# CHAPTER 2

# RANGE DESIGN CRITERIA AND SPECIFICATIONS

## INTRODUCTION

02001. **Aim**. The aim of this chapter is to outline details of the design and specifications applicable to all SA, Inf WS and 40mm Ranges and the marking, fencing, signing and lighting of all Defence Land Ranges (DLR) and training areas. Details specific to a particular type of range are given in Chapters 3-28. This chapter covers:



02002. **Categorisation of Criteria.** Criteria provided in this and other Chapters are categorised where appropriate to aid users in understanding the implications of that criteria on the safety of a range. The categories used are summarised below. For more details see Para 02063

a. **Critical (C).** Relates to criteria that may affect the ballistic safety or effective use of the range.

b. **Standard (S).** Relates to details / criteria which have been derived empirically and meet current safety requirements. Although not necessarily critical to the ballistic safety of the range, the detail / criteria provides an authorised standard solution which will be safe for authorised practices at any location. Unless stated otherwise all detail in this JSP may be taken as standard (S).

c. **Typical (T).** Relates to details / criteria which is provided for guidance only indicating a typical solution.

02003. **Range Compliance Checklist**. All new or refurbished ranges must achieve compliance particularly in those areas that may affect safety. A range compliance checklist is provided at the end of most range Chapters. The checklist has been produced as a `Guide' to assist range inspectors, Range Administrative Units (RAU), Project Sponsors (PS), Project Managers (PM), Designers and Contractors. The aim of the checklist is to provide guidance and therefore highlight areas that will be subjected to checks to confirm compliance of a new or refurbished range. Designers submitting plans to TAS (RE) for compliance checks must include all of the detail listed and any other relevant information. The checklist is not exhaustive; it is an aid to assist achieving compliance with JSP 403 Volume II. Refer also to Volume 1 Chapter 6.

02004 - Spare

## DEFINITIONS AND RANGE SAFETY TERMS

02005. **Definitions**. The definitions and range safety terms that relate directly to the contents of this Volume have been included in this Chapter.

02006. **Air Danger Area**. An Air Danger Area (ADA) is the airspace above a range which has been notified as such within which activities dangerous to the flight of aircraft may take place or exist at such times as may be notified. Airspace below 500ft is not controlled by the Civil Aviation Authority (CAA) however light aircraft, helicopters and military flights may use this airspace.

02007. **Air Danger Height.** The Air Danger Height (ADH) is the maximum height above ground level (AGL) at which a hazard may exist (see Notes 1 and 2). Table 1 below gives ADH for SA ammunition (Reference OB ML 04/98).

| Ser | Ammunition | Constructed LDA/FDA ranges | | FDA/LFTTA Ranges | | Remarks |
|---|---|---|---|---|---|---|
| | | No exposed hard surfaces | Exposed hard surfaces | QE <150mils | QE 150--1250 mils (Note 3) | |
| (a) | (b) | (c) | (d) | (e) | (f) | (g) |
| 1 | 5.56 mm Ball L2A2 | (ft) 500 | (ft) 1000 | (ft) 1000 | (ft) 8000 | Rifle/LSW |
| 2 | 5.56 mm Tracer L1A2,L110 | 500 | 1000 | 1000 | 8000 | Rifle/LSW |
| 3 | 7.62 mm Ball | 750 (see Note 4) | 1500 | 1500 | 8800 | |
| 4 | 7.62 mm Tracer | 1500 | 1500 | 2000 | 8800 | |
| 5 | 12.7 mm Ball | Not used | Not used | 3000 | 14300 | Incl..50” |
| 6 | 12.7 mm Tracer | Not used | Not used | 4000 | 14300 | Incl..50” |
| 7 | 30mm | Not Used | Not Used | Ground 4500 | Hard Target 9500 | |
| 8 | 9mm Ball | 500 | 500 | 1000 | 3200 | |
| 9 | 9 mm Tracer L3A1 Spotter | 500 | 500 | 1000 | Not used | 94 mm |
| 10 | 0.22 in Ball | 500 | 500 | 1000 | 1000 | |
| 11 | 0.22 in Tracer | 500 | 500 | 1000 | 1000 | |
| 12 | 8.6mm Ball | 500 | 500 | 3000 | 3000 | Note 5 |
| 13 | 4.6mm Ball | 500 | 500 | 1000 | 1500 | |
| 14 | Shotgun Slug | 500 | 500 | 500 | 5000 | Combat Shotgun |
| 15 | Shotgun Buckshot | 500 | 500 | 500 | 6000 | Combat Shotgun |
| 16 | GMG (all natures) | 3000 | 3000 | 3000 | 3000 | |

**Table 1 - SA Ammunition ADH**

**Notes**

1. The ADH is either the vertex height of the munition nature (propelling charge dependent) or its maximum ricochet height.
2. An ADH is measured in feet (ft) AGL. Altitude is measured in ft Above Mean Sea Level (AMSL).
3. For HEF (QE 150-1250 mils, Figure 19-3) the ADH provided should be applied when the cone of fire is not captured by the ground
4. 7.62mm ball may be fired with an ADH of 500ft providing an air sentry is provided and the air sentry has clear vision of the air space over the range. The minimum Duties of Air Sentries are given in Reference B (Pamphlet 21).
5. LRR 8.6mm ammunition fired under the specific control measures set out in Reference C.

02008. **Ammunition Danger Area.** The area in which personnel are controlled behind active firing points or fully protected within. See Weapon/Range Danger Area Template.

02009. **Angle of Sight**. The Angle of Sight (AofS) is the acute angle between the Line of Sight (LofS) and the horizontal plane. (For details of further ballistic angles see Figure 2-1 and Reference A4 (Volume IV)).

02010. **Approved Range Status.** . A range which varies from the design and build criteria specified for its type in JSP 403 or the appropriate Single Service publication. However, the resultant risk is assessed not to exceed the level for a Compliant Range of the same type. Approved Range Status is determined by the RAO based on advice/recommendation offered by the LRSSC. In many cases, particularly where a full RDA cannot be applied, it may be necessary to seek advice from DOSG who will use the Weapon Danger Area Laboratory (WDALab) to assess the level of safety of the range before Approved Range Status can be authorised. This advice may also be used to support a dispensation (see paragraph 02039).

