CHAPTER 11

TUBE RANGES

INTRODUCTION

1101. **General.** The tube or pipe range was originally known as an improvised range that was developed for use with rimfire SA and later for centrefire SA. The concept is a truly NDA range that suits those who need to minimise external noise levels.

1102. **Aim.** The aim of this chapter is to describe the design and construction of the tube range. In particular it covers:

1103. **Description.** These ranges are usually constructed using pre-cast concrete units, although any suitable tube or box section that will contain shot may be used. There is a firing bay at one end and may have intermediate firing/target distances. At the target end the target house contains the bullet catcher and targets. The range may be surface laid, half or fully buried. It is covered with top soil to enhance the ballistic safety and is normally covered with turf for aesthetic reasons. In some cases the firing point and target area are not fully enclosed. This range may be used for centrefire and rimfire weapons limited only by the ballistic criteria for backsplash, ricochet and penetration detailed in Chapter 2. Only one firer can use a tube however there may be multiple tubes allowing several firers to use the range simultaneously provided the minimum firing point widths given in Table 1 are adhered to.

1104. **Purpose**. This range provides a local facility for limited for single shot firing practices and the range may be suitable (dependent upon the diameter of the tube) for carrying out the pistol ACMT, introduction to shooting, remedial training, preliminary grouping and zeroing, and training sub-unit shooting coaches. It is also an ideal solution for zeroing ranges within secure operational bases. See paragraph 1145 onwards.

DESIGN

1105. **Design Criteria.** Illustrations of a typical range are shown in Figure 11-1 for a centrefire range and in Figure 11-2 for a rimfire range. Figure 11-3 shows the application of bullet catcher and defence zone criteria, which applies to both rimfire and centrefire ranges. Considerable variation in the design is possible, with consultation from TAS (RE). The principle of this range is that the tube will fully contain the shot fired in it. Whilst it is a simple matter to arrange the weapon to be within the tube, the safe capture of the shot and ricochet poses the biggest design problem. Environmental issues such as lead dust, unburnt propellant carbon monoxide and noise must also be considered where firing points and target house is enclosed. Refer to Chapter 30 for details of the hazards associated with enclosed ranges. Essential in the construction of new ranges is an internal finish specification that minimises the build up of dust. In existing firing rooms and bullet catchers all non-essential dust collecting surfaces should be removed or sealed to prevent dust accumulating out of sight. Consideration should be given to providing an open or semi enclosed firing point that will minimise the environmental issues.

1106. **Siting.** The range is intended for use in barracks or garrison areas, it is also suited for operational bases. It requires a flat and level site on firm, well drained land. The external considerations are lead dust from the extract filter, noise and aesthetics.

CONSTRUCTION

TARGET HOUSE

1107. **Bullet Catchers.** The bullet catcher is sized to capture all direct shot, as shown in Figure 11-3. The type of bullet catcher selected will depend principally upon the SA to be fired. These are:

a. **Rimfire and Centrefire Pistol/Carbine**

(1) **Flat Steel Plate with Anti-Splash Curtain.** This is the simplest and cheapest form of bullet catcher. It does however create a lot of lead contamination in the target area and the anti-splash curtain requires maintenance. The steel plate is bolted back to a solid wall with a material sandwich between to reduce both impact and transmitted noise (see Chapter 3). The thickness of steel is determined from Chapter 2 Table 7. Size will be dependent upon the distance from the end of the tube.

(2) **Angled Steel Plate with Anti-Splash Curtain.** Although this design is often selected by range builders, it offers no advantage over the flat steel plate and is often more noisy. With both this and the flat steel plate, a sacrificial plate at the MPI will extend the life of the bullet catcher. However, for the angled steel plate care will be required not to expose its leading edges to the LofF.

(3) **Alternative Bullet Traps**. There are many designs commercially available but most have safety shortcomings. Two bullet traps described below for Centrefire Rifle are also suitable for rimfire weapons, pistol and carbine, though they will be more expensive that the traps above. These are the Snail Bullet Trap and the Granulated Rubber Trap.

b. **Centrefire Rifle and Automatic Fire**

(1) **Sand Bullet Catcher.** Sand bullet catchers are not recommended indoors due to the dust hazard from the sand. For ranges where the bullet trap is not enclosed the traditional sand bullet catcher with canopy protection or limited danger area is acceptable. This latter option would be suitable for operational base tube ranges.

(2) **Angled Steel Plate with Anti-Splash Curtain.** This bullet catcher has been used on simple, low cost centrefire tube ranges but it may only be used for firing single shot. High maintenance costs make this design a poor choice on a centrefire range which is to be heavily used. A full specification for steel is provided in Chapter 2.

