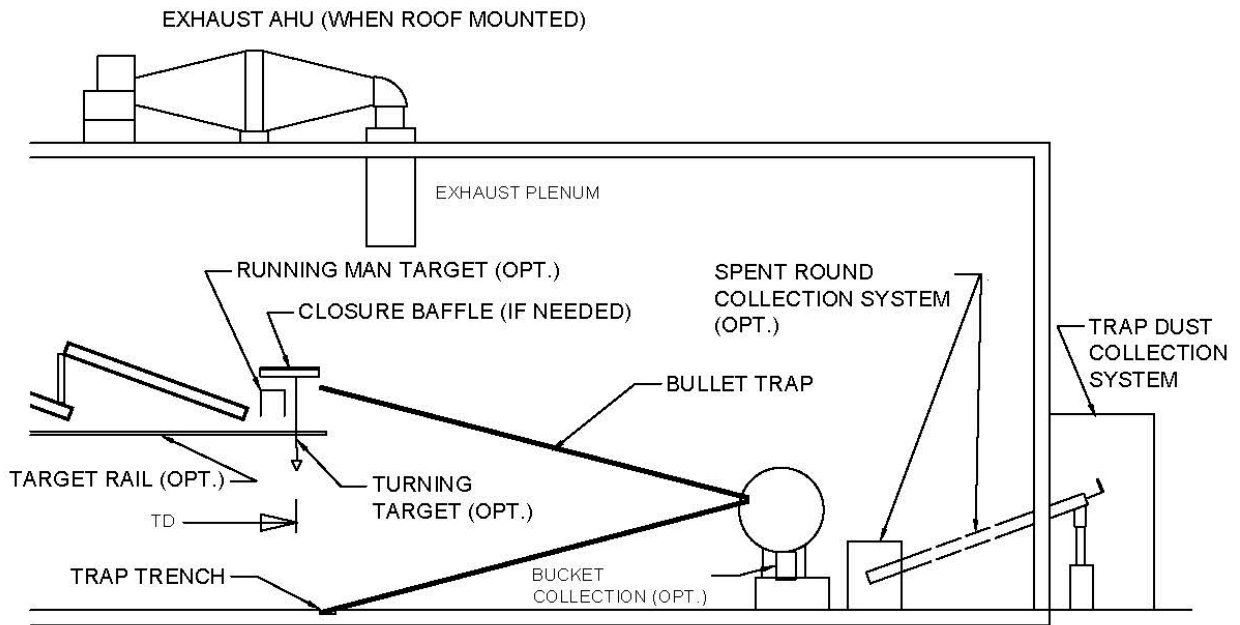
DISTANCES

- LANE WIDTH (LW): 4 ft. (1.2 m) MINIMUM
- BACK WALL (BW) : 16 ft. (5.0 m) FOR TD 25 m OR LESS
18 ft. (5.5 m) FOR TD OVER 25 m
- TARGET DISTANCE (TD) : AS NEEDED
- RANGE WIDTH (RW) : (# LANES x LW) + 4 ft. (1.2 m)
- RANGE CONTROL BOOTH WIDTH (CW): AS NEEDED TO PROVIDE LINE OF SIGHT (LOS) TO END LANES
- MIN NO. OF VESTIBULES: 1 UP TO 7 LANES
2 OVER 7 LANES
- MAINTENANCE AREA: 6 ft. (1.8 m) MINIMUM

Figure 4-2 Standard Range Section.



UPRANGE



DOWNRANGE

Table 4-1 Range Heights and Get Ready Area Distances.

Target Distance (TD)	Clear Vertical Height	Get Ready Area (Backwall to FL)
Up to 82 ft. (25 m).	8 ft. (2.4 m)	16 ft. (5 m)
Over 82 ft. (25 m) up to 165 ft. (50 m).	10 ft. (3 m)	18 ft. (5.5 m)
From 165 ft. (50 m) to 328 ft. (100 m)	12 ft. (3.7 m)	18 ft. (5.5 m)

4-5 INDIRECT SUPPORT AREAS.

4-5.1 Required Indirect Support Area.

The following areas are required:

- Administrative Area: This area contains offices for the range safety officer, instructors, and maintenance personnel along with file and shelf storage for operations data and maintenance records.
- Restrooms, Shower, and Locker Room Areas: Size restrooms based on occupancy and range use. Size shower and locker based on range staff.
- Laundry: For range laundry use only.
- General Storage: Provide adequate storage for targets, filters, tools, and maintenance equipment.
- Maintenance and Storage area.

4-5.2 Other Indirect Support Areas.

The following areas may be necessary:

- Brass sorting: Include table with raised perimeter and holes to collection buckets or drums underneath.
- Classrooms: This includes space to conduct classroom training prior to live-fire and after-action debriefings.
- Weapons Cleaning Area: This space accommodates workbenches, degreasing tanks, and spray hoods. Exhaust hoods and vapor proof electrical fixtures may be required. Provide a lavatory with potable water and eyewash in the immediate area.
- Arms and Ammunition Storage: UFC 4-215-01 Armories and Arms Rooms. When provided, include an issue and clearing area adjacent to the weapons storage and cleaning area.

- Break Room: Room for meals and breaks with space for refrigerator, sink, countertops, microwaves, coffee machines, table, and chairs. Provide signage that prohibits food inside the training area.
- Weapons Simulator Room: Design to accommodate anticipated system. These rooms may require raised flooring, compressor area, darkened or no windows, and a small control room. Signs must clearly mark room as simulation weapons only, with no lethal ammunition allowed.

4-6 FIRE PROTECTION.

The training area and trap area do not require a sprinkler system. Coordinate with the DFPE early in the design process for detailed requirements for the rest of the building. Provide 2-hour fire rated construction separating the training and direct support areas from indirect support areas.

4-7 COLLECTION, TEMPORARY STORAGE, AND DISPOSAL.

Design for the collection, storage, and disposal of:

- Brass, typically recycled.
- Supply filters, non-contaminated.
- Exhaust filters, contaminated after use.
- Filters from the dust collection system, contaminated after use.
- Dust captured in the dust collection system.
- Vacuum waste, contaminated.
- Trap collection waste, contaminated.
- Projectiles captured in trap collection system.

Note: Contaminate refers to material with lead, copper, and other compounds typically at levels that classify them as hazardous waste for storage and disposal purposes.

4-8 STANDARD INDOOR RANGE FEATURES.

Design a ballistically contained structure that:

- Contains all shots from each intended firing location, at all respective targets, for all weapons and calibers based on the intended training in the facility.
- Provides airtight connections between walls and roof to prevent air leakage into the range that can interfere with the ventilation system's negative pressure.
- Seals all utility connections leading into the range.
- Provides proper detailing and door hardware for an airtight closure.

- Provides a maintenance double door behind the firing line.
- Provides at least one maintenance double door in the area behind the bullet trap. Two double maintenance doors, one on each side, may be necessary to provide access to all heavy items and equipment.

4-9 MULTIPLE BAYS.

To increase flexibility and reduce spans, ranges may be divided into separate bays with structural walls extending the length of the range from floor to roof that prevent air movement between bays. Ranges that have a partial dividing wall or an interior row of columns are not multiple bay ranges. Design each bay to operate independently from adjacent bays with separate and independent:

- Ventilation systems and controls.
- Bullet traps and trap related equipment.
- Target systems.
- Range control booths.

4-10 CEILING, WALLS, AND DOORS.

Design walls to reduce noise transmission to adjacent occupied spaces and to withstand negative and positive pressures that would be encountered should the ventilation supply or exhaust fans fail. Walls must provide an airtight enclosure to maintain negative pressure inside the range as required for range ventilation. Seal any penetrations in wall including ductwork and utility penetrations.

4-10.1 Uprange Ceiling and Wall Behind Firing Line.

Slope suspended ceiling from back wall to edge of safety ceiling behind firing line to provide a gradual transition for supply air movement to firing line. Place removable suspended ceiling panels along the width of the back wall under ventilation balancing dampers for maintenance access.

4-10.2 Ballistic Side and Downrange Walls.

Make side walls and the downrange wall behind the bullet trap a minimum of:

- Concrete: 8 in. (203 mm) thick using either cast in place, tilt up, or precast construction. Structural design and internal thermal insulation may dictate thicker walls. If internal cavity is provided, the interior section must meet the minimum thickness requirement. Walls must be smooth and flat with no protrusions, indentions, cavities, exposed steel, or any other feature presenting a ricochet hazard.
- Steel: Minimum 0.375 in. (9.5 mm) AR500 steel plate.

- Provide splatter protection on steel and concrete up to 8 ft. (2.4 m) above the floor and a minimum of 16.4 ft (5 m) down range of all firing positions, except do not place any splatter protection within 10 ft. (3 m) of the bullet trap. This is to allow inspection of the wall where it is most susceptible to bullet strikes.

4-10.3 Wall Joints.

Provide complete ballistic integrity across joints. For side walls, this includes joints from finished floor up to the highest point of the ceiling baffles. For the downrange wall behind bullet trap, this includes up to 12 ft. (3 m) above finished floor. Ballistic integrity can be accomplished using keyed construction joints or by placing 0.375 in. (9.53 mm) thick AR500 steel plate over the joint. When used, design plate to protect the joint and reduce chance of ricochets by:

- Flush mounting plate to wall.
- Placing a 45-degree bevel on the leading edge of the plate that faces the shooter, with the plate fitted securely to the wall with no gaps over 0.0625 in. (1.6 mm) between plate and wall.

4-10.4 Downrange Doors.

Avoid doors between the firing line and bullet trap, but they may be necessary on large ranges to meet Fire and Safety codes. When placed downrange past the firing line, doors and door hardware must meet UL 752 Level 8 protection standard. This includes doors on back wall behind the trap so that rounds cannot escape during a trap failure. Doors behind the bullet trap that are located on the side walls are not required to meet this UL level. Use locking hardware, panic hardware, or magnetic door locks to ensure personnel do not inadvertently enter during live fire events. For doors on the side wall between the firing line and bullet trap, a wall baffle must be placed just uprange of door extending from the floor to the height of the door to reduce the chance of an errant shot striking the door hardware.

4-10.5 Maintenance and Vehicle Entrance.

For each bay, include a 6 ft. (1.8 m) wide maintenance double door uprange at least 4 ft. (1.2 m) behind the firing line. A larger door may be required if vehicles will be used in training. These doors are not operated during training and therefore do not require a double airlock vestibule.

4-11 FLOORS.

Concrete floors must be level with a smooth finish, without any protrusions or irregularities.

- Seal all floor joints and design to minimize ricochet potential.
- Locate longitudinal floor joints between firing lanes. Provide backer material when necessary to support sealant.