02011. **Backsplash**. Backsplash is fragmentation or target debris thrown backwards at any angle produced by projectile impact. Anti backsplash curtains set clear of the impact surfaces can prevent backsplash enabling closer engagement. Where no such protection is provided the following backsplash distances apply:

| Ser | Weapon | Fragment/Earth Throw Distance Hard Tgt (m) | Fragment/Earth Throw Distance Ground Tgt (m) |
|---|---|---|---|
| (a) | (b) | (c) | (d) |
| 1 | Air gun | Refer to Chapter 26 | |
| 2 | Rimfire, centrefire pistol and carbine | 22 | 10 |
| 3 | Centrefire rifle | 50 | 22 |
| 4 | 7.62 mm tracer | 125[5] | 125[5] |
| 5 | 30 mm RARDEN PRAC and APDS | 400 | 400 |

**Table 2 - Backsplash Zone (Safety Distances)**

**Notes**

1. The Backsplash Rule is described in detail in Reference B (Pamphlet 21).
2. Backsplash from well maintained stop butts into the gallery on gallery ranges should not exceed 5m (see Note 5 below). For NDA ranges authorised practices may be undertaken down to 10m from targets providing the bullet catcher is well maintained. A well maintained stop butt and bullet catcher is one where no bullet debris is permitted to build up around the MPI and any scooping raked over after each days use.
3. Control measures for backsplash on LFTTAs is covered in Reference B.
4. Backsplash zone for MDP practices using MP7 and 4.6mm steel ammunition against well maintained bullet traps should not exceed 10m.
5. Backsplash from 7.62mm tracer is 125m from all hard structures and sand structures with front faces of less than 56deg and heights in excess of 2m. On compacted earth slopes the 7.62 mm tracer rounds are normally captured without ricochet.

02012. **Burst Safety Distances**. Burst Safety Distances (BSD) are hazard distances away from fragmenting ammunition. Full definitions are given in Reference A4 (Volume IV).

02013. **Clear Range Procedure.** A procedure authorised by the Range Administering Unit and applied by the user unit to ensure that the Range Danger Area is clear of unauthorised persons before firing commences and that it remains clear throughout the time firing is in progress. The procedure includes provision for the timely cessation of firing before it poses a risk of hazard to an intruder in the Range Danger Area. Refer also to Reference A1 for more detail.

02014. **Clear Vision Line.** Clear vision lines are projected from above and below the firer to the target to ensure there are no distracting protrusions within the firer's peripheral field of vision in all firing postures (see Figure 3-3). The extent of clear vision required is set out in the relevant sections and chapters of this Volume. Clear vision lines are established to ensure that:

a. The risk of backsplash to the firer is eliminated.

b. An unrestricted view to the target and its immediate surround is achieved and maintained.

c. The physical build of individual firer's is accounted for.

02015. **Cone of Fire**. The Cone of Fire (CofF) is the distribution of fired projectiles within a margin of error in the vertical and horizontal planes. For design purposes the cone of fire figures in Table 3 below are applied around each Line of Sight (+elevation, - depression and +/-azimuth). The CofF accounts for acceptable deviation caused by errors associated with the firer and machining or manufacturing tolerances, and allows an additional margin for unacceptable firer error. Table 3 lists the authorised SA CofF applicable on MOD ranges.

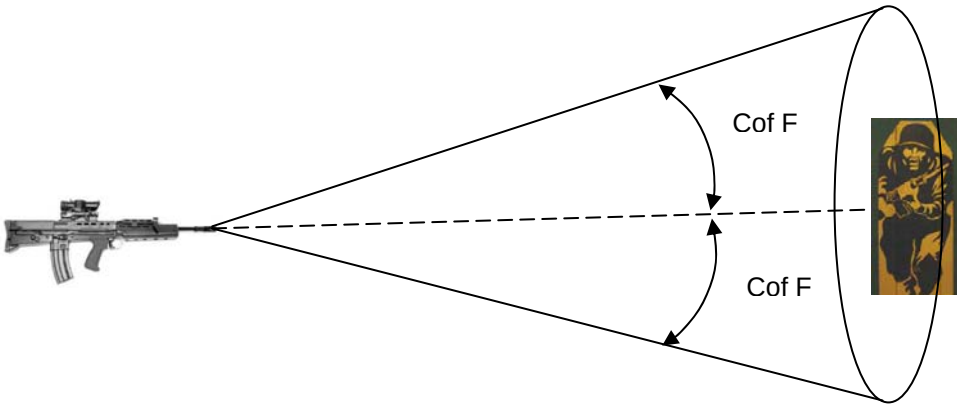



Figure 1 – Cone of Fire around Point of Aim

| Ser | Practice | Engagement Type | CofF | |
|---|---|---|---|---|
| | | **SS = Single Shot**<br>**A = Automatic** | **Azimuth (mils)** | **Elevation (mils)** |
| 1 | **LDA/FDA Ranges** (Notes 1 & 2)<br>Rifle / Carbine Static to Static | SS<br>A | ±40<br>±60 | ± 40<br>± 40 |
| 2 | Static to Moving | SS<br>A | ±60<br>± 90 | ±40<br>±40 |
| 3 | Moving and moving vehicle smooth track to Static or Moving | SS/A | ± 120 | ±60 |
| 4 | Pistol | SS/A | ± 135 | ±135 |
| | **Field Firing** | | | |
| 5 | Static to Static | SS/A | ± 60 | ±60 |
| 6 | Static to Moving | SS/A | ± 90 | ±60 |
| 7 | Moving and moving vehicle smooth track to Static or Moving | SS/A | ± 120 | ±90 |
| 8 | Moving Vehicle rough terrain to Static or Moving | SS/A | ±150 | Max[4] Range |
| 9 | High Elevation Fire (HEF) | SS/A | ±150 | Max[4] Range |
| 10 | Pistol | SS | ±250 | ±190 |
| | **Restricted Practices** ( | | | |
| 11 | Target shooting rifle/carbine[3] supported only Static to Static[3] | SS | ± 21.5 | ± 21.5 |
| 12 | Target shooting rifle/carbine supported only Static to Moving[3] | SS | ± 40 | ± 21.5 |
| 13 | Sniper practices. (snipers who have completed initial sniper training only.) | SS | ± 12 | ± 12 |
| 14 | Combat Shotgun - Slug<br>Combat Shotgun - Shot | SS<br>SS | +80<br>+80 | +80<br>+200 |

## Table 3 - Authorised SA Cones of Fire to be applied on MOD Ranges

**Notes**

1. LDA/FDA ranges include all open ranges that have DA limited by construction, or a combination of construction and QE.
2. On LDA ranges automatic fire is restricted to burst fire from bipod/tripod mounted 5.56 and 7.62 mm weapons. Unsupported Automatic Rifles may only be burst fired on a FDA range with a 2900 m or greater DA.
3. The reduced CofF recommended by DOSG may be applied only under the following conditions;
   a. Use is restricted to competent marksmen authorised in writing by the unit CO, using a rifle zeroed or check zeroed at not more than 100m each time the weapon is brought onto the range.
   b. The reduced CofF of 21.5mils is approved only for single shot supported shooting practices.
4. Maximum range of the weapon system is normally achieved with a barrel elevation of about 620mils. Above and below this rounds fall short of maximum range.