(3) **Snail Bullet Trap**. This is a proprietary bullet decelerator, patented by the Savage Arms Corporation of the USA, reduces lead pollution problems at the target end of the range, can be used for automatic fire and it can be produced to accept the 0.5 in round. It must however be individually designed for each range by the supplier to ensure that military safety criteria are met. This type of trap is unsuitable for steel or steel tipped rounds. Snail traps cannot be locally manufactured due to precise impact surface design.

(4) **Granulated Rubber Trap**. The granulated rubber trap used at a natural angle of repose potentially is a very cost effective and environmentally friendly solution. Details of this trap are provided in Chapter 2 and it is illustrated at Figure 3-6b.

1108. **Defence Zone.** The defence zone is intended to be impenetrable to shot and is to contain ricochet beyond the bullet catcher. It is sized as shown in Figure 11-3. Any portion of the target house within the defence zone is to have a minimum construction as detailed in Table 7, Chapter 2 or be over-plated with steel as specified Table 7a, Chapter 2. Defence zone criteria also applies where there are trap doors above the target end of the range.

1109 **Targetry Selection**. When selecting targets and target mechanisms, the difficulty of moving down the range to mark or change targets should be borne in mind if target retrieval systems are not installed in the tube. An automatic marking system and a simple turning target mechanism will greatly enhance the range and the training value. Fall-when-hit systems are difficult on a tube range as the concentration of the sound energy in the tube may activate the mechanism without the target being struck. Representative targets, sized to give the appearance of targets at greater ranges (see Chapter 29) provide valuable training on shorter ranges. The tube range

lends itself to competition shooting. To minimise the risk of ricochet off the tube walls, targets should be presented centrally in the tube.

1110. **Ricochet and Backsplash**. There should be nothing within the backsplash zone (see Table 2, Chapter 2) that could cause ricochet or backsplash. Any services, ducts or parts of the target mechanism that can be struck are to be protected. Should falling plate or other impenetrable target be used the distance from the target to the firing point must be greater than the hard target backsplash distance (see column c, Table 2, Chapter 2) and the effects of subsequent ricochet on services and fittings in the target house must be considered.

1111. **Target Illumination.** Target illumination is ideally achieved with a single 5 ft fluorescent strip light per target which may be mounted above or below the target or to the sides between each tube. Reflector lamps (tungsten) of 100 watt per target may be used if dimming is required for low light level shooting.

TUBE

1112. **Size.** The diameter (dia) of the tube should be selected to suit the targetry and practices. The size selected must allow a clear view of the whole target but is not to be less than:

a. **Ranges up to 25 m**: 900 mm dia to allow for access. For existing ranges tubes of less than 900 mm dia, special provision for cleaning will be required.

b. **Ranges greater than 25 m:** 1800 mm dia is desirable but the minimum size is 1200 mm, which is also the minimum size to accommodate the Figure 11 target.

1113. **Laying.** A reinforced concrete pipe with a wall thickness of not less than 75 mm, of the type typically used for drainage works, is normally selected to form the firing tube. Particular attention shall be paid to the bedding of tube sections to ensure future settlement or movement is eliminated as any such settlement will render the range unsafe. The tube must be laid straight to line and level. The laying tolerance is plus or minus 50 mm over a 100 m length. No edges or lips may occur which would cause backsplash if struck and any of 3 mm or more facing the firer must be ground off and feathered out. To avoid problems with settlement of the sectional tube components a flexible continuous liner may be inserted into the tube. The tube may be completely or partially below ground or may be laid at ground level and banked over. The tube should support its own dead loads and all the loads imposed upon it. Tubes without a liner should:

a. Be bedded and supported to eliminate any subsequent settlement that will generate backsplash hazards from misaligned joints.

b. Have the socket end of the pipe facing the firer.

c. Have all joints sealed watertight and the tube coated with a waterproof membrane.

1114. **Earth Cover.** Earth cover to the tube will vary depending on the type of tube range. An additional allowance has to be made for landscaping such that over the seasons soil erosion and ground maintenance works will not reduce the compacted earth cover to less than a minimum of 500 mm for centrefire rifle ranges but for rimfire tube ranges no earth cover is required for ballistic purposes.

1115. **Lighting**. Some form of lighting may be required according to the length of the tube.

1116**. Weapon Muzzle Limit.** At each firing point a line that is clearly visible should be painted 150 mm (C) inside the tube to denote the point to which the muzzle should be inserted before engaging the target. This will preclude any chance of rounds striking the leading edge of the tube.