- Sawn control joints more than 0.25 in (6.3 mm) wide are not permitted.
- Traditional chamfered construction joints are not permitted.
- Surface seal floor with a waterproof sealant to facilitate cleaning.
- Use non-reflective flat or flat satin sealant when range is designed to allow lasers.

Steel floors may be 0.375 in. (9.5 mm) AR500 steel plate with support to prevent sagging.

- Provide a slip-proof coating.
- Do not apply any surface on the flooring that prevents the bullets from reaching the bullet trap or that will entrap firing residue and hinder the cleaning of the range floor.

4-12 RANGE MARKINGS.

Provide permanent range markings as required by the service. Use nonreflective paint when designing for laser use. The following are recommended:

- 4 in. (100 mm) wide red floor stripe across the width of rear uprange firing line.
- 4 in. (100 mm) wide black stripe across the width of the range in front of the trap at the last target line.
- 4 in. (100 mm) wide vertical black stripes up both side walls with critical target distances starting at the floor and extending 4 ft. up the wall. Provide 4 in. (100 mm) letters above this line indicating distance with units in either yards or meters depending on training requirements. For ranges with fixed firing lines and movable targets, the distances must be measured starting at the firing line. For ranges with a fixed target line at the trap end, the distances must be measured from the target line back towards the firing lines.
- Lane markings at the firing line and the last target line are to be coordinated with users on size and type of markings. For Air Force projects see Chapter 2.
- 4 in. (100 mm) wide yellow ready line 8 ft. (2.4 m) behind the firing line.

4-13 TARGET SYSTEMS.

Choose target systems based on the type of training anticipated and scoring accuracy required. The type of target system used will influence the floor plan, baffle design, and range height and must be considered in the design. Policies for procuring range target system equipment vary between services. All target systems must be designed to prevent ricochets and splatter from returning to shooters, with steel and other hard material angled and no blunt edges presented to the firing line. A variety of systems are available. Some options are presented below.

4-13.1 Static Target Stands.

Basic target stands allow for manual placement of target. Stands may be of wood, poly synthetic, steel angled away from line of fire, or other material designed to reduce ricochets.

4-13.2 Overhead Target Rail System.

Overhead monorail target systems have:

- Rigid overhead rails.
- Capability of 180-degree turning targets.
- Capability of moving and stopping target at all target distances.
- AR500 angled steel plate on front of carrier, target clamps, and connections between clamp and carrier designed for anticipated weapons and ammunition.
- Target rails approximately 7.5 ft. (2.3 m) above the finished floor.
- Ability to control single targets from individual lanes.
- Ability to control both single targets individually and all targets collectively from controls in the range control booth.
- Programmable target positions in both yards and meters.
- Programmable parameters including positions, start/stop times, and edge face targets.
- Drive system located behind the firing line using a cable system for moving targets.

Optional:

- Dimmable light illuminating target on target carrier.
- 360-degree target turning.
- Self-driven target carriers with internal motors and drive system.

4-13.3 Running Man Targets.

Running man targets are typically mounted on overhead rails that move targets left and right across the width of the range near the last target line. Running man targets can be either a single target system or a double system that runs two targets in opposite directions at the same time. Coordinate rail location with bullet trap, overhead baffles, other target systems.

4-13.4 Fixed Turning Targets System.

Turning targets are located at the trap end and have a target clamp on a vertical pivoting rod to rotate targets between face and edge. Clamps must hold targets

securely but allow one-handed placement and removal of targets. The target clamp and vertical rods should be protected by 0.375 in. (9.5 mm) AR500 steel plate placed at an angle to extend life and help prevent ricochets. The unprotected components of the system must be placed behind overhead baffles to block line of sight from all shooting positions.

4-14 SHOOTING STALLS.

Shooting stalls may be used to provide shooting barriers, separate shooters, mount target controls, block ejecting brass from adjacent lanes, and limit ability of shooters to accidentally shoot sideways. Fold down or swing out tables and barricades may be included. Check individual service policy for requirements.

4-15 BARRIERS AND BARRICADES.

Training may require barriers or barricades and must be addressed in the design. Include storage space when they are not permanently affixed to the building. These may be portable wooden frames or features incorporated into shooting stalls. Other options include swing out barriers that fold flat to a side wall and barriers that can be temporarily attached to the wall and removed for storage when not in use. Check individual service policy for requirements and procurement policy. The following provides geometry for some service specific barrier and barricade requirements:

- Air Force: Position barricades as described in Chapter 2.
- Navy: Standing, low, and window barriers for Practical Weapons Courses in OPNAV 3591.

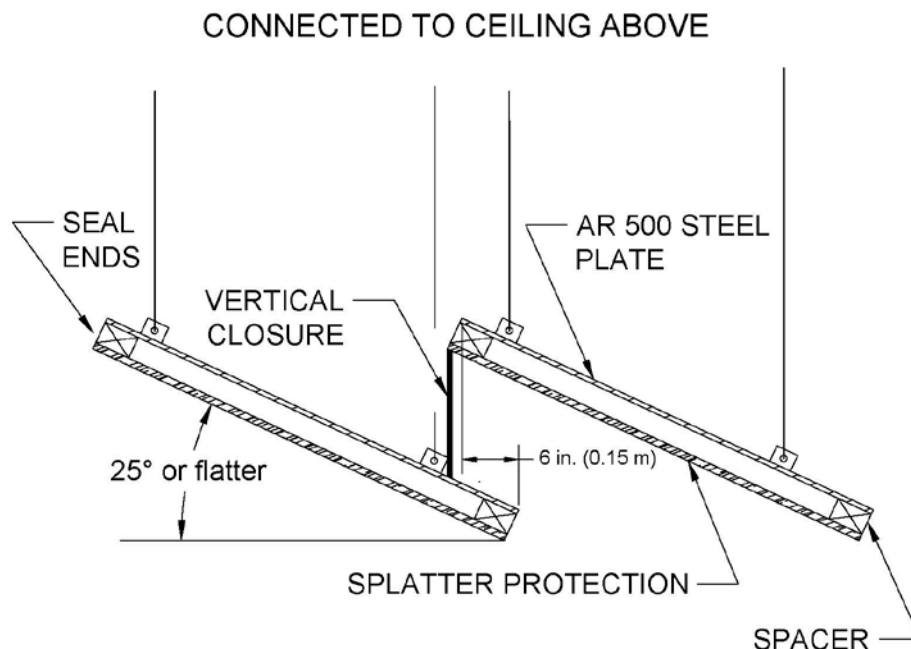
4-16 OVERHEAD BAFFLES AND SAFETY CEILING.

Design baffle system to provide complete overhead containment within the training area in accordance with Figure 4-3 and the following:

- Minimum 0.375 in. (9.5 mm) AR500 steel plate.
- Maximum 25-degree angle from horizontal.
- Minimum 6 in. (0.15 m) horizontal steel-steel overlap between adjacent baffles.
- Maximum 0.0625 in. (1.6 mm) gap between steel plates for butt joints and 0.125 in (3.2 mm) where backing plate or lap joint is used.
- Non-ballistic vertical closure sections from the lower end of one baffle to the upper end of the next baffle downrange to prevent air from moving between open area below to space above baffles.
- Complete coverage from side to side with no gaps. This can be accomplished by using an AR500 plate connected to the side wall that overlaps with the overhead baffles.
- Provide intermediate support to prevent steel plates from sagging.

- Sealed off baffle section between steel plate and splatter protection to prevent the creation of a plenum that would allow air to move between training area below and ceiling space above. Spacers may be run in either direction provided ends are sealed between steel plates and splatter protection.
- Splatter protection provided on all baffle surfaces a minimum of 16.4 ft (5 m) down range of all firing positions.
- A closure baffle as shown on the downrange section in Figure 4-2 above may be required to complete ballistic protection when a running man target system is used.

Figure 4-3 Overhead Baffles



4-17 BULLET TRAPS.

Unless directed otherwise, all new indoor bullet traps must be commercial steel traps. Design the trap for the most powerful round to be used. Steel traps must have:

- Minimum 0.375 in. (9.5 mm) thick AR500 steel plate. A thickness of 0.5 in. (12.7 mm) is recommended to increase the life of the plates. All plates will eventually wear and warp depending on weapons, ammunition, and usage.
- Capability to replace individual plates as they become worn or warped.
- Maximum lower ramp slope of 15 degrees off horizontal.

- Maximum slope of 15 degrees off horizontal for upper ramp plates immediately above the deceleration chamber. The upper ramp is typically hung from the roof.
- Continuous throat across the width of the trap with no vertical connector sections such that a rod placed inside the slot can move unimpeded across the width of the trap.
- Dust collection system to reduce dust at the trap end of the range. Provide forklift access to the dust collection drums.
- Spent round collection system. Provide forklift access to collection drums.

4-17.1 Cantilevered Upper Ramp Support.

On existing ranges where a steel trap is being added, verify the roof can handle the additional load. Where the additional load of the trap cannot be supported, a structural cantilevered arm mounted to the floor behind the trap may be used. The cantilever option reduces roof load but takes up more floor space and increases cost. Account for the extra space required when using a cantilevered arm mount.

4-17.2 Dust Collection System.

The trap must include a system to capture and collect airborne contaminants at the deceleration chamber that provides:

- Noise levels below 80 dB when measured 10 ft. (1.2 m) from the system.
- Fans and filters located outside on back or side wall of range.
- Monitoring from within range control booth with indicators that show when system is running, filter status, and when dust collection drums are full.
- The ability to turn system on and off from within range control booth.
- A minimum volumetric flow of 500 cfm (14 m³/min) for every 10 ft. (3 m) of trap.
- Sealed ductwork that prevents the escape of dust.
- HEPA filters on the exhaust.

4-17.3 Spent Round Collection System.

Choose either a simple bucket system or mechanical system:

4-17.3.1 Bucket System.

Bullets fall from the deceleration chamber into buckets underneath. System must be sealed to contain lead dust and allow for easy removal and replacement with no special tools.

4-17.3.2 Mechanical System.

These increase complexity and cost over the bucket system but reduce the labor involved in collecting projectiles. These can be either:

- Auger Bullet Collection Unit: Spent rounds fall from the deceleration chamber into a sealed trough below. An auger pushes the bullets and fragments to one side of the room where another perpendicular inclined auger raises and drops them into a collection drum below.
- Drag Conveyor: Same as auger system except a conveyor belt is used to move spent rounds and fragments to the collection drum.

Include capability to monitor status of mechanical system and to turn system on and off from within the range control booth.

4-17.4 Granular Rubber Trap Option.

A granular rubber trap may be used when approved. Do not use on Air Force or Navy ranges.

4-17.4.1 Advantages and Disadvantages.

Compared to steel bullet traps, granular rubber traps:

- Take up less space.
- Cost less.
- Capture rounds more intact and thus reduce lead dust at the trap end.
- Can provide some limited reduction in sound reverberation time.
- Require more routine maintenance.
- Will fail if rubber levels are not maintained properly.
- Can ignite if not used and maintained properly.