02016. **Danger Area/Zone.** See Range Danger Area / Zone

02017. **Danger Area Template**. See Weapon/Range Danger Area Template.

02018. **Danger Area Trace**. See Range Danger Area Trace.

02019. **Design Approval**. Design approval is the formal act of authorisation in document form, by the Responsible Authority that the design meets the stated requirements and is suitable for MOD use with or without limitations. For range works and projects this will be the responsibility of those responsible for Works and Project delivery.

02020. **Design Authorisation**. Design authorisation is the order or direction to do something to meet stated requirements by the branch or establishment responsible for doing so i.e. by the Responsible Authority (Defence Standard (DEF STAN) 05-10). The responsibility may be more limited e.g. Design or Technical Authorities. Their appointment and limitations are authorised by the Responsible Authority. For range works and projects this will be the responsibility of the Property Manager or Project Sponsor (PS).

02021. **Design Certification**. Design certification is a signed statement by a qualified person that the design wholly or partially meets or complies with the approved specification(s), which includes legislation. TAS (RE) are responsible only for certification of range safety compliance on range works and projects.

02022. **Ground Target (also called Soft).** Ground target refers to all surfaces which, when impacted at low angle ($<30^0$), will deform or break up. Water surfaces and ice are also classified as a ground target. In this document used by contractors and those involved in the design and construction of ranges the term `Soft' will be used.

02023. **Hard Target.** Hard target refers to all material which possesses sufficient strength and surface hardness in relation to a given weapon that at low angles of impact the target suffers little or no deformity. When hard surfaces are exposed to the firer, the additional DA wings are to be applied (see Figure 19-2).

02024. **High Elevation Fire**. High Elevation Fire (HEF) is fire at a variable vertical firing angle for engaging targets where the CofF is elevated so that no portion of it is captured by the ground within a general firing angle of 150-1250 mils. For SA it denotes All Arms Air Defence (AAAD) shooting.

02025. **Hill Background.** A hill background exists when ground immediately behind the targets rises to form a hill beyond which no projectile hazard is predicted to exist. If the criteria are met, consideration can be given to reducing the RDA. (See also paragraph. 02105).

02026. **Impact Area/Zone**. An impact area/zone is a space authorised and applied permanently, or at the time of firing, in which specified weapons may impact, detonate, break up or operate. The space must be large enough to contain ricochet but have its edge no closer to the DA/Z boundary than the authorised fragment BSD or other bursting weapon hazard distance. Access to the impact area/zone must be physically controlled as directed by the Range Authorising HQ. Additional controls may be required due to the

possible presence of blinds. For a full description of impact areas see para.02130 - 02136.

02027. **Jump.** Jump is the vertical component of the acute angle between the muzzle axis before firing and the line of departure. It can be positive or negative, depending on the gun.

02028. **Line of Fire.** The Line of Fire (LofF) is an imaginary straight line from the barrel of the weapon delivery system to the target. The LofF is used by range designers to ensure safety from all firing positions. The distinction between Line of Sight (LofS) and LofF is critical when shooting from the prone position and for sniper fire from inside a building as although the sight to target is clear, the Line of Fire may not be. For example, the SA 80 optical sight is 90mm above the centre line of the barrel. (Figure 2)

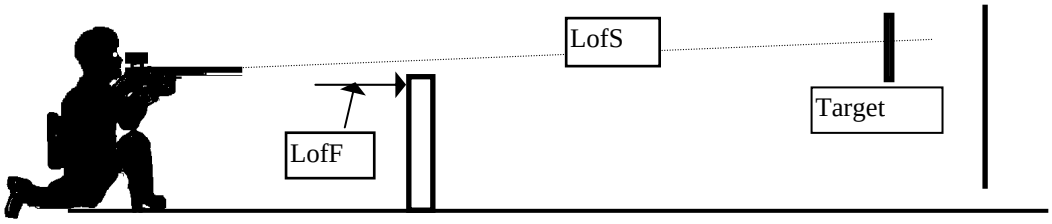



Figure 2

02029. **Line of Sight.** The LofS is a straight line passing through the aiming device (sight) of the delivery system and the point of aim on the target so that the firer can see the target he is engaging. (Figure 2)

02030. **Military Measurement.** The angle of military measurement is a mil which subtends 1 mm at 1 m and 1 m at 1 km and is approximately 1/6400 of a circle. This simple unit of measurement aids setting out and estimating angles and distances in the field Example: The height of a range component is required to be 6 mils measured from the firing point. If the distance from the firing point to the component is 30 m, the height required is:

$$\frac{6 \times 30}{1000} = \textit{0.18 m or 180 mm}$$

Note:1 *mil* = 0.0562 deg *and* 1deg = 17.778 *mils*

02031. **Prepared Impact Area**. Where exploding ordnance has a grazing fuse that may not ignite in soft ground, the area around the target is prepared with stone or gravel. The extent of the hard surface will depend on the predicted weapon and aimer error.

02032. **Quadrant Elevation**. The Quadrant Elevation (QE) is the angle between the horizontal plane and the axis of the bore when laid (sighted). (See Figure 2-1). For the purposes of range design in this publication the following sub definitions are provided:

a. $QE_{TCH}$ = QE to the Target Centre Height (Physical point on a range that can be measured).

b. $QE_{Actual} = QE_{TCH}$ + CofF.

c. $QE_{Max}$ = QE Restriction applied.

02033. **Range (Zone).** A range is a space reserved, authorised and normally equipped for hazardous firing (weapons or lasers). The following are types of range:

a. **Indoor Range.** An indoor range is fully contained within a building or other structure.

b. **Open (Outdoor) Range**. An open range is exposed to the natural effects of light, wind and other meteorological conditions. The range may be completely open or contained partially by a structure.

c. **No Danger Area Range**. A No Danger Area (NDA) range is a range where, for all practical purposes, the design precludes risk of injury or damage to persons or property beyond the range floor caused by shot, direct or ricochet, fired in accordance with authorised procedures and aimed within the bounds of acceptable aimer error.

d. **Limited Danger Area Range**. A Limited Danger Area (LDA) range is an open range for which the minimum design requirements are to capture shot so that any resultant ricochet remains within the RDA.

e. **Full Danger Area Range.** A Full Danger Area (FDA) range is an open range where hazard including any Burst Safety Distance (BSD) is only limited by the elevation of the delivery system and the skill of the firer.

f. **Total Energy Range**. A total energy range is a range where a weapon may be fired without restriction.