FIRING BAY

1117. **Firing Points**. Firing points should be constructed as per Chapter 3, ideally with the height such that the weapon is positioned centrally in the tube for all firing postures, although this is less important in large diameter tubes, i.e: over 1200 mm. To cater for all three postures, platforms at two or three different levels may be required. Small diameter tubes are best limited to the prone position or prone and standing in a trench. The firing point widths given in Table 1 are the minimum widths required and take into account:

a. Practices to be fired.

b. The space required for coaching.

c. Disturbance caused by adjacent weapon noise.

d. The hazard caused by ejected cartridge cases.

1118. **Screens.** Screens between firers can be used to reduce firing point width. The screen should be designed to reduce both noise transmission to adjacent firing points and reflected noise (reverberation). Screens must not be so deep that they restrict the RCO's view of the firers. Table 1 is a guide to firing point widths on a multi-firing point range.

Minimum Firing Point Width	**Width of Each Firing Point (m)**	
	With Screens	**Without Screens**
(a)	(b)	(c)
Pistol	1	1.8
Rimfire Rifle	1	1
Centrefire Rifle	1.8	1.8
Automatic Fire	2.5	2.5

Table 1- Minimum Firing Point Widths

1119. **Floor Finish.** The floor finish on the firing point must be smooth and impervious to facilitate the removal of lead dust and traces of unburnt propellant. A sealed, non-slip surface of rubber or PVC may be provided with a cushioned backing. Porous materials such as mats and sand bags, which

can harbour lead or unburnt propellant, are not to be used in the range. A hard smooth floor will reduce ricochet potential.

1120. **Pistol Firing Points**. Particular care is required in the design of pistol firing points. It is possible for an unintentional shot to be fired at about 45^0 (800 mils) to the LofS and even withdrawn from the tube. Surfaces which capture or direct the round without ricochet or backsplash are essential.

1121. **Intermediate Firing Distances**. Two options are possible to provide short firing distances for pistol practices on longer rifle ranges:

a. **Large Diameter Tubes**. If the tube diameter or section is 1750 mm or larger, intermediate target positions can be provided within the tube which are engaged from the main firing point. The bottom of the tube can be levelled with a soft bitumen macadam so that firers can move down the tube to mark and change targets. Target mechanisms and edges within the tube are to be protected against backsplash (see para.1109).

b. **Small Diameter Tubes**. Tubes of less than 1750mm in diameter or section are regarded as too small for firers to walk down. Pistol firing points in this case are provided in firing rooms forward of the main firing point . The design must ensure that the RCO can maintain effective control. This is an expensive option as added requirements are:

(1) Ventilation and noise attenuation in two locations.

(2) Anti-ricochet and backsplash protection around the intermediate firing point.

(3) Safety interlock and warning systems to ensure that more than one firing points cannot be entered at the same time (see para.1125-1132).

1122. **Firing Point Chamber.** The firing point chamber is to provide sufficient circulation space for firing details to change safely. On ranges with three or more firing points, separate entry and exit doors should give access to an assembly room behind. A walkway is needed behind the firing points for the RCO and space should be provided on large ranges for a coach to assist the RCO. Open or partially enclosed firing rooms will reduce the impact of weapon emissions and noise but it makes it difficult to control air flow in the tubes.

1123. **Lighting**. Lighting levels are to be such that when exposed, the targets are clearly visible to the firers.

1124. **Control, Waiting and Assembly Rooms.** If AMS and turning targets are installed, a control room may be positioned behind the RCO's walkway. It should be a glazed sound-proofed booth. The waiting detail and assembly room are also to be isolated from the firing point noise and be provided with a glazed viewing panel.

SAFETY MEASURES

1125. **Access**. As the RCO is unable to observe outside the range, control measures are required to prevent access to the range when it is in use, and where doors cannot be secured, to activate audio and visual warnings and safety interlocks.

1126. **Entrances.**

a. **Main**. A red lamp or sign is placed in a prominent position to warn that the range is in use.

b. **Other**. Doors that can be opened to the target house or to intermediate firing chambers are to cause target lights to be extinguished and to activate an audio and visual alarm in the main firing chamber. Provision is to be made to allow the RCO to reset the audio-visual alarm within the firing room. The alarm system is to have a device that indicates the alarm is correctly reset and is `live'. Where all down range doors are fully secured by the RCO such measures are not required.

1127. **Shields**. A safety shield is to be provided at the opening of the tube behind each intermediate firing chamber so that it can be raised to block off the tube behind it.

1128. Spare

1129. **Noise.** All new tube ranges should include noise control measures specifically designed for the range. Full details are given in Chapter 2. However, the following are pertinent to a tube range:

a. **Noise Containment**. This is effectively achieved by burying the tube under earth. If the target house and firing rooms are not buried, additional measures may be necessary (see Chapter 2).

b. **Noise Attenuation**. Noise in the tube can be severe if it is not effectively controlled. Careful thought is required to cover the tube's curved surfaces to provide the maximum reverberation time (RT), which should not exceed 0.5 sec at 500 and 1000 Hertz (Hz).