NOTE: Rubber trap fires have caused significant damage on several DoD indoor ranges, mostly from using tracers which should never be allowed at indoor ranges.

4-17.4.2 Design.

Do not reduce the range length when a rubber trap is chosen since it will eliminate the option of replacing the rubber trap with a steel trap in the future. Coordinate baffle and trap layout so that any round fired from any firing position will contact either 2 ft. (0.6 m) of rubber or an overhead steel baffle. Design the trap frame to hold the weight of the trap, rubber, and 120,000 7.62 mm projectiles for every 4 ft. (1.2 m) of trap across the width of the range. Design the trap to reduce the amount of rubber that spills onto the floor and include:

- Shredded rubber material with average diameter of 0.375 in. (9.6 mm) to 0.875 in. (22 mm).
- Clean chopped rubber that is 99.9 percent free of loose wire or exposed steel, by weight.
- Fire retardant and adhesion promotion treatment.
- Minimum 2 ft. (0.60 m) of rubber as measured perpendicular to the sloping face.

Coordinate with the local fire authority for design requirements that help contain smoke in the event of a fire including:

- Plenum and roof vents above the trap area to collect and release smoke.
- Vertical smoke barrier above the ceiling baffles across the width of the range towards the trap end to limit the movement of smoke uprange.
- Fire protection plan showing recommended access to trap in the event of a fire.

4-18 COMMUNICATIONS.

Include a loud speaker system between range control booth and range with volume control and capable of producing 110 dBA at the firing line. Locate as to not interfere with supply air flow. Include wall mounted handheld microphones for communication back to the range control booth, with one on each side wall and one on back wall below the range control booth window.

4-19 LIGHTING.

Design lighting system to reduce glare and provide independent lighting zones in accordance with Table 4-2 and:

- Locate downrange lights out of the line of fire. This can be accomplished by placing them behind the vertical section of the overhead baffles.
- Size and locate light and fixtures behind the firing line so they do not interfere with the supply airflow.
- Provide fully dimmable areas with flicker free lighting from 0 to 100 percent intensity levels.
- Locate lighting controls in the range control booth to allow adjustments with clear view of training area. Label controls to allow intuitive operation so that an operator unfamiliar with the system will be able to select and manipulate the controls accurately without any instructions.
- On ranges where training will occur using Night Observation Devices (NODs), all lighting, including emergency lighting, must be able to be turned completely off. Red lighting may be added downrange to assist visibility during low light training.

Table 4-2 Lighting Requirements

LOCATON	**FT CANDLES	TYPE
Range Control Booth.	60	Fully dimmable + dimmable red light.
Vestibules.	40	On/Off with switches in vestibule + range control booth.
Get Ready Area and Uprange Firing Line.	60	Fully dimmable + dimmable red light.
Target Area.	80	Fully dimmable.
Last Target Line.	100	Fully dimmable.
Area Behind Trap.	40	On/off.

** Measured at 4 ft. (1.2 m) above the floor.

4-19.1 Range In Use Lights.

Include a red Range In Use light above and outside vestibule entrances that indicate when range is in use. Light is on when range is operational. Locate switch in range control booth.

4-19.2 Security Training Lights.

Optional flashing lights may be required behind or above the firing line to simulate the flashing lights from security vehicles. Choose location to provide desired effect downrange while minimizing impact on ventilation air movement. Check with local security force for proper color and flashing effects.

4-19.3 Emergency Lighting.

For exit lighting, provide low profile lights oriented with smallest profile pointing downrange to minimize interruption of supply airflow.

4-20 NOISE.

Design range to meet:

- The maximum ambient and live fire noise levels in Figure 4-3.
- Reverberation Time 60dB (RT60) less than 1.3 seconds as described in the sound decay rate testing paragraph below.

4-20.1 Noise to Adjacent Land.

Consider all notable sources of noise associated with the training facility when determining its layout. Noise transmitted outside of indoor ranges can be significant and depends on several factors including weapons and ammunition, thickness and material of walls and roof, roof to wall connections, and direction of fire. Air handling and dust collection systems can also produce significant noise. Noise transmitted outside of indoor ranges can be reduced through a combination of strategic layout, acoustic dampening characteristics of construction materials, and construction methods. The location of the range and the adjoining land use will determine the acceptable level of noise transmitted outside of the range.

4-20.2 Noise Inside the Training Area.

The training area design must incorporate acoustic control elements to reduce internal ambient noise levels and reverberation time. To meet these levels, the acoustic design should incorporate strategic layout, construction materials with acoustic dampening characteristics, and intentional construction method types. The seals on doors and windows should be tight to minimize the direct transmission of noise out of the firing range and into other interior rooms or occupied spaces of the facility. Absorptive acoustical surfacing will reduce the noise level in the range. Ambient noise does not include the impulse noise generated by gunfire but does include other noise sources such as air handling and dust collection systems. Ambient noise levels are generally controlled by preventing the noise from reaching the occupied spaces. Some noise sources can be isolated from the occupied spaces. Walls with designated Sound Transmission Class (STC) ratings can also be used to separate noise generating equipment from occupied spaces. Extending partitions to the ceiling or roof level and sealing air gaps will reduce noise transmission.

Short duration impulse noise peaks created by gunfire will exceed the 85 dBA level and could exceed 160 dBA. Reflective surfaces in a range will reverberate noise during firing, extending the decay time of the noise.

4-20.3 Acoustical Treatment Locations.

Acoustic absorbing materials may be used behind the firing line and on the wall, ceiling, and ceiling baffle surfaces extending down range. Treat the ceiling baffle nearest to the firing line with acoustic absorbing materials as it is the most important ceiling baffle regarding noise levels behind the firing line. Floor areas of the range must remain bare concrete or steel. The floor behind the firing line may be covered with rubber or other acoustic mitigating materials so long as the materials are suitable for floor application and do not impede the removal of ammunition residue. Include the acoustic design calculations in the design analysis.

4-20.4 Acoustic Panels.

Acoustic panels may be installed on walls, ceilings, and baffles. Blown-on acoustic material and carpeting are not permitted due to the difficulty of cleaning accumulated

ammunition residue. Acoustic materials must be nonflammable and not impede the vacuum removal of ammunition residue. Do not paint acoustic tiles or surfaces as paint significantly degrades the sound absorbing qualities of the acoustic surfaces. Acoustic panels often serve dual purpose to mitigate sound and provide bullet splatter protection.

4-20.5 Acceptance Testing.

For all new, addition, and modification projects that include modifications to the sound-absorbing materials within the range, acceptance testing must be performed by an independent acoustic specialist whose firm is a member of the National Council of Acoustic Consultants.

4-20.5.1 Sound Decay Rate Testing.

The acoustic design must include mitigation methods and construction materials to reduce the measured Reverberation Time 60dB (RT60) to less than 1.3 seconds in the 250 Hz, 500 Hz, 1 kHz, 2 kHz, and 4 kHz octave bands in accordance with ASTM E2235. Testing must be performed in accordance with ASTM E2235 with noise generating devices placed at the firing line. Aim device parallel with the line of fire when not using omni-directional devices. The contractor must provide certified test results showing that the reverberation time requirements are met.

4-20.5.2 Ambient and Live Fire Noise Level Testing.

The contractor must provide certified test results showing that the ambient and live fire noise levels within the range do not exceed levels shown in Figure 4-3.

- All Ambient and peak noise level measurements must be taken with all range equipment on, including the air handling and dust collection systems, and no gun fire.
- All live fire noise levels must be taken with all range equipment on and with continuous gunfire from four Government provided shooters firing the maximum caliber design weapon, at full automatic if applicable, and using ball ammunition. Firing must be from the most uprange firing line without using suppressors.

Table 4-3 Maximum Noise Levels

	Maximum Ambient Noise Levels (dBA)	Maximum Live Fire Noise Levels (dBA)
Inside the Firing Range	75	Sound Decay Rate Test
Inside the Range Control Booth	60	85
Offices	45	55
Classrooms	45	55

4-21 RANGE VENTILATION.

In order to provide safe training and working environment, the ventilation system must limit exposure to airborne lead, copper, and other contaminants generated during small arms training. To achieve good air flow across the entire firing line, compliance with the following paragraphs is required. A recommended contracting strategy to help achieve these stringent requirements is provided in Appendix B.

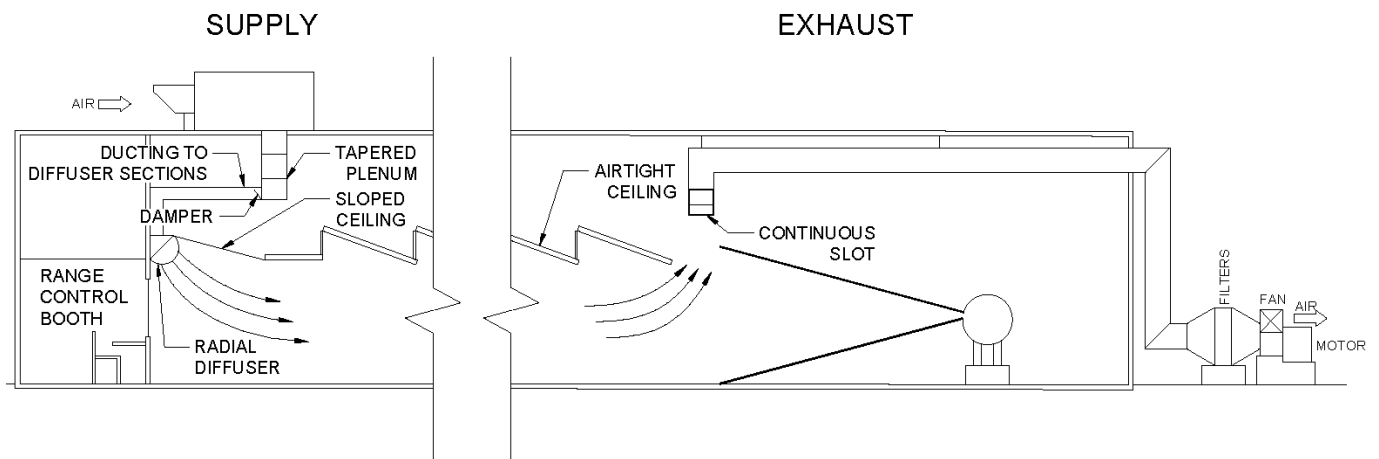
4-21.1 General Ventilation Requirements.