02034. **Range Authorising Officer**. The Range Authorising Officer (RAO) is the officer responsible for personally certifying on the MOD Form 904 the weapon systems, munitions and explosive stores which can be used on the range (see Reference A1 (Volume I)).

02035. **Range Danger Area/Zone**. The RDA/Z is the space within a range in which there may be a risk to personnel, equipment or property from firing authorised weapons within specific arcs. The RDA/Z should be within the training area boundary. Access to and movement within the RDA/Z are controlled through Range Standing Orders (SO). RDA includes the ADA and is better described as Range Danger Zone (RDZ)

**Note:** Boundaries on land are to have appropriate control measures in place to warn the public and to deter access eg signs, fences, flags, lights and sentries. See also Reference A1. At sea buoys may have to be provided.

02036. **Range Danger Area Template.** A Range Danger Area Template (RDA Template) is a technical drawing which defines the boundary of prescribed risk from firing authorised weapons on a specified bearing line of fire, on a range built to an approved type drawing/standard. The RDA Template is to be worked to a given scale and produced on appropriate material for convenient application to a map.

**Notes:**

a. Elements of construction including firing point alignments with targets will affect hazard contours and hence change the shape of specific RDA.

b. The RDA template will only apply to a range built to the specifications and criteria set out in this JSP.

c. The RDA template is range type, weapon(s) type, munition(s) type and QEMax specific.

d. Combining templates may be used where MOD land is available to resolve non compliance issues and adjacent range restrictions. Full Danger Area (FDA) RDA may be reduced to LDA in width only to minimise adjacent range restrictions where range floors are flat, firing points perpendicular to the line of fire and no large ricochet surfaces. In all cases refer to TAS(RE) on options to utilise combined templates on fixed ranges.

e. In areas where there is limited land available, particularly if there are hills in the direction of fire, it is possible using alternative information such as that provided by the Weapon Danger Area Lab (WDALab) allied to additional controls to allow the use of a reduced danger area.

02037. **Range Danger Area Trace**. A RDA trace is a technical drawing of a common composite DA which is deduced from an amalgamation of a number of WDA templates. The trace is worked to a given scale and produced on appropriate material for convenient application to a map.

02038. **Range Floor.** The range floor comprises the ground from the furthest firing point to the target including any range construction intended for or capable of capturing correctly aimed shots or reducing ricochet.

02039. **Range Safety Dispensation**. A range safety dispensation is considered for a particular range that cannot be designated as an Approved Range due to range structure, layout or danger area. It is a written authorisation by a one Star operational theatre commander or for a PTR, 2 star level or above, to permit continued use of a range when it does not meet currently prescribed safety criteria. Range Safety Dispensation covering practices is described in Reference A1 (Volume I).

02040. **Ricochet**. A ricochet is the change of direction and velocity, induced in a projectile, missile or fragment caused by its impact with a surface. For design purposes ricochet is generally taken as $30^0$ off soft targets and $45^0$ off hard surfaces in elevation and azimuth for high velocity ammunition. For low velocity ammunition the ricochet angles are taken as $15^0$ off ground and $45^0$ off hard. For specific range advice TAS may utilise data provided by DOSG from trials (See also para.02096b). Ricochet greater than $90^0$ is regarded as backsplash (See para.02011).

02041. **Small Arms**. Small Arms (SA) is a general term for small calibre (normally up to 12.7 mm) weapon systems. Reference A4 (Volume IV) describes categories of SA.

02042. **Tangent Elevation**. Tangent elevation (TE) is the angle between the LofS to the target and the axis of the bore.

02043. **Template**. A template is a technical drawing worked to a given scale and produced on appropriate material for convenient application. See also RDA & WDA Template.

02044. **Trace.** A trace is a technical drawing of an amalgamation of WDA templates worked to a given scale and produced on appropriate material for convenient application to a map.

02045. **Type Standard.** Type Standards are produced to provide contractors and consultants with a more detailed explanation of each of the range types to assist in the development of their design solutions. The document contains the technical specialist ballistic elements of a design brief for a range and detailing the ballistic and functional requirements to be incorporated in the design.

02046. **Vector Angle**. A vector angle is an angle with a horizontal and vertical component. Vector angle is not used in assessing range compliance as the ricochet angle used represents total turn and not the elevation and azimuth components of ricochet.

02047. **WDALab.** Weapon Danger Area Laboratory. A computer programme run by DOSG that simulates rounds fired on a range that produces a probabilistic assessment of where rounds fall given ground features, weapons used and predicted cones of fire.

02048. **Weapon**. A weapon is an object designed, used or capable of being used as an instrument for inflicting harm to health, property or the environment.

02049. **Weapon Danger Area/Zone**. A WDA/Z is the space into which specified weapons or their fragments may travel, impact or function given normal firing conditions. The WDA/Z excludes low probability human and system errors.

02050. **Weapon Danger Area Template**. A WDA template is a technical drawing of an approved DA for a single delivery means and a single target, projected on a specified LofF bearing, worked to a given scale on appropriate material for convenient application to a map.

**Notes:**

a. On a LFTTA the WDA template can be used to deduce a variable safe area by swinging the template within allocated arcs. The deduced safe area becomes a trace for the single weapon system. (See Reference B (Pamphlet 21)).

b. Combining more than one WDA template produces a trace.

c. RDAs and WDAs, and therefore the templates, require review. Unless a revised template has been approved in accordance with Service instructions, it must never be used for firing.

02051. **WUF**. Weapon Unloading Facility either static or transportable. All transportable units are proprietary designs.

02052 – 02054 Spare

## RANGE SAFETY STANDARDS

02055. **General.** The risk of a projectile leaving a range is minimised by a combination of design, training and control.

02056. **Design Parameters**. Range design is based on historical evidence, advice from DOSG advice and the previous Ordnance Board Proceedings and Members Letters, this JSP and advice from TAS(RE). DOSG have provided advice on scientific data generated from trials and considered opinion, based on appropriate ballistic and statistical calculations, on reasonable levels of range safety. NDA and other open ranges are not designed on the absolute worst case. They are designed to capture all properly aimed projectiles with an additional degree of safety for acceptable aimer error and ricochet. Ranges are not designed to capture all projectiles from accidental or negligent discharge. Ranges that were designed to type drawings have given no cause for concern and still meet the current minimum level of safety. New ranges and major refurbishment of ranges are to be constructed to the design criteria in this Volume; advice from TAS(RE) is to be sought. Legislative requirements of the Health and Safety at Work Act and the Management of Health and Safety Regulations are satisfied by the design process undertaken by consultants and contractors commissioned by the MOD under the conditions given in Reference G The mandatory detail provided in this Volume addresses identified and predictable hazards, to which it provides engineering solutions to reduce the perceived risk to As Low As Reasonably Practicable (ALARP). The controls necessary to achieve these reduced risks are stipulated in Reference B (Pamphlet 21), which in conjunction with this Volume, form the major components of the "Safe System" whereby a safe environment for effective operational training with SA, Inf WS and 30mm is achieved.