1130. **Ventilation.** The requirements for ventilation in indoor training ranges are given in Chapter 30.

1131. **Fire Hazard.** When specifying materials used in range construction, their fire rating must be considered. Materials such as rubber compounds and timber can present a fire hazard. This, combined with factors such as heat from target lighting and the presence of unburnt propellant, require that careful consideration is given at the design stage to fire prevention. Means of escape should conform fully to the regulations.

1132. **Fire Approval**. Attention is drawn to Regulatory Reform (Fire Safety) Order for England and Wales; the Fire Safety (Scotland) Act and the Fire Safety (Scotland) Regulations, the Fire and Rescue Services (Northern Ireland) Order. The requirements include a general duty to carry out a risk assessment and take precautions against fire. Fire safety is also covered by the respective Building Regulations (England and Wales; Northern Ireland;

Scotland). The advice and approval of DFRMO is mandatory on all new or reconstructed indoor ranges.

1133. **Eye Protection**. In small tubes where there are rough joints in the tube walls or other backsplash obstructions in the tube these should be rectified wherever possible. In cases where this is not possible eye protection is to be worn by all firers. For current eye protection see Reference B, PAM21.

COMMUNICATIONS

1134. **External**. A means of summoning the emergency services, ideally a land laid telephone, is to be available.

1135. **Internal.** A means of communication between the RCO and the waiting detail in the assembly room should be provided. On larger ranges and when there is a separate control room, a full Public Address (PA) system should be considered.

SAFETY SIGNS

1136. **Safety Signs**. The risk assessment for the range will determine what safety signs are required. Details of the signs are illustrated in Chapter 2. However in all cases the following signs should be provided;

a. No Smoking.

b. No food or drink in the range.

c. Keep out when range is in use.

d. Hearing protection to be worn when firing.

MAINTENANCE

1137. **General.** Regular cleaning is essential to ensure that lead dust and unburnt propellant do not build up in the range. Cleaning requirements are given in Chapter 30. The target line must be kept clear of target debris. In some smaller ranges the target house may need to be considered a confined space and the appropriate control measures should be applied when accessing for maintenance. Advice from local works officers should be sought.

1138. **Bullet Catchers.**

a. **Steel Plate Bullet Catchers with Anti-Splash Curtain.** It is essential that this type of bullet catcher is regularly de-leaded. The anti-splash curtain is to be inspected before firing begins to ensure that it is not holed. To prevent holing, the curtain should be rotated regularly to ensure that the MPI location is moved. Holes can be repaired by patching with pieces of salvaged curtain using a suitable adhesive. There must be no more than two layers of anti-splash curtain at any point in the line of fire.

b. **Sand Bullet Catchers.** See Chapter 2. In addition the sand is to be kept moist to stop dust getting into the range.

c. **Snail Bullet Trap.** It is necessary to keep the reservoir of the Snail Bullet Trap topped up with lubricating fluid and to ensure that the

pump is running before firing starts. Spent rounds in the collection baskets must be emptied periodically.

d. **Granulated Rubber Trap.** This trap requires little maintenance. The MPI should be prodded regularly to check for accumulation of rounds and to assist in round migration though the granulate. De-leading should be as detailed in Chapter 2.

1139. **Tube settlement.** Where concrete tube sections have settled causing a concrete lip to appear that may generate hard backsplash such lips are to be removed by grinding or treated to prevent backsplash. Use of epoxy mixes well bonded to the concrete surfaces and feathered out presenting a low angle slope to the firer should be sufficient to prevent backsplash.

1140. **Responsibilities.** Maintenance is the responsibility of the RAU. Responsibilities may be divided as follows:

a. **Range Warden.** See Reference A1.

b. **Property Management.** General inspection with particular emphasis on:

(1) The back wall especially the defence zone area.

(2) Tube alignment. Careful checks to ensure settlement of the tubes has not presented a hard backsplash hazard.

(3) Access security systems.

(4) The ventilation system (if fitted).

(5) Check for bullet damage to any electrical fittings.

c. **Equipment Management**. Repairing and servicing equipment installed by single Service contract.

1141. **Frequency.** Proper maintenance is dependent upon good liaison between the Range Warden and the RAU, and on properly scheduled maintenance periods. A heavily used range may need one day or more maintenance each week plus one or two day's maintenance by the Range Warden each month. For frequency of de leading .22" ranges refer to Chapter 30, deep cleaning. Other trap systems may differ in frequency of maintenance and de-leading. For deep cleaning refer to Chapter 30.