All ventilation system controls must meet the cyber-security requirements found in UFC 4-010-06. The training area ventilation system must be separate and independent from the support and administrative area ventilation system. Design the training-area ventilation system to meet the following:

- An air flow of 75 fpm (23 m/min.) at the firing lines meeting the acceptance standards included later in this section.
- 100 percent outside air with no recirculation.
- A negative pressure inside the range of -0.05 +/- .02 in (1.3 mm +/- 0.5 mm) of water column relative to the non-training areas in the range.
- Paired supply and exhaust units with each exhaust fan interlocked with one corresponding supply fan.
- The preferred location of the supply Air Handling Units (AHUs) is on the roof to reduce the amount of turbulence in the air before it reaches the supply plenums.
- The preferred location of the exhaust AHUs is on the ground to simplify filter changes.
- AHU motors limited to 75 horsepower or less.
- Variable Frequency Drives (VFDs) on all supply and exhaust AHU motors.

- Supply intake vents separated from exhaust outlets by a minimum 30 ft. (9 m).
- Location of exhaust ductwork coordinated with baffle and trap design to protect against direct hit and ricochets.
- Independent local control. Base-wide control systems may connect to the system for monitoring purposes but must not control or alter the system settings.
- Ductwork protection for all ranges within approximately one mile (1.6 km) of salt water bodies. Include a sprayed-on weather and corrosion resistant coating, such as the polyurea coating used to line truck beds, for all ventilation ductwork exposed to the environment. Consider for all other locations where corrosion is a problem. Choose material and thickness based on local conditions and ductwork material.
- See Figure 4-4 for a schematic range ventilation system.

Figure 4-4 Range Ventilation Schematic



4-21.2 Climate Control.

4-21.2.1 Heating.

Provide heat when sustained temperatures are under 50 degrees F (10 degrees C). Specify design heating temperature and heating type. Choose a dry bulb discharge temperature between 65 and 70 degrees F (18 and 21 degrees C) that minimizes temperature differentials between winter and summer temperatures inside the range. Air-to-air heat exchangers may be included in cold climates when cost savings are supported by life cycle analysis.

4-21.2.2 Cooling.

Provide cooling only in climates with both sustained temperatures over 100 degrees F and humidity over 70 percent. Evaporative cooling may be considered if reduced temperatures do not drive humidity over 65 percent.

4-21.3 Supply Distribution System.

Design system to provide:

- Supply air from the air handling unit through a continuous graduated plenum that is gradually tapered to produce an even pressure along the length of the plenum.
- A single or double duct with an adjustable damper leading from the tapered plenum to each diffuser section.
- Interconnected double wall radial diffuser sections at the top of the back wall above the viewing window, with each section a maximum 5 ft. (1.5 m) long. Design and size diffuser sections to provide enough surface and free area to smoothly transition air as it moves to the firing line. Radial diffusers may be half or quarter round.
- Noise from supply system limited to 70 dBA or less when measured at the most uprange firing line, with no whistling noise coming from the diffusers.
- Single stage Minimum Efficiency Reporting Value (MERV) 8 supply filters as a minimum.
- A supply filter system that prevents filters from being pulled into fan.
- Align dampers within the diffuser sections with lane dividers in order to facilitate testing and balancing.

For high debris areas, provide double stage supply filters consisting of a minimum MERV 8 filter followed by a MERV 13 filter. Take the direction of the prevailing local winds into consideration when selecting location and direction of supply intakes.

4-21.4 Exhaust System.

Design exhaust system to provide:

- An air volume of minimum 110 percent of the rated supply volume of air.
- An exhaust plenum located above and downrange of the trap entrance, with a semi-continuous slot at the intake spanning the entire width of the shooting lanes.
- Minimum exhaust duct velocities of 2000 ft./min (57 m/min).
- Air velocities of 350 to 450 fpm (10 to 13 m/min) across the filter media.
- A two-stage filtration system with a MERV 15 Bag filter no less than 26 in. long (66 cm) followed by a HEPA filter with a 99.95 percent efficiency rating.

- Three-stage HEPA rated racks, leaving one stage empty for future flexibility.
- AHUs sized to provide minimum 5 in. (127 mm) of external static pressure for filter loading over clean required static pressure.
- Factory HEPA rated filter housing for the HEPA filter.
- AHUs and filter housing with a minimum 4 ft. (1.2 m) clearance from all adjacent features.
- Filters capable of being removed and replaced by hand without any special tools or equipment.

4-21.5 Controls.

Incorporate a Direct Digital Control (DDC) system to:

- Initiate supply and exhaust fans at low speeds that ramp up to field adjustable levels as necessary to reach desired negative pressure inside the range.
- Provide gradual adjustments to power and prevent noticeable hunting and modulation of the AHUs.

Note: Values for adjustable parameters must be selected during design and adjusted during balancing as necessary to optimize air movement.

Incorporate the following:

- Two clearly labeled emergency red mushroom cutoff switches wired directly to the supply and exhaust VFDs and the heat enable that manually and safely shut off the entire ventilation system. Locate one switch in the training area behind the firing line and the other inside the range control booth.
- Ability to connect to the internet and allow remote diagnostics. The government will provide the internet connection.
- A ventilation control panel located in the range control booth with diagnostic screen, an on/off switch, and three condition lights on the panels: Safe to Shoot, Warning, and Do Not Shoot. Locate panel such that all condition lights are easily visible from all positions inside the booth.
- Diagnostic screen that scrolls through all conditions, settings, and status.

Require all controls and logic necessary to produce the following light conditions:

(1) Condition-Green Safe to Shoot light:

- All systems are within operating parameters.

(2) Condition-Yellow Warning light:

- Pressure drop across exhaust pre-filter is past adjustable set point.
 - Pressure drop across exhaust HEPA filter is past adjustable set point.
 - Pressure drop across supply filters is greater than an adjustable set point.
 - Range temperature is outside given adjustable set points.
- (3) Condition-Red Do Not Shoot light. If any of these conditions occur, controls will sound alarm and shut down range ventilation system:
- Either supply fan or exhaust fan is off.
 - Pressure differential for any of the air filters is outside extreme limits.
 - Doors leading into the range from the air lock vestibule remain open for more than a given set point, with an adjustable set point initially set to 5 min.
 - Door into trap area is opened.
 - Any door leading into the range training area from outside is opened.
 - Range pressure is outside the upper limit of zero in. of water and the lower adjustable limit for a given time limit initially set to 2 min.
 - Supply static pressure is below adjustable limit.

4-21.6 Acceptance Testing.

Test all new ventilation systems and any system where modification or adjustments have been made that would impact airflow.

4-21.6.1 Controls.

Test all controls for proper operation including fan start up and initiation, emergency cut offs, control panel operation, and all light conditions.

4-21.6.2 Air Flow.

Uprange:

Take measurements at the most uprange firing line in the center of each lane at 1 ft. (0.3 m), 3 ft. (0.9 m), and 5 ft. (1.5 m) off the floor. Test with clean filter first, then block off portions of HEPA filters to simulate a yellow warning condition and retest.

Acceptable readings for both scenarios are:

- No single reading under 50 fpm (15 m/min) or over 120 fpm (37 m/min).
- Each lane average between 60 fpm (18 m/min) and 90 fpm (27 m/min).
- Range average between 71 fpm (22 m/min) and 79 fpm (24 m/min).

Downrange:

- With clean filters and measurements taken at the most downrange position nearest bullet trap but no closer than 9 ft. (3 m) from trap, take three measurements at each lane at 5 ft. (1.5 m) off floor.
- Average of three lane readings must be between 50 fpm (15 m/min) and 80 fpm (24 m/min).

Retest as necessary until all acceptance standards are met.

Notes:

These acceptance test standards only apply to new ventilation systems and replacement of existing systems. For existing systems use NEHC TM 6290.99.

All meters can be unreliable when measuring non-ducted air flow of 50 fpm (15 m/min) and below. When 90 percent of the measurements along one line are acceptable, smoke tests should be used to verify the unacceptable readings. If the smoke tests show steady air movement downrange at these locations, they should be considered acceptable.

4-22 RANGE OPTIONS.

4-22.1 Relocatable Ranges.

Relocatable ranges constructed of modular sections are designed to be disassembled and relocated using standard overland transportation to alternate locations as the training requirements change or are relocated. To provide this relocatable capability the relocatable modular range must meet all requirements for indoor ranges above with the following exceptions:

- Indirect Support Areas are not required.
- The range control booth may double as the air lock vestibule on small ranges with three or fewer lanes.
- Buffer between end lanes and side wall is not required and distance from back wall to firing line may be reduced to 12 ft. (3.6 m). These modifications are allowed because relocatable ranges can be sealed better than typical indoor ranges and this improves the airflow control.
- The range control booth back to front distance may be reduced to 8 ft. (2.4 m).
- The floor may be 0.375 in. (9.5 mm) AR500 steel plate with support to prevent sagging. Provide a slip-proof coating. Do not apply any surface on the flooring that prevents the bullets from reaching the bullet trap or that will entrap firing residue and hinder the cleaning of the range floor.
- For ranges with defined lanes where no angled shooting is allowed, a more compact steel trap may be used with 0.5 in. (12.7 mm) AR500 steel plates, a vertical throat with replaceable knife edged sides lined up with

lanes and rated for the intended ammunition. The range ventilation exhaust may be routed through the trap to function as the dust collection system.

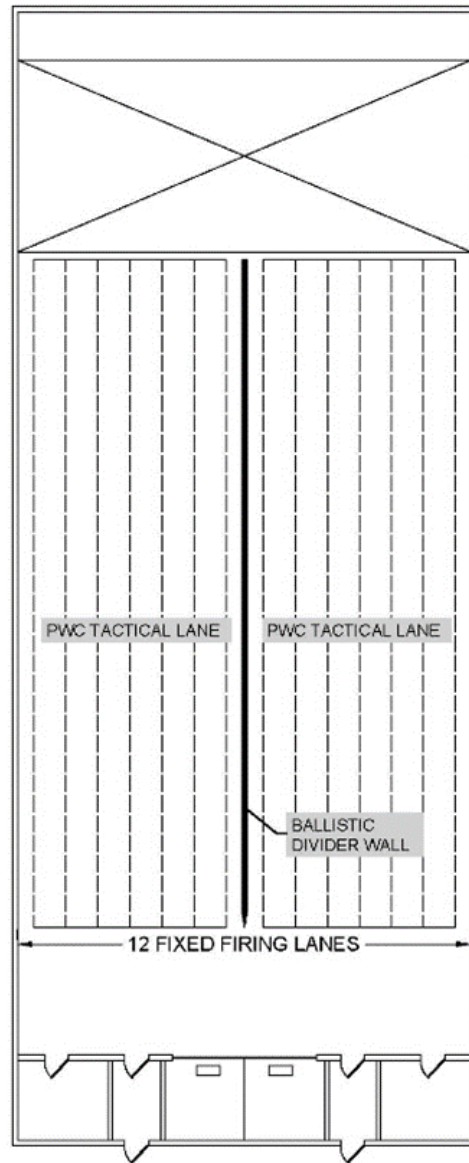
- A granulated rubber trap may be used when approved.
- In lieu of concrete, the downrange wall behind the trap may use 0.5 in. (12.7 mm) AR500 steel plate for ballistic containment.