02057. **Accuracy of Construction.** This publication provides the minimum standards that should be achieved. Where an element is fundamental to the level of safety provided it is indicated as Critical (C). These elements will be subjected to compliance checks on completion of works. On existing ranges, elements that do not conform to the standard must be included in the range Risk Assessment to determine if the level of safety provided is affected. Where the level of safety is reduced, control measures must be applied to maintain the level of safety required. Where this cannot be achieved the range may only operate under dispensation until such time as a full assessment is completed and Approved range status is authorised. Elements that are not classified as (C) will be subject to acceptable construction tolerances. See also para.02002.

02058. **Compliant Ranges.** A range which meets the design and build criteria specified for its type in JSP 403 or the appropriate Single Service publication. Most ranges have some degree of non conformity. Although different from those illustrated in this JSP they will conform to the safety critical elements described in the respective chapters. For marginal non compliance where the TAS (RE) and the RAO considers such non compliance will not significantly increase the level of risk on the range the range may be authorised by the RAO as compliant. Where doubt exists, TAS (RE) is to be consulted and if necessary DOSG advice will be sought prior to seeking Approved Range Status. See paragraph 02009.

02059. **Maintenance**. To ensure that ranges in use conform to current safety criteria, effective maintenance is essential. Range Wardens' duties are given in Reference A1. When a range does not warrant a full time Warden, the RAU is to appoint a competent person to carry out these duties. On the DTE maintenance is carried out by contract. The frequency of maintenance and inspections is given in Reference A1 (Volume I). A range works inspection guide is available to all range works officers from TAS (RE describing the range elements that are to be inspected at least every 2 years as set out in Reference A1, Volume 1.

02060. **Conduct and Training**. A range is designed and built only for qualified and authorised personnel with weapon systems authorised for use on the range, under proper supervision and in accordance with Service instructions.

02061. **Population Density**. Planning Staff and the Board of Officers must consider population density and public sensitivity around a proposed range before determining location and orientation.

02062. **Siting Preferences.** Outdoor ranges should be sited facing north in the Northern Hemisphere and south in the Southern Hemisphere so that firers do not engage targets into direct sunlight. The range should also be sited as far as possible from habitation as it is difficult to reduce impulse noise generated without modification to the weapon. When siting ranges, aligning the direction of fire away from habitation when possible should take precedence. The total energy template should be considered when assessing population and habitation in the area of the proposed new range.

02063. **Identification of Critical, Standard and Typical requirements**. All details in the respective range chapters represent the authorised STANDARD (S) to be adopted. Those elements that may be provided in many forms will be designated as TYPICAL (T). As the margins of safety incorporated in the STANDARD are wide, a range element that fails to meet this STANDARD is unlikely alone to make the range unsafe. Elements that do not comply with the STANDARD are non compliant and should be assessed to determine the level of safety achieved (see para.02054). Critical (C) dimensions are provided where minimum ballistic data exists.

02064, Spare

## LIMITATIONS OF BALLISTIC PERFORMANCE ON RANGES

02065. **General.** This section applies to SA; the limitations for other Inf WS are given in the appropriate Chapters.

02066. **Weapon Performance**. The performance of weapons can be expressed in several ways. For the design of ranges, muzzle velocity (MV) and muzzle energy (ME) are used. These performance criteria are directly related to current MOD ammunition types in determining WDA, penetration data, backsplash and ricochet. However, it is essential to specify the weapon performance limits for each range type to ensure that the range remains safe during use. Weapon performance may vary depending on several factors, two of which are:

a. **Type of Ammunition.** Certain types of ammunition can significantly enhance the effects of a weapon system that could result in its performance exceeding the design criteria of the range.

b. **Cartridge Loading**. In the case of hand loaded or re-loaded cartridges, the manufacturer's specification must be rigidly adhered to. Altering the quantity or quality of propellant to meet performance specifications can be dangerous. The MV and ME specifications for the particular range are not to be exceeded.

02067. **Authorised SA Weapons**. As the requirement is to limit firing to those SA that perform safely within the design criteria of the range, only those weapons whose MV and ME do not exceed the criteria stated on the MOD Form 904 may be fired on constructed ranges. When only one performance criterion of a SA conforms to the authorised limits, TAS(RE) should be consulted on matters of construction and the HQ of the RAO or the RAU for clearance to fire; both may wish to seek DOSG advice. For example, a light, small calibre bullet with an MV higher than the specification for the range may have an ME within the specification but such a bullet is likely to have very different ricochet characteristics to the slower, heavier bullet for which the range has been designed. Civilian long barrelled pistols may only be used with the shoulder stock extended. AP ammunition is not to be fired on constructed ranges. For RDA details of authorised weapons refer to Chapter 19 Figure 19-2 and 19-3.

02068. **Muzzle Velocity and Muzzle Energy Limitations.** Each range will be authorised for specified SA and ammunition. The limitations for SA, contained in Table 4 and any other limitations on how a range can be used will be stated on the MOD Form 904, in Range SO and on certificates issued to police or civilian shooting clubs which may use the range. The commonly used term “Low Velocity” (LV) is related to serials 1 to 3 in Table 4 below. “High Velocity” (HV) refers to weapons with MV greater than 655m/s (2145ft/sec).

| Ser | Weapon Type | Indoor | | Open | |
|---|---|---|---|---|---|
| | | MV(m/s) | ME (J) | MV(m/s) | ME (J) |
| (a) | (b) | (c) | (d) | (e) | (f) |
| 1 | Air rifle | N/A | 16 (12ft lbs) | N/A | 16 (12ft lbs) |
| 2 | Rimfire weapon only | 530 (1735ft/sec) | 285 (210ft lbs) | 610 (2000ft/sec) | 480 (350ft lbs) |
| 3 | Centrefire pistol/carbine | 520[2] (1705ft/sec) | 645[2] (475ft/bls) | 655 (2145ft/sec) | 2030 (1495ft lbs) |
| 4 | Centrefire rifle NDA ranges | 1000 (3280ft/sec) | 7000 (5160ft lbs) | 1000 (3280ft/sec) | 7000 (5160ft lbs) |
| 5 | Centrefire rifle on ranges with GR LDA | | | 1000 (3280ft/sec) | 4500[1] (3319ft lbs) |
| 6 | Centrefire rifle on other ranges | | | No ME/MV limits – Refer to Chapter 19 Figure 19-2 to determine extent of RDA required. | |