COMPLIANCE CHECKS

1142. The following should be checked

a. Authorised weapons, ammunition and practices.

b. Target House - Type of bullet catcher, bullet catcher sizing, defence zone sizing and structure, target material and fixing method, target centre height.

c. Tube diameter, wall thickness, material, tolerance and cover.

d. Any protrusion in the tube greater than 3mm that might generate backsplash.

e. Firing Bay - Firing point height, width and spacing and intermediate firing distances, if applicable.

f. Signage and lighting.

g. Noise control measures.

h. Ventilation arrangements.

1143- 1144. Spare

OPERATIONAL TUBE RANGES

DESIGN.

1145. **General.** The tube or pipe range has been known for many years as an improvised range. The concept suits those who need to develop semi permanent NDA ranges in troop operational base areas. The range is suited for zeroing and grouping practices for small numbers only.

1146. **Aim.** The aim of this advice is to describe the design and construction of an improvised tube range where it differs from the detail for PTR..

1147. **Design Criteria**.. Due to the temporary nature of these ranges foundations to avoid long term settlement of the tubes and the total enclosure of the range may not be necessary. Considerable variation to the basic design is possible with advice from TAS(RE). The principle of this range is that the tube will fully contain shot fired within it even where the firing point and bullet trap is not fully enclosed. All range design proposals should be copied to TAS in order to ensure ballistic safety is achieved.

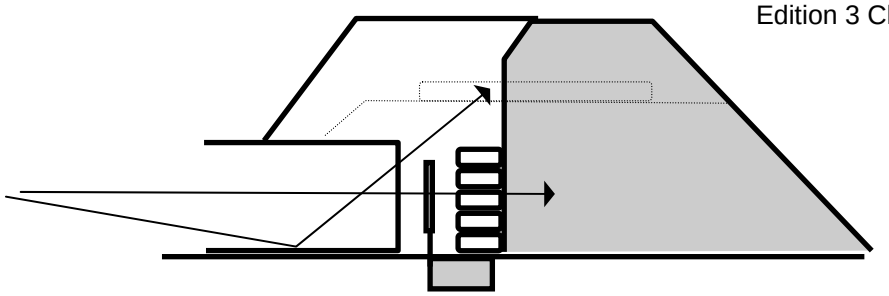
1148. **Siting.** The permanent tube range is intended for use in barracks or garrison areas. Temporary ranges are constructed in Operational bases. These ranges require a flat and level site on firm, well drained ground. With an open firing point, noise will be a consideration to avoid disturbing resting troops.

1149. Spare

CONSTRUCTION

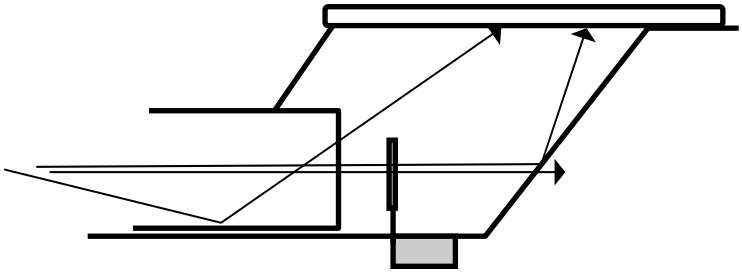
1150. **Bullet Catchers**. The bullet catcher must stop both direct fire and ricochet. The bullet catcher for improvised ranges may be constructed of local material providing that it is free of stones or rock. There are two options suitable for improvised ranges;

a. **Sandbag wall / bund**. This trap presents a steep (min 56deg) or vertical sand or earth face from which ricochet is not likely. Ricochet off the tube towards the end is a factor that will dictate the height of the vertical face of the stop butt. Clearly the closer the stop butt to the target the better. A canopy may be used to reduce the need for a high stop butt. The problem with this trap is that the MPI will soon be shot out and require repair. A sacrificial front wall of sand bags will avoid the need to rebuild the bund each time. Where steel mesh gabions are used sand bags should be used behind targets to avoid hard ricochet or backsplash (50m) with timber boarding over the remainder of steel exposed to the firer.



Section 1 – Typical bullet trap arrangement.

b. **Traditional sand bank with canopy or 100m Range Danger Area**. The traditional sand bullet catcher with a 900 mm depth of sand at 34° (600 mils) is a safe, reliable and proven design. It is safe for automatic fire in short bursts. To capture high angle ricochet and 7.62mm pop over, a canopy of minimum 180mm thick timber (rail sleeper) or steel plate should cover the target area. If there is sufficient space, a 100m RDA may eliminate the requirement for a canopy.