4-22.2 Combination Fixed and Tactical Range.

A range with a ballistic center wall extending from the firing line to the base of the bullet trap can be used to increase flexibility by ballistically dividing the training past the firing line. An example is shown in Figure 4-5 that allows the range to operate as either:

- One 12 lane range with a fixed firing line to accommodate the Navy's OPNAVY 3591 rifle qualification course.
- Two tactical lanes with moving and shooting downrange at the same time to accommodate the Navy's OPNAV 3591 Practical Weapons Courses (PWC).

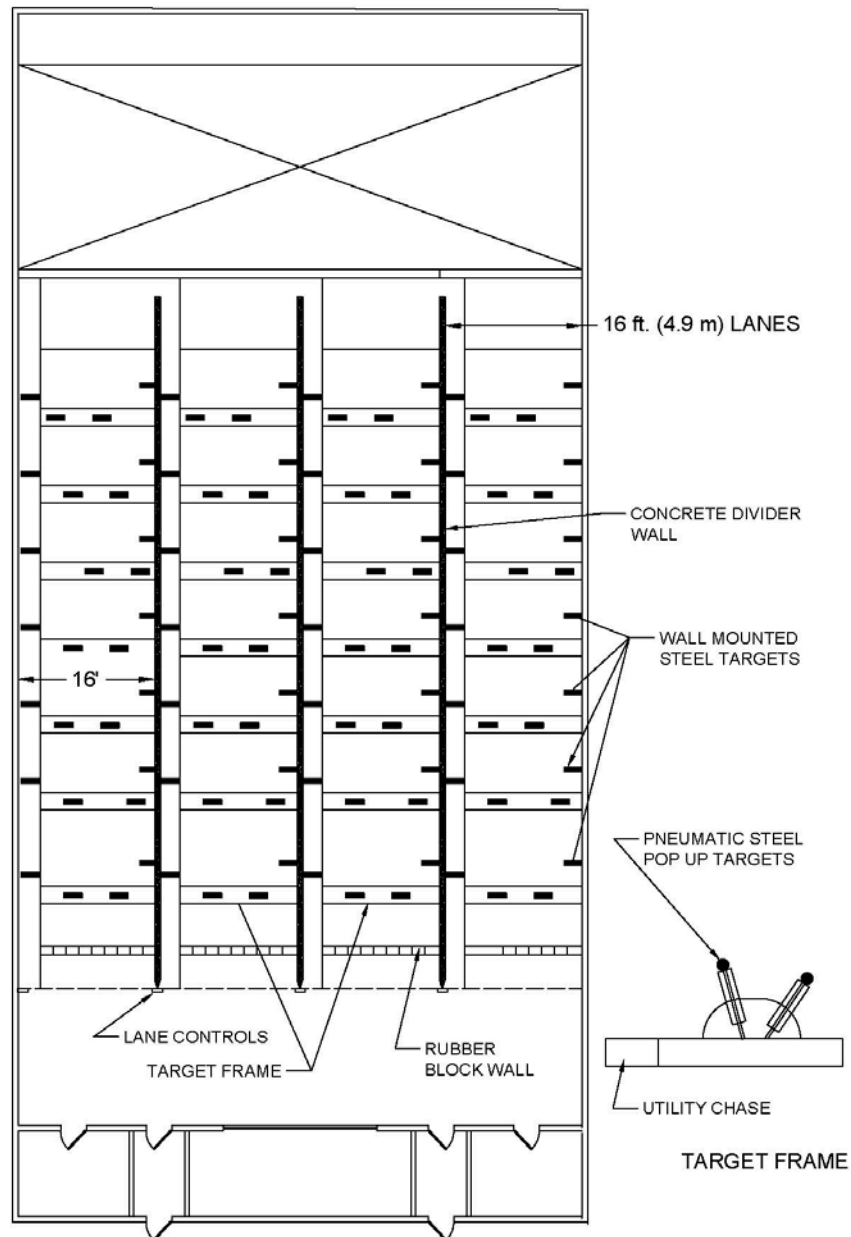
Figure 4-5 Range with Ballistic Divider Walls



4-22.3 Steel Reactive Range.

Advanced training with a knockdown steel target system provides immediate feedback to the shooters. One example is shown in Fig 4.6 but can be varied to meet training and maintenance objectives. This example has 16 ft. (5 m) wide lanes with a series of popup steel head plate targets in each lane. Limit ammunition to frangible rounds or as necessary to prevent rounds and splatter from coming back towards shooter and to minimize damage downrange. Design side walls and lane divider walls for direct hits and splatter where targets are placed near side walls. A control system and hit sensors can be designed to track and score hits. Protect target bases from direct hits.

Figure 4-6 Steel Reactive Range



4-22.4 Wide Angle Shooting.

Ballistic protection can be provided on side walls to allow shooting at angles of 180-degrees (side to side) or more. Downrange protection is provided by a bullet trap. There are several design options for protecting the walls with varying degrees of protection, space, and cost including:

- Placing 0.375 in. (9.5 mm) thick AR500 steel plates with splatter protection to a height of 8 ft. (2.4 m). This is only recommended when all rifle ammunition can be limited to frangible rounds.

- Covering the concrete side walls to a height of 8 ft. (2.4 m) with AR500 steel plate, with another wall in front consisting of a series of angled overlapping AR500 steel similar to a venetian blind trap and covered with splatter protection. The removable plates are sacrificial and should be sized and designed to meet the intended training and allow for easy removal and replacement. This is only recommended when all rifle ammunition can be limited to frangible rounds and rounds that do not have penetrators in the tip.
- Placing an 8 ft. (2.4 m) wall section designed with 0.375 in. (9.5 mm) AR500 steel plate, an approximate 2 ft. (0.6 m) air space, and a 12 in. (300 m) thick ballistic rubber block wall on the exposed shooting side. A wooden support system may be needed to secure the ballistic rubber blocks in place. The space is required to allow inspection of the underlying steel plates.
- Placing bullet traps along the side walls. This provides a high level of protection to the side walls but requires a significant amount of space.

CHAPTER 5 STEEL CLOSE QUARTER FACILITIES.

5-1 GENERAL

Close Quarter Combat (CQC) facilities, also known as shoothouses, allow up to 360-degree shooting into ballistic walls. These structures can be built to simulate locations where close quarter combat training may be needed including residential, commercial, industrial, and shipboard environments. CQC facilities may have the following features:

- A full ballistic enclosure that contains all rounds within the facility.
- Ballistic walls with a separate ballistic roof above.
- No ballistic roof. – These are considered outdoor ranges and require a 360-degree SDZ or a waiver.
- Catwalks across the tops of the ballistic panels that allow RSOs to monitor training below.
- Ventilation provided by either a mechanical system, open eaves to encourage natural air movement, ceiling fans, or some combination of these.
- Non-ballistic walls and limited to non-lethal force-force rounds.

5-1.1 Applicability.

This chapter provides criteria for live fire CQC facilities that have steel ballistic walls, a ballistic roof, and limited to:

- Frangible rifle rounds and pistol rounds fired directly into ballistic walls. Note: Frangible rounds produce less airborne contaminants, have reduced ricochet potential, do significantly less damage to steel plates, and greatly reduce the chance of wall failure.
- Ball rounds without tungsten or steel penetrators fired into bullet traps as the primary impact surface, with ballistic walls providing secondary containment.
- Facilities with formal, documented, routine inspections of all ballistic steel plates. All live rounds have the capability to eventually penetrate any ballistic wall and therefore routine inspections are critical.
- Shooting and movement training. These facilities are not intended for multiple shooters firing multiple rounds in one area in a short period of time which can overwhelm the ventilation system.

For Army shoothouses, refer to the information contained in DA Pam 385-63, TC 25-8 and the RDG for training intent, standard shoothouse layouts, design information, instrumentation, support facilities, etc. In the event of conflicting information, these documents take precedence over this UFC for Army shoothouses.

5-1.2 Items Not Addressed.

This Chapter does not apply to CQC facilities and shoothouses where:

- Rounds with tungsten or steel penetrators, such as M855 5.56 mm and M855A1 5.56 mm, are allowed.
- Explosives are used. Explosives requirements are outside the scope of this criteria.
- Shock Absorbing Concrete (SACON) is used for the ballistic walls.

For these facilities follow service provided guidance.

5-1.3 Design.

The design must address:

- Ballistic containment.
- Targetry.
- Fire protection and alarms.
- Lighting.
- Laser use.
- Ventilation to provide a safe training and working environment.
- Maintenance and Storage.
- Noise reduction to the extent possible.

5-2 RANGE AREAS.

A CQC facility can be divided into two different areas:

- (1) Live fire area where training occurs.
- (2) Support area.

5-2.1 Live Fire Area.

Size area and design ballistic panel layout to support intended training. Careful coordination with trainers is critical to provide a combination of hallways, doors, room sizes, and other training features that maximize training value. Recommend panel layout be approved early in the design phase. Strategically placed movable or swap-out panels may be used to allow significant floor plan changes with minimal effort and panel adjustments. Options include:

- Ballistic panels hung on rollers that slide on a track system above.

- Pivoting panels. As an example, a selected panel that creates a dead end on a hallway in one scenario may be designed to pivot 180 degrees opening that hallway but creating a dead end on an adjacent hallway.
- Swap-out panels designed to allow simple switching between wall and door sections.

When incorporated, design movable and swap-out panels to:

- Maintain ballistic protection between panel, floor, and adjacent panels.
- Allow changes that can be made by two people within a reasonable time with simple hand operated equipment is recommended.

When movable or swap out panels are used, consider requiring mock up panel sections for approval before full scale installation by contractor.

5-2.2 Direct Support Areas.

Design must account for the following:

- Storage for targets, range equipment, and expendables such as splatter protection and spacers.
- Maintenance area for range equipment, targets, and expendables.
- Mechanical and electrical rooms.
- Control space for lights, monitoring, and recording systems.

Restrooms, lockers, and showers may also be provided to support personnel inside the CQC facility.

5-3 EQUIPMENT AND SPECIAL EFFECTS.

Equipment and special effects to enhance training may be incorporated into the design, including:

- Camera systems and two-way Public Address (PA) system throughout.
- Equipment to produce special effects including smoke, lighting, sound, and smells.
- Digital Video Recorder (DVR) systems for recording training and providing after-action review.
- Simulator equipment to project moving targets onto ballistic panels with cameras that can sense and record hit and misses.

5-4 TARGET SYSTEMS.

Target systems may include any of the following:

- Paper targets.

- Overhead rail targets.
- Popup targets.
- Three-dimension (3-D) Targets that are visible when using NODs.