**Table 4 - SA Ammunition Maximum MV and ME Limitations (C)**

Notes:

1. Weapons with ME greater than 4500J but less than 7000J may be used on gallery type ranges providing authorised control measures[6] are in place. Where there may be any doubt about the ammunition or practice, civil clubs and police are to be restricted to MAX 4500J, 1000m/s.
2. These figures relate to defence structure specification in Table 7a.
3. Civilian use of tracer is not permitted on constructed ranges. Where tracer is authorised on LFTTA ranges civilian clubs may fire tracer ammunition providing provision is made to ensure any local restrictions are made known to the club.
4. Civil clubs may only use copper or steel jacketed lead core or solid lead rounds on MOD ranges.
5. Range structures such as bunkers on MMTTR, Control buildings on the range floor and structures on IBSR have sufficient protection for weapons up to 7000J.
6. Authorised control measures are those issued by HQ Inf for military snipers in Reference C2 AOSP Vol.2 and control measures approved by MOD and issued by the NRA for all civil and MOD police and all civilian full bore target practice.

02069. **Black Powder Weapons.** Black powder or black powder substitute propelled weapons may be fired on open DLR. MV and ME must not however exceed the specified limits for that range. Black powder weapons are not to be fired in indoor DLR.

02070. **Combat Shotgun.** Combat shotgun is authorised for use on LFTTA or constructed ranges using buckshot or solid slug. WDA for combat shotgun is shown in Figure 19-2. Other shotgun uses are covered by CPSA safety rules.

02071. **Jacketed and Non-Standard Bullets**. Table 7a gives the required thickness of steel protective plating for indoor ranges to be safe against jacketed and unjacketed bullets. Tracer and other specified specialist ammunition natures may be fired on various ranges, the conditions for which

are to be found in the chapters of this Volume that deal with particular range designs.

02072. **Conversion of Ballistic Data.** It may be necessary to convert ballistic data to make a comparison with data available in this Volume and elsewhere. This paragraph provides simple equations to calculate ME when MV and weight are known, and to convert weight expressed in grains (gr) to an expression in grams (g).

a. **Calculation of Energy**. When MV and bullet weight are known, ME in joules (J) may be calculated:

$\frac{1}{2}NV^2 = ME_J$ N = Bullet weight in kg

V = MV in m/s

e.g. Eley Tenex 0.22 in

Bullet weight (N) = 2.59g or 0.00259kg

MV(V) = 331 m/s.

Answer: $ME = 0.5 \times 0.00259 \times 331^2 = 142J$.

b. **Conversion of Bullet Weight.** Bullet weight expressed in g (avoirdupois) may be converted to g SI (Système International d'Unités):

1gr = 0.065g 1g = 15.432gr.

c. **Energy**. ME expressed in foot pounds (ft lbs) force (imperial) may be converted to J (SI).

1J = 0.738ft lbs 1ft lbs = 1.3556J

d. **Velocity**. MV expressed in feet per second (ft/s imperial) may be converted to metres per second (m/s) (SI):

1ft/s = 0.3048m/s 1m/s = 3.281ft/s

02073. **Automatic Fire**. The constraints for automatic fire on specific ranges are set out in the relevant chapters. Additional limitations will be found in References B (Pamphlet 21) & X (LUMAT).

02074. **Tracer Ammunition**. In most cases 5.56mm tracer ammunition may be treated as ball, however tracer may generate fires in granulate rubber or shoot facilities constructed with rubber blocks or tiles. Where ball ammunition is fired into granulated rubber traps the RAU is to ensure that there is no residual heat in the rubber at the end of each days firing.

02075. **CQM LFMT 3m Shoots**. Where CQM 3 m shoots are authorised the QE may be excessive. Great care is needed to ensure shot will fall where it is expected particularly when firing at the higher aiming point from 3 m in the kneeling position. Restrictions are provided in the respective Chapters.

02076 – 02079 Spare

## RANGE DETAILS AND DRAWINGS

02080. **Imperial and Metric**. In line with Government metrication policy implemented on 1 October 1975, all future range design will be in metric units. This Volume has converted imperial dimensions to metric, rounded as

appropriate where safety parameters allow. Inspectors should measure imperial ranges against the original imperial dimensions. Where ranges are converted from imperial to metric, then checks should be carried out using metric units. On those ranges that are a mix of imperial and metric, care must be taken to ensure critical safety parameters are maintained. The principal areas of concern for each range type are covered in the respective chapters of this Volume.

02081. **General**. The MOD, through the Land Ranges Safety Sub-Committee (LRSSC), a sub-committee of the Defence Land Ranges Safety Committee (DLRSC), approves design criteria and, where applicable, drawings for the range types outlined in this Volume so that authorised training objectives may be achieved. There are several categories of range drawings and their purpose is given in this section.

02082. **Type Drawings/Type Standards**. Type Drawings were originally created to give the requirements necessary to construct new range facilities. However they contain much constructional detail that is prescriptive and out of date. Type Drawings are no longer issued to contractors or consultants. Type Drawings are replaced with Type Standards (TS) and Range Design Guides (RDG) that place the design responsibility onto consultants commissioned by MOD to develop a range. Current Type Standards are listed in Table 5.

| Ser | Number | Description |
|---|---|---|
| (a) | (b) | (c) |
| 1 | TS-01 | RGGS – (Obsolete) |
| 2 | TS-02 | Indoor Ranges |
| 3 | TS-03 | Non Standard Outdoor NDA Ranges |
| 4 | TS-04 | Converted Gallery Ranges |
| 5 | TS-05 | Tube Ranges |
| 6 | TS-06 | 25m Barrack Ranges |
| 7 | TS-07 | Electric Target Ranges |
| 8 | TS-08 | CQB Urban Live Fire Ranges |
| 9 | RDG-01 | Test Ranges |
| 10 | RDG-02 | Control of Noise on constructed ranges. |

**Table 5 – Type Standards Held by TAS(RE)**

02083. **Construction/Record Drawing**. Construction drawings based on the Type Standard and are produced by a consultant or contractor. These will be specific to the site with the details of the shape of the range floor, foundations and all that cannot be specified in the Type Standard. If during the construction of the range there are no fundamental changes to the contract, the construction drawing serves as the record drawing.