Section 2 – Typical bullet trap using sand natural angle of repose

(30 – 34deg)

1151. **Target Selection**. When selecting targets and target mechanisms, the difficulty of moving down the range to mark or change targets should be borne in mind as target retrieval systems cannot easily be installed in the tube. An automatic marking system and a simple turning target mechanism will greatly enhance the range and the training value. Fall-when-hit systems are difficult on a tube range as the concentration of the sound energy in the tube may activate the mechanism without the target being struck. The Figure 11 remains the target of choice for military practices but requires a large diameter tube. Representative targets, sized to give the appearance of targets at greater ranges provide valuable training on shorter ranges. To minimise the risk of ricochet off the tube walls, targets must be presented centrally in the tube. Multi-point targets should not be used unless the range has been specifically designed for this type of target.

1152. **Ricochet and Backsplash**. Refer to paragraph1110.

1153. **Target Illumination**. Refer to paragraph 1111.

1154. **Firing Points**. Refer to paragraph 1117.

1155. **Pistol Firing Points**. Refer to paragraph 1120.

1156. **Intermediate Firing Distances**. Refer to paragraph 1121.

1157. **Weapon Muzzle Limit**. Refer to paragraph 1116.

1158 – 1159 Spare.

SAFETY MEASURES

1160. **Access.** The RCO must be able to observe the bullet trap area and RDA where an RDA is provided but not secured.

1161. **Range in Use warning**. A red flag is placed outside the main access point to the range to warn that the range is in use.

COMMUNICATIONS

1162. A means of summoning the emergency services, is to be available.

MAINTENANCE

1163. **General.** Regular cleaning is essential to ensure that lead dust and unburnt propellant do not build up in the range. The target line must be kept clear of target debris.

1164. **Bullet Catchers.**

a. Sandbag Bullet Catchers. Ballistic slopes must be maintained at 56deg or greater and stone free. The depth of sand visible from the tube must never be less than 900mm.

b. Sand Bullet Catchers. The sand must be maintained at an average of 34deg, never less than 30deg in use. The depth of sand visible from the tube must never be less than 900mm. The canopy roof must be maintained to ensure rounds do not penetrate.

1165. **The Tube.** Regular checks inside the tube are required to ensure there is no backsplash hazard from differential settlement of the tube sections.