5-5 ALARMS.

Provide audio and visual alarms activated by mushroom switches at key locations on walls and catwalk. Design system to provide the following results when activated:

- Lights and alarms turn on.
- Ventilation system shuts down.
- Special effects, when provided, turn off.
- Magnetic doors, when provided, unlock.

5-6 FIRE PROTECTION.

Each CQC facility is unique and fire protection requirements such as life safety and means of egress, sprinkler systems, fire alarms, and other passive and active systems will vary based on the mission and features of the individual CQC. Therefore, coordinate with the DFPE early in the planning and design process for fire protection requirements.

5-7 LIGHTING AND ILLUMINATION.

Select lighting and illumination based on training goals, requirements, and:

- Include dimmable lighting throughout.
- Locate all lighting above ballistic panels. One option is a grid tracked system just above the panels.
- Include illuminators at key locations on catwalks, exits, and in training area that will not interfere with the light spectrum of Night Vision Devices.

5-8 NOISE.

Design to reduce ambient noise and noise from gunfire to the extent possible. The requirements in Chapter 4 are not feasible and do not apply to the training area. For classrooms and administrative rooms, meet the noise requirements in chapter 4 for these rooms.

5-9 LASERS.

Design for laser use by eliminating all reflective surfaces inside the range. Provide a nonreflecting coating on all surfaces visible from the live fire area including:

- Walls and ceilings.

- Joists and beams.
- Ductwork.
- Door and other hardware.
- Housings for cameras and special effects equipment.
- Exposed piping and utility features.

Exceptions: Any part of any feature where a coating would interfere with its operation including sprinkler heads, lights bulbs, lens, and emergency switches.

5-10 BALLISTIC PROTECTION.

5-10.1 Ballistic Walls.

All wall surfaces subject to live fire must have ballistic panels composed of a minimum 8 ft. (2.4 m) tall and 0.5 in. (13 mm) thick AR525 steel plate with splatter protection covering all surfaces exposed to live fire. Minimize the need for welding and only allow techniques that do not reduce ballistic properties.

5-10.1.1 End Closure.

Design panels with ballistic steel end closures so that there are no panels with open sides or tops for ricochets to escape. This includes all panel tops, doors, and ends of termination panels. Closure must be minimum 0.375 in. (9 mm) AR525 steel plate.

5-10.1.2 Joints.

Provide complete ballistic protection across joints. Where ballistic steel panels cover concrete walls, plates may be bolted to the concrete using concrete anchor fasteners with a flat AR525 steel plate of same thickness as panel covering the joint.

5-10.2 Ballistic Roofs and Decking.

Design the roof to provide weather protection and ballistic containment consisting of either:

- Minimum 3 in. (76 mm) thick concrete.
- 0.375 in. (9.5 mm) thick AR500 Steel Plate.
- Bullet resistant fiberglass panels UL 752 protection level 8.

For multi-story CQC facilities, design deck between floors subject to direct fire on either side with a minimum 4 in. (150 mm) thick concrete, 0.375 in. (9.5 mm) AR500 steel, or ballistic equivalent.

5-10.3 Exterior Openings.

Design exterior openings subject to live fire to prevent rounds from escaping through a combination of:

- Controls and limitations.
- Lockable Level 7 UL 752 ballistic doors.
- Offset ballistic exterior walls covering exits.

5-10.4 Army Shoothouses

- Army shoothouses not designed to support EPR rounds require an exception to standard in accordance with AR 350-19.
- Army shoothouses do not require a ballistic roof; an SDZ deviation may be required.
- The ballistic walls are intended for secondary containment only, bullet traps or hot walls are required behind targets to capture the majority of rounds.
- Bullet traps must be designed for the specific rounds that will be fired in the facility.
- Moveable/sliding covers are an option for covering exterior openings.
- Other materials, as shown in DA Pam 385-63, are allowable for the shoothouse walls.

5-11 CATWALKS.

Catwalks may be included in the design when required to support the training or to provide the range safety officer with visibility and control. Design layout such that all rooms below are observable from positions on the catwalk. Provide stairs to the catwalk outside the ballistic panel enclosure. Where roof overhangs perimeter panels, consider locating the stairs outside the panels but inside the roof line. Retractable vertical ladders may be provided to allow floor access from catwalks above. Ladder should be in the raised position until needed. Catwalks can be supported from above to allow reconfiguration of the panels below in the future.

5-12 VENTILATION.

Consider maintenance and noise to adjacent areas when selecting location of ventilation equipment. Ventilation requirements in Chapter 4 do not apply. Design a mechanical ventilation system to:

- Create air movement within all rooms that clears smoke between training runs.
- Provide each fan with VFD and DDC controls tied to the control room to allow gradual start up and adjustment for obtaining optimal air movement.
- Limit all motors to 75 horsepower or less.
- Minimize noise and vibrations. Provide fans with vibration spring isolation that meet seismic requirements.

- Provide a Noise Criterion (NC) rating of less than 50 on exhaust grills during normal facility operations.
- Roof access to mechanical equipment that meets safety and force protection requirements.

Army ventilation requirements are contained in DA Pam 385-63.

5-12.1 Air Flow Requirements.

Design system to move air and clear smoke from all live fire rooms that meets the following:

- Top to Bottom Systems: A minimum cfm (m/min) to provide a vertical air velocity of 25 fpm (7.2 m/min) in all live fire areas.
- Over the Top and Open Eave Systems: Design system to clear smoke from all rooms within three minutes and all hallways within six minutes. To achieve this, the designer must specify a minimum cfm (m/min) based on the design and account for short circuiting, but as a minimum use 40 air changes per hour (ACH).

Note: A cfm selected based on 20 ACH will theoretically clear smoke within 3 minutes. Smoke will usually take much longer to clear due to short circuiting and inefficiencies.

5-12.2 Design Documents.

Design documents must include:

- Location and cfm for all AHUs.
- VFDs on all supply and exhaust motors.
- Roof penetrations and curb detail for all roof mounted equipment.
- Location and sizing of ductwork. Coordinate with catwalk and structural features.
- Location and sizing of supply and exhaust diffusers and registers.
- Filters location and requirements.
- Acceptance test requirements.

5-12.3 HEPA Filters.

The requirement for HEPA filters on the exhaust will be made on a case-case basis as determined by the responsible local environmental office. When HEPA filters are required, design as follows:

- Locate all exhaust AHUs on the ground.
- Provide two stage filtrations using a MERV 15 Bag filter no less than 26 in. (66 m) long followed by a 99.97 percent HEPA filter.

- Provide 3 stage HEPA rated racks, leaving one stage empty for future flexibility.
- Include 4 in. (100 mm) of external static pressure for filter loading in addition to that required for operating with clean filters.

5-12.4 Contractor Experience.

It is highly recommended that a range ventilation contractor, experienced in providing systems with similar requirements, is made responsible for the final design and construction of the ventilation system including controls and balancing. An approach similar to that recommended in Appendix B for indoor ranges can be used.

5-12.5 Acceptance Tests.

Acceptance tests must include the following:

- Air flows at supply and exhaust: Test and balance each supply diffuser and exhaust register against the design air flow. Provide acceptable readings based on system provided.
- Smoke Tests: With the system set in training mode with doors shut and the ventilation system turned on, release smoke into each room using smoke machines capable of filling rooms with smoke. Smoke in all rooms must show movement and signs of clearing and be completely clear within the time specified. Any rooms where smoke is stagnant or fails to clear room completely within time specified constitutes failure requiring the contractor to readjust and modify system until all rooms pass test.

5-13 ENCLOSED CQC FACILITIES.

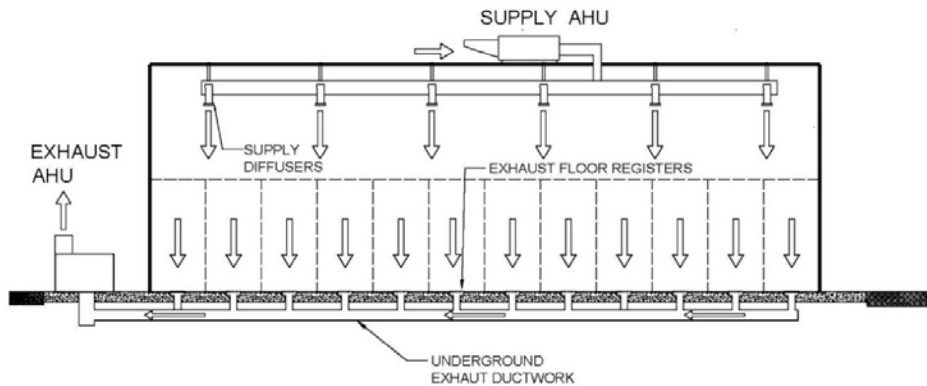
A concrete structure with a ballistic roof to prevent any round from leaving the facility. Ballistic steel panels with splatter protection must cover all surfaces subject to live fire. Multiple levels may be provided.

5-13.1 Top to Bottom Ventilation System.

Design a mechanical ventilation system that supplies air from the top and exhaust air through floor registers spaced a maximum of 10 ft. (3.0 m) on center. Floor registers must be flush with floor and a maximum of 0.25 in. (6 mm) openings to prevent brass from entering pit. Coordinate floor register layout with panel layout to minimize the number of walls on top of floor registers. See Figure 5-1.

Army ventilation requirements are contained in DA Pam 385-63.

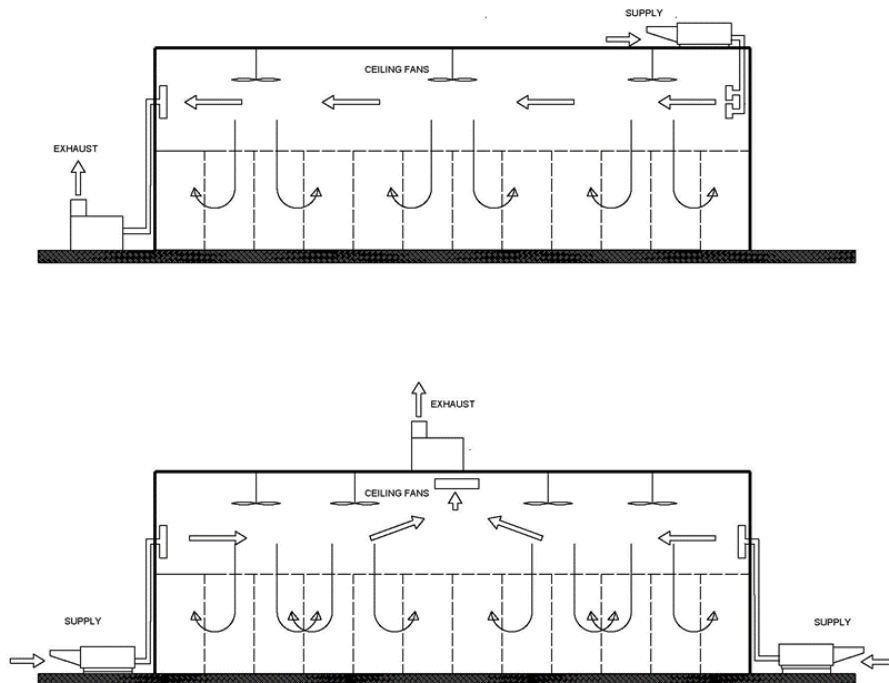
Figure 5-1 Top to Bottom Ventilation System Schematic.