02084. **As-Built Drawing.** If during the contract details are changed from the original design, as-built drawings are required to record the actual details of the range. Normally their provision is part of the standard contract and is a requirement of the Construction (Design and Management)

Regulations. For existing ranges without record or as-built drawings, they should be provided retrospectively.

02085. **Drawings produced by TAS(RE).** The production of the Technical Office and Sketch series of drawings ceased at the end of December 1996. All important drawings were archived and retained for record purposes and copies will only be released after careful consideration of the content and potential implications of issue (using a covering letter where necessary to highlight the drawing status/purpose and how the details may be used). From January 1997 the release of drawn information has been restricted to the following:

a. **Type Standards and Design Guides**. The production of Type Standards and Design Guides replaces the existing outdated and prescriptive Type Drawings and are approved for issue by the TWG. These essentially form the specialist technical elements of a design brief, detailing only the ballistic and functional requirements.

b. **Certification Drawings**. This series of drawings referred to as Licensing Drawings (LD) are approved for issue by OC TAS and have been introduced to support the Certifying Officers of all three services by giving extremely accurate range location and template details to assist in the certification of facilities. For each range the danger area is projected from actual lines of sight on that range, which are not always parallel, producing a range specific danger area template. All open ranges should seek to have a range specific template that reflects their range danger area precisely and will also assist the siting of adjacent ranges or facilities. On range complexes where RDA overlap adjacent ranges a table of restrictions is provided either on the LD drawing where there is space or on separate sheets. Additional range management detail required by the RAU or RAO may be included such as the range controlled boundary.

c. **Illustrative Sketches**. This series of drawings serves three basic purposes, the aim being to provide assistance to all concerned with range compliance, design and development:

(1) To illustrate TAS Total Station surveys with the criteria overlaid to determine compliance or otherwise with Standard Criteria. Usually read in conjunction with Survey Record (SR) Drawings.

(2) To illustrate proposed templating and / or range positioning as part of or following a desktop study.

(3) To illustrate where necessary, principles or typical solutions in support of written reports.

d. **Survey Records**. Survey records are a series of drawings illustrating the results of Total Station and GPS surveys supporting technical drawings of a range and the danger areas.

e. **WDALab Drawings**. Drawings developed solely in support of DOSG WDALab tasking.

02086**. Range Maps**. There are a number of maps available to RAUs each provided to meet specific needs.

a. **Range Master Map**. Provided by DE as required by Reference A1. This includes definitive information on MOD boundary, lease land, over firing rights, sea danger areas from the Hydrographic Office and the extent of range danger areas from TAS(RE).

b. **Training Area Mapping**. Provided by HQ DTE for general issue or for local use by RAU. Formal justification is required for a new training area map for general issue. A revision programme controlled by HQ DTE is in place to update existing training area mapping. Training area mapping overlays provide additional information to assist troops training and the management of the training area by an RAU.

02087 **Change Records.** Original range ballistic construction details are recorded on the MOD Form 1057. Any subsequent significant changes to the range must be recorded onto the MOD Form 1057 or where there is substantial change, a new MOD Form 1057 is issued. This will ensure a clear audit trail is maintained and that all changes are properly checked for compliance. Significant changes include adding or changing firing points or target types and positions.

02088 – 02089. Spare

## RANGE TYPES

02090. **Small Arms and Infantry Weapon System Ranges.** This Volume deals with all Small Arms and Infantry Weapon System Ranges designed for a specific purpose. The range types included in this volume include:

a. **No Danger Area (NDA) Ranges**. To be classed as an NDA range, all anticipated shot must be contained within the range with a substantial margin of safety. See definition at paragraph 02032c. The following range types may be classed as NDA ranges;

(1) Indoor Ranges including tube ranges.

(2) 25m Barrack ranges.

(3) The 1908 design 30m range (now only used from the 25m firing point).

(4) Some test ranges.

(5) Non standard open NDA ranges.

b. **Limited Danger Area (LDA) Ranges.** Ranges where some rounds are expected to leave the area of the range floor either from direct fire or ricochet have a limited danger area to ensure all rounds are contained in a controlled area. Such ranges include;

(1) **The Gallery Range (GR) (See Chapter 15 for details).** The Gallery range has a limited danger area based on the principle that the CofF is lifted from the range floor by the mantlet thereby reducing the incidence of ground ricochet, the primary source of rounds escaping a range. A 1830m RDA is applied from the target line. Most existing GR ranges have a QE

restriction ($QE_{max}$)of 70mils, which equates to $QE_{tch}$ of 30mils to ensure the limited danger area is sufficient. Gallery ranges with modified mantlet and stop butts that have been increased in height to capture the whole CofF do not need to impose the QE restriction as all predicted direct fire from the 100m firing point will be captured. A further reduction in the length of the RDA from 1830m may be considered if and when hill background criteria is met or WDALab indicates that a smaller RDA will provide a similar level of safety.

(2) **The Converted Gallery Range (CGR) (See Chapter 16 for details**). This range is a Gallery range with the gallery frames and Fixed Electric Targets (FETs) mounted into the top of the mantlet.

(3) **The Electric Target (Limited Danger Area) Range (ET(LDA)R) (See Chapter 16 for details).** This range has no gallery, and has Fixed Electric Targets (FETs) mounted into the top of the mantlet often with Automatic Marking Systems (AMS) fitted.

(4) **The Grouping & Zeroing (GZ) Range. (See Chapter 14 for details)** 100m range constructed to gallery criteria with a full stop butt.

(5) **Baffle Ranges**. Open baffle ranges are no longer considered cost effective designs as they do not as previously thought capture all rounds. UK Baffle ranges are designated as an Approved ranges following WDALab advice. German Baffle ranges operate with Cautionary Zones as described in German Standard Range Specifications. Chapter 13 has more detail.

(6) **25m Barrack Range and centerfire non-standard No Danger Area ranges.** Ranges with normal bullet catcher but without a canopy are classed as LDA ranges as they have a 100m RDA beyond the back wall to take account of expected ricochet. Chapter 9 provides the details. Where the bullet trap face is 56 deg or more no ricochet is expected.

(7) **Hill Background Ranges**. No ranges to date have met the criteria in Fig. 2-5. Open ranges with a hill rising behind the stop butt may be assessed by WDALab to determine the actual RDA required on such ranges.

c. **Full Danger Area (FDA) Ranges.**

(1) **The 100m Grouping & Zeroing (GZ) range. (See Chapter 14 for details)**. Where gallery criteria is not met this range operates on a WDA. A small stop butt may be provided to indicate the fall of shot.