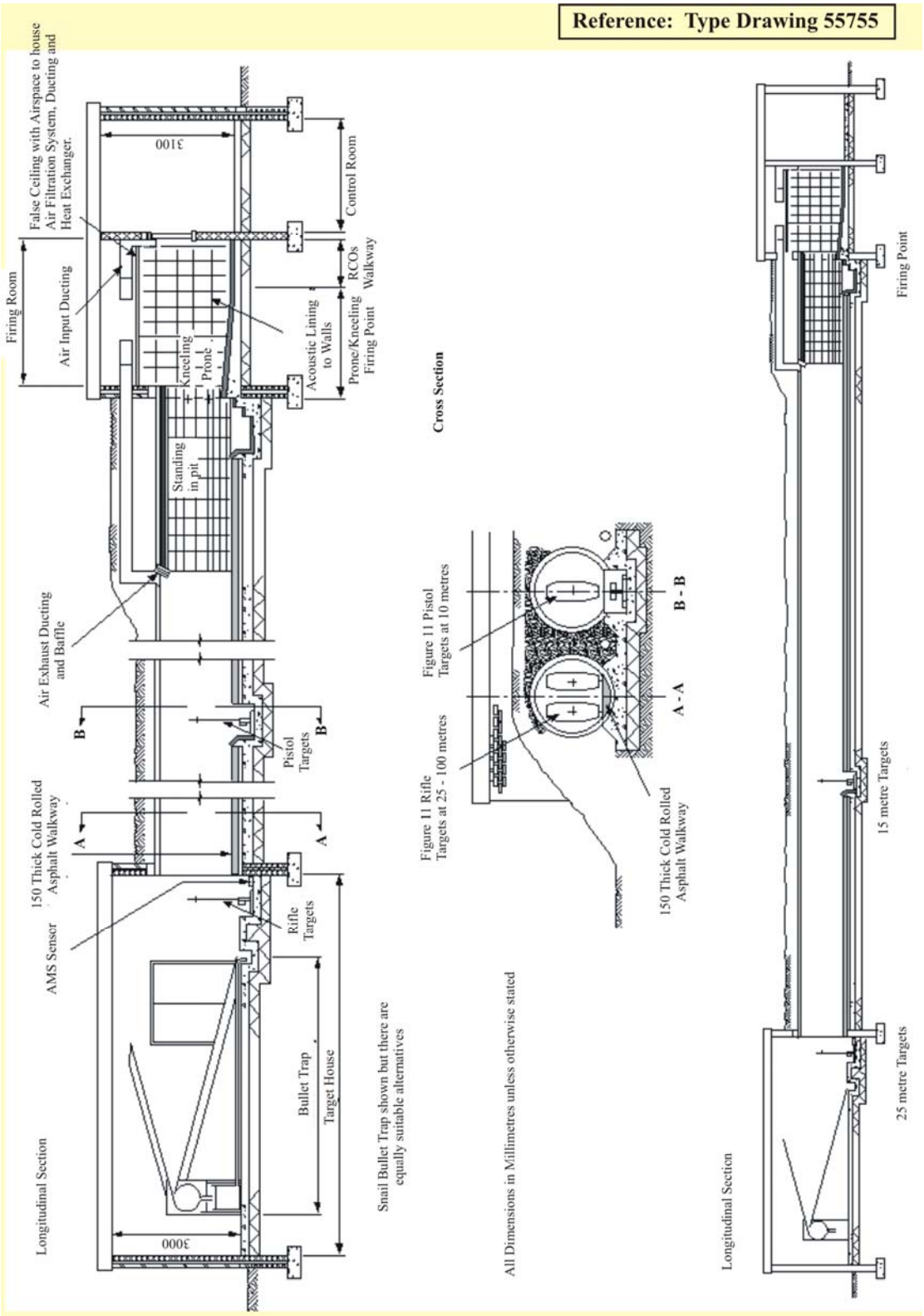
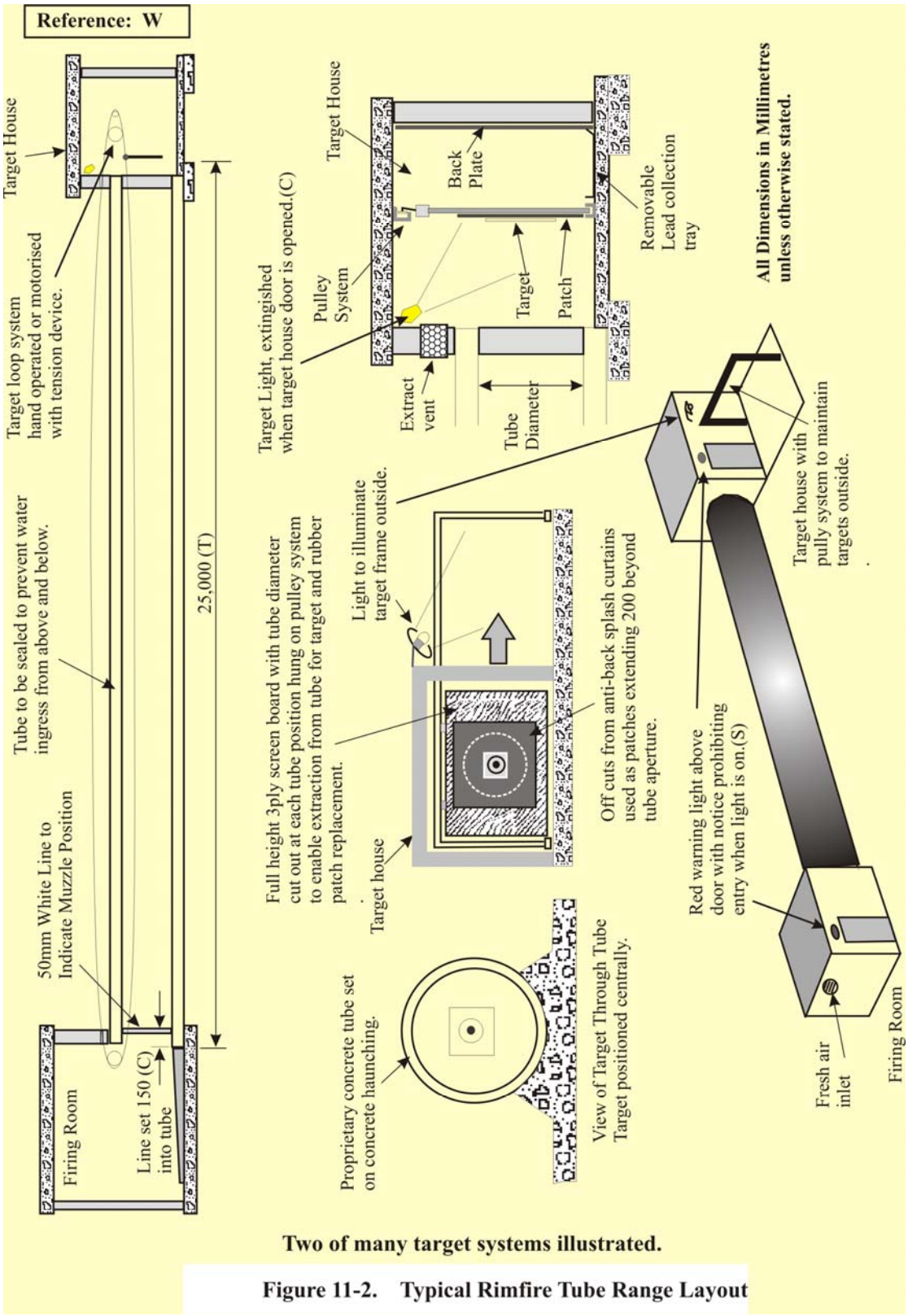