5-13.2 Across-the-Top Ventilation System.

Design a mechanical system that moves air across the top of the panels with supplemental blowers or ceiling fans to push air down into the rooms below. AHUs can be roof or ground mounted. The schematics in Figure 5-2 show options for roof and ground mounted AHUs.

Figure 5-2 Across-The-Top Ventilation System Schematics.



5-14 CQC FACILITIES WITH OPEN EAVES.

This facility has ballistic steel plates connected to a concrete floor, with splatter protection on all shooting sides. A separate roof structure is built over the ballistic walls

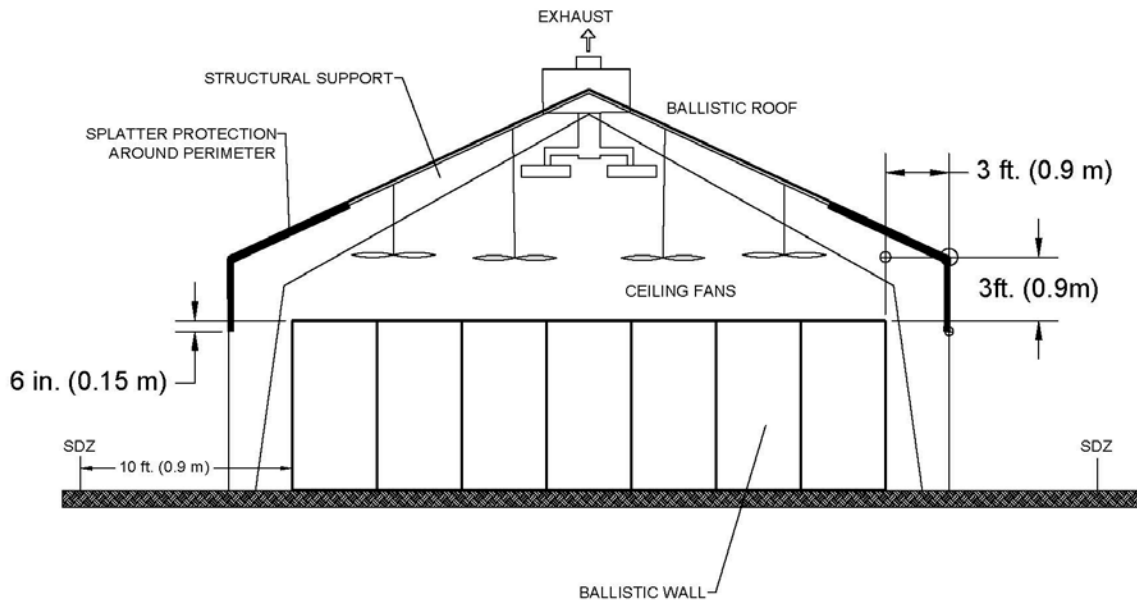
with structural columns connected to the concrete outside the ballistic walls creating an open eave in between.

5-14.1 Minimum Distances.

As a minimum, provide the following clearances between ballistic roof and walls:

- Minimum 3 ft. (0.9 m) above ballistic walls.
- Minimum 3 ft. (0.9 m) away from ballistic walls.
- Roof sides extend a minimum 0.5 ft. (0.15 m) below height of ballistic walls.
- See Figure 5-3.

Figure 5-3 Ventilation System Supplemented with Natural Airflow



5-14.2 Ventilation.

Design system with open eaves to promote natural air movement supplemented with ceiling fans or blowers and exhaust fans pulling air from above.

Army ventilation requirements are contained in DA Pam 385-63.

APPENDIX A BEST PRACTICES

This information is guidance and not requirements. The main purpose is to communicate proven system/facility solutions and lessons learned and may not be the only solution to meet UFC requirements.

A-1 INDOOR RANGE VENTILATION CONTRACTING STRATEGY.

Providing a ventilation system that limits exposure to airborne contaminants is challenging because:

- Range ventilation is a significant portion of the construction cost.
- Performance testing includes measuring airflow velocities at each lane and firing position and comparing them to strict acceptance standards, and this typically comes near the end of the project.
- Meeting the required average airflow velocity across the width of the range is relatively easy, but meeting airflow requirements at each lane and firing position can be very difficult.
- Numerous failures have occurred when inexperienced range ventilation contractors were used.
- When failures occur, it can be difficult to determine whether the problems are related to the design, construction, controls, balancing, or testing. It can be especially difficult when these responsibilities are split between several sub-contractors, which is typically the case.
- The problem persists with both full design and design-build projects.
- Should the system fail to meet the acceptance standards, it may be difficult and time consuming to resolve problems. Significant rework may be required.

Therefore, it is highly recommended that the contract documents only allow range ventilation contractors with proven experience meeting these or similar performance standards and require that this contractor be responsible for the final design, construction, controls, testing, and balancing of the system. In addition:

- Range experience alone should not be considered, it must be experience meeting similar performance requirements since the majority of non-DoD indoor ranges do not use these stringent standards.
- The acceptance testing should be witnessed by experienced government personnel or third parties to verify all tests are performed properly.

A recommended contracting strategy is provided below.

A-1.1 Phase 1 – Requirement Development.

For Design-Build (DB) projects, this is the Request for Proposals (RFP). For Design-Bid-Build (DBB) projects, this is the project design phase.

For DBB and DB projects, include the following in the contract documents:

- Power supply location, and verification that power is sufficient.
- Minimum air flow in cubic feet per minute (cfm) and cubic meters per minute (m³/min.) required for both supply and exhaust systems.
- General location of Air Handling Units (AHU), including whether they are roof or ground mounted. Require stair access to roof when AHUs are located on roof.
- General location of dust collection and spent round collection systems.
- General location of ductwork and diffusers.
- Filter and filter rack requirements.
- Heating requirements.
- Cooling requirements. Cooling is only required in extremely hot climates.
- Ventilation contractor's experience requirements.
- Design requirements edited for the project, with all options selected or clarified as appropriate.
- Acceptance testing requirements.

For DBB projects, the additional detail below is required to allow coordination with other design disciplines:

- Location of AHUs. Provide estimated weights and electrical loads of all equipment.
- Power connection details.
- Location and general sizing of ductwork, dampers, and radial diffuser in enough detail to allow coordination and avoid conflicts with other design disciplines.
- Exact location of VFDs, control panels, and emergency cutoffs switches.
- Roof penetration and curb details shown for all AHUs and ductwork.
- Section at wall between range control booth and training area showing radial diffuser, ductwork to diffusers, viewing window, suspended ceiling, and structural ceiling.
- Stair access when exhaust AHUs are roof mounted.

Options to be selected and included in the Phase 1 stage:

- Location of supply AHUs: Locate on the roof when possible and centered with symmetrical ductwork leading to the supply diffusers.

- Location of exhaust AHUs: Locate on the ground when possible to allow easy replacement of HEPA filters. When located on the roof, stair access must be provided.

A-1.2 Phase 2 - Ventilation Contractor Requirements.

Make the ventilation contractor responsible for providing the final design, construction, controls, balancing, and final acceptance testing of the range ventilation system. Require that contractor to have completed a minimum of five indoor range ventilation projects with similar design and acceptance testing requirements, including 75 fpm (23 m/min.) air velocity when measured along the entire rear firing line and at least three different heights. During the bidding process the ventilation contractor is encouraged to submit a Request For Information (RFI) if, in their opinion, the Phase 1 design requirements will not result in a system that meets the performance acceptance tests.

Have the ventilation contractor provide:

Prior to starting work:

- Proof of previous experience, including contract documents from each project showing design and acceptance test requirements, along with final acceptance test reports.
- A confirmation that they can provide a system meeting the Phase 1 design and the acceptance testing performance requirements.
- Full design of ventilation system including duct design and supply, exhaust, and filter schedules.

At end of work:

- Prior to acceptance testing, a detailed testing plan for approval with a checklist and step-by-step procedures in a logical sequence.
- Acceptance testing performed in the presence of the Contracting Officer Representative. Provide all materials, equipment, and personnel necessary to perform the tests including smoke generators, air flow meters, communications, plan, and checklist.
- Operations and Maintenance manuals.
- A minimum 8 hours of on-site training covering operations, maintenance, and troubleshooting of the entire range ventilation system.

This Page Intentionally Left Blank

APPENDIX B DOD WEAPONS AND AMMUNITION

A wide variety of small arms weapons and ammunition is used throughout DoD. Some common weapons and ammunition categories are listed below. The Army's Hazard Classification of United States Military Explosives and Munitions is a useful guide that provides detailed information on every DoD approved round including a unique identifier known as the Department of Defense Identification Code (DODIC).

B-1 WEAPONS.

- 12-gauge Shotguns.
- Pistols/handguns: 9 mm and .45 cal.
- Rifles : M4/M16 5.56 mm variants, M14 7.62 mm.
- Crew Served Weapons: M249 5.56 mm and M240 7.62.
- M2 .50 cal. Machine gun.

B-2 CATEGORIES OF SMALL ARMS AMMUNITION.

Most weapons can chamber different types of ammunition with different characteristics. Here are some different types of ammunition and typical uses:

- Short Range Training Ammunition (SRTA): These training rounds much shorter maximum distances than standard rounds allowing them to be used in areas where SDZs prohibit standard ammunition. Some SRTA rounds rely on light plastic projectiles to limit distance and others rely on projectile design to intentionally destabilize the flight path. These rounds are typically lethal and should not be confused with non-lethal training rounds.
- Frangible rounds: These training rounds are designed to disintegrate into tiny particles after impacting steel for minimizing penetration, reducing back splatter, and reducing damage to range components on indoor ranges and Shoothouses. They create more fragment and dust which may increase filter loading. These rounds are lethal and should not be confused with non-lethal training rounds.
- Reduced and zero lead content rounds: Some rounds are completely lead free. Other have small amounts of lead in the primer to prolong shelf life. These rounds can reduce or eliminate the chance of lead exposures and may reduce the costs of disposal of range filters and clean up debris. However, they may contain other potentially harmful compounds and therefore do not lessen range ventilation requirements.
- Non-lethal ammunition: These rounds allow force on force training (participants shoot at each other). They do not imply zero risk and serious injury can occur if not used properly. The DoD versions typically have small amounts of lead in the primer to increase shelf life.