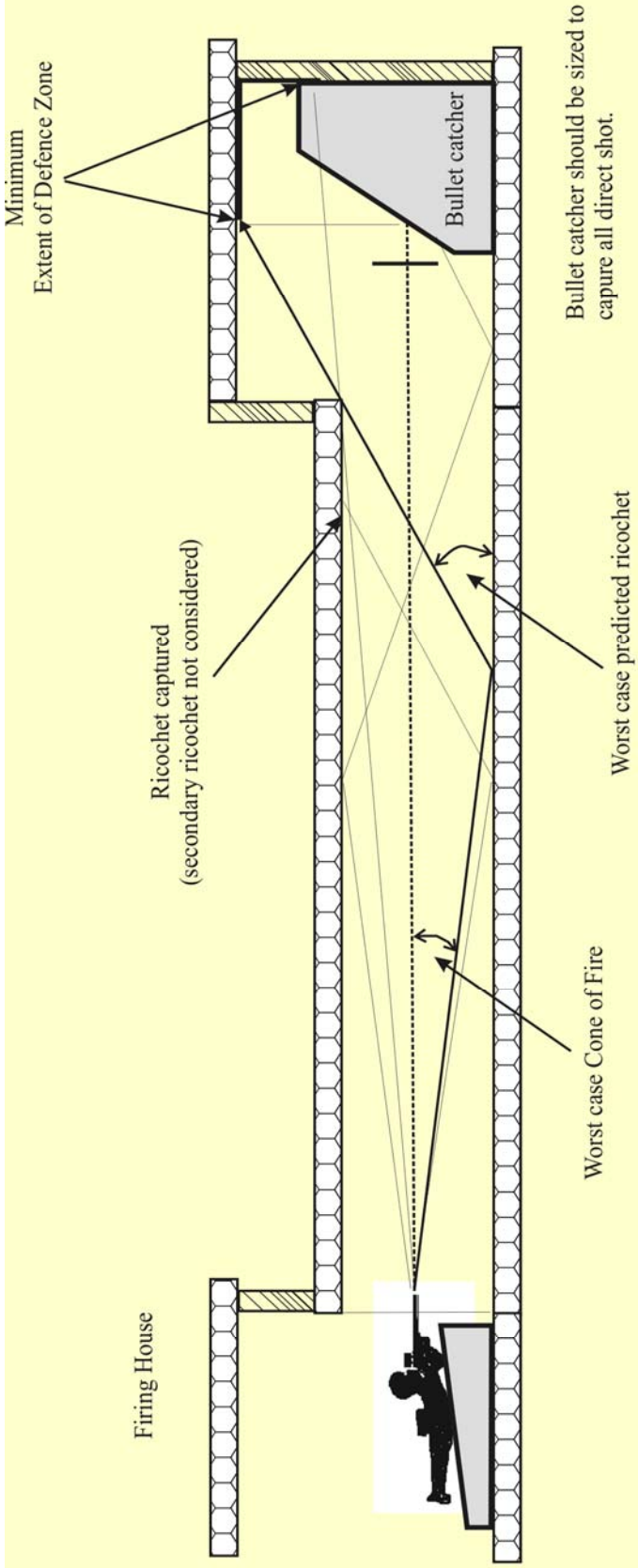
Figure 11-1. Typical Centrefire Tube Range Layout



Two of many target systems illustrated.

Figure 11-2. Typical Rimfire Tube Range Layout

Reference: W



Notes:

1. Worst case ricochet off rough or soft surfaces for high velocity ammunition is 30^0, for low velocity it is 15^0.
2. Ricochet off smooth hard undamaged surfaces is taken as half the impact angle.
3. For Cone of Fire details refer to Table 3 Chapter 2.
4. Defence zone - where there is a target room - refer to Table 6 Chapter 2.

Figure 11-3. Tube Range Criteria