- Rounds with steel penetrators: These rounds have steel penetrators to increase penetration through steel, but generally not to the extent of AP rounds.
- Armor Piercing (AP): These rounds have tungsten tips (or penetrators) to increase penetration through steel. These should not be allowed on indoor ranges, or on outdoor ranges with steel bullet traps or steel targets.
- Tracer rounds: Typically used in belt fed weapons loaded with standard rounds plus a tracer round every fourth or fifth link. Tracer projectiles contain a pyrotechnic making the trajectory visible and enabling the shooter to make aiming corrections. These should not be allowed on indoor ranges and shoothouses.
- Breacher Rounds: Shotgun slug or shot made especially for employment close range into door hinges.
- Multiple Properties: Some rounds have multiple characteristics such as being both lead free and frangible, or SRTA and frangible.

APPENDIX C GLOSSARY

C-1 ACRONYMS

AFCEC	Air Force Civil Engineer Center
AHU	Air Handling Unit
AP	Armor Piercing
AR	Army Regulation
AR	Abrasion Resistance (When used in conjunction with steel plate)
BIA	Bilateral Infrastructure Agreement
BMP	Best Management Practices
CCMCK	Close Combat Mission Capability Kit
CFR	Code of Federal Regulations
CQC	Close Quarter Combat
DA PAM	Department of the Army Pamphlet
dBA	A-weighted decibels
DB	Design Build
DBB	Design-Bid-Build
DDC	Direct Digital Control
DF	Direct Fire
DoD	Department of Defense
DODIC	Department of Defense Identification Code
EOD	Explosive Ordnance Disposal
EPR	Enhanced Performance Round
FAA	Federal Aviation Administration
FL	Firing Line
FLFS	Firing Line Floor Surface

GIS	Geographic Information System
HBW	Hardness Brinell Wolfram (Tungsten)
HE	High Explosive
HEPA	High Efficiency Particulate Air
HNFA	Host Nation Funded Construction Agreements
HQUSACE	Headquarters, U.S. Army Corps of Engineers
KD	Known Distance
LAW	Light Antitank Weapon
LLF	Lower Limit of Fire
LOMAH	Location Of Miss And Hits
LOF	Line of Fire
LOS	Line of Sight
MERV	Minimum Efficiency Reporting Value
MCO	Marine Corps Order
MIT	Moving Infantry Target
MOUT	Military Operations in Urban Terrain
NAVFAC	Naval Facilities Engineering Command
NOD	Night Observation Device
NOSSA	Naval Ordnance Safety and Security Activity
OSSHA	Occupational Safety and Health Administration
RCP	Reinforced Concrete Pipe
RDG	Range Design Guide
RFP	Request For Proposal
RMTK	Range Mangers Tool Kit
RSO	Range Safety Officer

RT60	Reverberation Time 60dB
SACON	Shock Absorbing Concrete
SAR	Small Arms Range
SAW	Squad Automatic Weapons
SDZ	Surface Danger Zone
SESAMS	Special Effects Small Arms Marking System
SOP	Standard Operating Procedures
SOUM	Safety of Use Memorandums
SOFA	Status of Forces Agreements
SRTA	Short Range Training Ammunition
STC	Sound Transmission Class
TC	Training Circular
UFC	Unified Facilities Criteria
ULF	Upper Limits of Fire
U.S.	United States
USACE	United States Army Corps of Engineers
UXO	Unexploded Ordnance
VDZ	Vertical Danger Zone
VFD	Variable Frequency Drive

C-2 DEFINITION OF TERMS

Close Quarter Combat (CQC) Facility: A live fire shoothouse that supports short-range training such as room-room clearing.

Crew Served Weapon: Any weapon system that requires a crew of more than one individual to function at optimum efficiency such as a belt fed machine gun.

Direct Fire: Fire delivered to a target within the line-of-sight of the shooter using the target itself as the point of aim.

Distance X: The maximum distance a projectile (to include guided missiles and rockets) will travel when fired or launched at a given quadrant elevation with a given charge or propulsion system.

Double Hearing Protection: Wearing earplugs in combination with noise muffs or noise attenuating helmets. Impulse noise levels can be so high that single hearing protection does not adequately protect hearing.

Dry Fire: Operating a weapon with no ammunition in the chamber. Not all weapons should be dry fired.

Firing Line (FL): The line which consists of firing points or positions, from which weapons systems are fired.

Firing Line Floor Surface (FLFS): The ground surface along the firing line.

Firing Position: The point or location at which a weapon system is placed for firing.

Indirect Fire: Fire delivered to a target when the weapon is not in line of sight with the target.

Line of fire (LOF): An imaginary line drawn from the shooting position to the target.

Live Fire: As used in this UFC, live fire includes use of any potentially lethal ammunition.

Lower Limit of Fire (LLF): An imaginary line consisting of the lowest point on all LOFs combined. This is often taken drawn a prone shooter firing at the lowest target.

Military Operations in Urban Terrain (MOUT) Facility: A mock town or city providing urban warfare training.

Navigable Waterway: Any body of water open to the free movement of marine vessels.

Officer in Charge (OIC): The officer, WO, or Non-Commissioned Officer (NCO) responsible for personnel conducting firing or operations within the training complex.

Partially Contained Range: This range has a covered firing line, side containment, overhead baffles, and a bullet backstop. Direct fire is totally contained by the firing line canopy, side containment, baffles, and bullet trap (no "blue sky" observed from firing positions). Ricochets and splatter are not contained.

Range Safety Officer (RSO): The officer, warrant officer (WO), or noncommissioned officer (NCO) who is the direct representative of the Officer In Charge (OIC) for insuring the adequacy of safety of firing, training operations, and ensuring compliance with laser range safety and local standing operations. Qualifications vary between services.

Reverberation Time 60dB: The time it takes for the sound pressure level to reduce by 60dB, measured after the sound source is abruptly switched off.

Shoothouse: See Close Quarter Combat (CQC) Facility.

Single Hearing Protection: Wearing either earplugs, noise muffs, or noise attenuating helmets.

Small Arms: For this UFC small arms includes all pistols, shotguns, rifles, carbines, submachine guns, light, medium, and heavy machine guns up to and including .50 caliber.

Sound Transmission Class: A rating used to compare the acoustical isolation of different barrier materials or partition constructions.

Surface Danger Zone (SDZ): The ground and airspace designated within the training complex (to include associated safety areas) for vertical and lateral containment of projectiles, fragments, and debris, and components resulting from the firing, launching, or detonation of weapons systems to include explosives and demolition.

Upper Limit of Fire (ULF): An imaginary line consisting of the highest point on all LOFs combined. This is often taken drawn from a standing shooter firing at the highest target.

Vertical Danger Zone (VDZ): For non-contained and partially contained ranges, the VDZ is the volume of airspace above the SDZ between the ground surface and the maximum ordinate of a direct-fired or ricochet round. The height of the VDZ varies with the weapon and ammunition fired. For fully contained ranges, the VDZ is the area between the SDZ and the upper limits of containment.

APPENDIX D REFERENCES

AMERICAN SOCIETY FOR TESTING AND MATERIALS

<https://www.astm.org/>

ASTM C75, *Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe*

ASTM E10-08, *Standard Test Method for Brinell Hardness of Metallic Material*

ASTM E2235, *Standard Test Method for Determination of Decay Rates for Use in Sound Insulation Test Methods*

CODE OF FEDERAL REGULATIONS (CFR)

<https://www.gpo.gov/>

29 CFR PART 1910.25 *Occupational Safety and Health Administration*

33 CFR 334 *Danger Zone and Restricted Area Regulations*

DEPARTMENT OF THE AIR FORCE

AFMAN 31-129, *USAF Small Arms and Light Weapons Handling Procedures*

AFI 36-2654, *Combat Arms Program*

AFMAN 36-2655, *USAF Small Arms and Light Weapons Qualification Programs*

ETL 11-18, *Small Arms Range Design and Construction*

FC 4-179-03F, *Air Force Indoor Small Arms Range*

DEPARTMENT OF THE ARMY

<https://www.Armypubs.army.mil>

Army Range Design Guide (RDG) Web Based tool - access provided by project sponsors.

AR 350-19, *Army Sustainable Range Program*

AR 350-52, *Army Training Support System*

DA PAM 385-63, *Range Safety*

Range Managers Toolkit (RMTK) – check with sponsor.

TC 25-8, *Training Ranges*

USACE Centers of Standardization (CoS)

Outdoor Sports Facility Standards. check with sponsor.

U.S. Army Defense Ammunition Center

Hazard Classification of United States Military Explosives and Munitions

DEPARTMENT OF THE NAVY

<https://www.public.navy.mil>

OPNAV 3591.F *Small Arms Range Training and Qualification*

OPNAV 5100.27.B *Navy Laser Hazard Control Program*

Navy Environmental Health Center

Technical Manual NEHC TM 6290.99 *Indoor Firing Ranges Industrial Hygiene Technical Guide*

Naval Facilities Engineering Command

Military Handbook 1027-3B *Range Facilities and Miscellaneous Training Facilities Other Than Buildings*

ENVIRONMENTAL PROTECTION AGENCY

<https://www.epa.gov/nscep>

902-B-01-001 *Best Management Practices for Lead at Outdoor Shooting Ranges*

AP 42, *Compilation of Air Emission Factors*

MILITARY SPECIFICATIONS

Mil-A-46100 *Armor Plate, Steel, Wrought, and High-Hardness*

UNDERWRITER'S LABORATORY

<https://www.ul.com>

UL 681, *Installation and Classification of Burglar and Holdup Alarm Systems for Alarm System Installation*

UL 752, *Standard for Bullet-Resisting Equipment*

UL 2050, *National Industrial Security Systems* - only distributed to those demonstrating relevant national industrial security involvement

UNIFIED FACILITIES CRITERIA

http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4

UFC 1-200-01, *DoD Building Code*

UFC 1-200-02 *High Performance and Sustainable Building Requirements.*

UFC 3-120-01, *Design: Sign Standards*

UFC 3-600-01, *Fire Protection Engineering for Facilities*

UFC 4-010-01, *DoD Minimum Anti-Terrorism Standards for Buildings*

UFC 4-020-01, *DoD Security Engineering Facilities Planning Manual*

UFC 4-020-02, *DoD Security Engineering Facilities Design Manual, (currently in draft and unavailable)*

UFC 4-021-02NF, *Security Engineering Electronic Security Systems*

UFC 4-020-04A, *Electronic Security Systems: Security Engineering*

UFC 4-215-01 *Armories and Arms Rooms*

UNITED STATES MARINE CORPS

MCO 3570.1C, *Range Safety*

MCO P3350.10 *Policy and Procedures for Range and Training Area (RTA) Management*

Range Managers Toolkit (RMTK) – check with sponsor.