(2) **The Electric Target Range (ETR) - 600m - (See Chapter 17 for details).** A flat range floor with FETs located at 100, 200 & 300m from the main firing point. This range is ideally suited for the ACMT. All shot is automatically recorded and targets are able to fall when hit. A WDA is usually applied with hard target wings when necessary.

(3) **Mechanised Moving Target Trainer Range (MMTTR) - 150m. (See Chapter 20 for details)** A flat floor range with 10m target runs for each lane. A WDA is applied.

(4) **Individual Battle Shooting Range (IBSR) 300m - (See Chapter 18 for details).** This range provides excellent transition training to Stage 5 providing firing from cover, controlled Field Firing and moving targets. A WDA is usually applied with hard target wings when necessary.

(5) **Pistol Ranges.** Pistols are often fired on NDA and other ranges. When fired on LDA / FDA ranges the pistol template is applied in accordance with the principles illustrated in Fig. 19-2 using the CofF for pistol under LDA/FDA ranges in Table 3. A 1500m RDA is usually applied.

02091 – 02094. Spare

## RANGE DESIGN

02095. **Design Principles**. Safety on and around ranges is provided by the provision of safe weapon systems, training, control measures, supervision and for constructed ranges, safe design. To ensure ranges remain safe the design must also take into account cost in use by minimising the maintenance effort. There are four categories into which all ranges fall to provide a safe shooting environment.

a. **Total Energy Range**. A total energy range will have a template large enough to capture all shot fired in a particular direction without further restriction. Large land or sea danger areas are required to capture the maximum projectile trajectory.

b. **Full Danger Area (FDA) Range**. A Full Danger Area (FDA) range is an open range where the hazard is limited by the elevation of the delivery system and the skill of the firer. The amount of land or sea danger area required is minimised by controlling the elevation of the weapon.

c. **Limited Danger Area Range**. A Limited Danger Area (LDA) range is an open range for which the minimum design requirements are to capture direct shot and any resultant ricochet remains within the RDA. A combination of limiting elevation and the inclusion of range structures to capture shot and or minimise ricochet enables the danger area to be further reduced.

d. **No Danger Area Range**. A No Danger Area (NDA) range is a range where, for all practical purposes, the design precludes risk of injury or damage to persons or property outside the range.

02096. **Safe Design**. The standard details provided in the respective range chapters have proven to be safe over a long period of extended use. The margins of safety in the standard designs extend far beyond the predicted Cone of Fire (CofF). No current modern design solution will be allowed to fall below these existing levels. For non standard open NDA ranges for instance, following application of CofF criteria in Fig 2-4, the established criteria shown in Figs 2-2 and 2-3 are applied and it is the safer of the two solutions that are

used. Minor changes have been made to particular elements to ease maintenance and therefore become more cost effective in use. Factors considered to ensure a safe range include;

a. **Direct Fire.** Predicted direct fire is either stopped by defence structures, limited by Quadrant Elevation (see Fig. 2-1) or a full energy template is provided. For design purposes, direct fire is that shot which falls within the Cones of Fire (CofF) set out in Table 3. Experience, trial evidence and advice indicate that these CofF are more than adequate for authorised practices.

b. **Ricochet**. (See also paragraph 02040). Ricochet from range structures and surfaces are generally the limiting factor for the range designer. The exception is where ricochet occurs off hard smooth surfaces. In this circumstance the exit angle is normally half the impact angle. Ricochet must be expected off all surfaces that a round may strike at angles of less than $30^0$ including standing water. Ricochet is minimised off slopes of $30^0$ or more and eliminated off slopes of $56^0$ or more. Tracer ammunition has different ricochet characteristics the extents of which are provided in Fig. 15 - 1. Ricochet will influence the size of defence structures and danger areas including the air danger height. The use of ricochet pits can reduce the height of capture structures when using logical design principles. On all ranges, rounds that strike the range may;

(1) Be captured by the ground or structure.

(2) Break up on impact and fragment over a small area.

(3) Remain intact, change direction, exit at shallow angle and tumble with sufficient residual energy to achieve medium range potential.

(4) Remain intact, change direction, exit at shallow angle, re stabilise, with sufficient residual energy to achieve longer range potential.

(5) Deflect off target frames or other range components with little loss of energy.

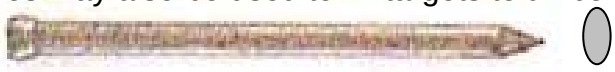
c. **Backsplash**. Provision has to be made to prevent backsplash from any structure, fixtures or fittings that may otherwise reach back to the firing point. Table 2 gives backsplash distances and the relevant chapters give further details. There is an additional hazard from poorly designed or fitted protective measures. If a round is able to pass through a timber baffle, protective material, target backing, target holder or post, it may decelerate sufficiently so that it does not penetrate through the anti-splash curtain but bounces back from the curtain and could reach the firing point with a hazardous velocity. This problem may occur on indoor, tube, test or other ranges where anti splash curtains are used.

d. **Hidden Attrition**. High velocity rounds penetrate soft material such as timber loosing very little energy and leaving only a slight indentation at the point of entry. When a round strikes the dense material behind all energy is dissipated often causing extensive

damage (attrition) behind the softer protective material. Defence structures should be capable of taking all predicted shot over a long period without undue attrition and should be designed to eliminate the possibility of hidden attrition. Where this is not possible procedures will need to be put in place to ensure the ballistic element is not

penetrated. This will entail ease of access to facilitate inspection of the hidden element.

0296e. **Fixings.** When fixing a material to the structure in the ballistic zones, care is required to ensure unwanted ricochet or backsplash is not caused. Oval head nails not round head nails (see below), are to be used to fix timber on to hard surfaces and the nail heads punched in. Bolts and screws are to be countersunk and plugged. Any other metal fixings should also be countersunk or protected. The wider heads of round head nails will cause rounds to shatter on impact sending fragments of nail head and bullet in many directions. Industrial staples may also be used to fix targets to timber supports.



f. **Tracer Ammunition.** With the exception of 5.56mm (see paragraph 02074) tracer ammunition is much less predictable and additional danger area boxes must be provided on all ranges where tracer may strike extensive sand range structures that project above ground level. The extent of tracer ammunition danger area around structures is illustrated on Fig. 15-1. (Earth banks hold and contain tracer rounds more so than sand.)

02097. **Design Criteria**. Common to all range design are the following criteria;

a. **Line of Fire (LofF).** An imaginary line taken from the barrel of a weapon to the point of aim on a target. Range structures in front of the barrel and down range such as baffles are designed by applying the respective CofF to the LofF or Lines of Fire where more than one points of aim or firing points exist. On 25m Barrack ranges assessment for compliance is taken only from the 25m firing points to the centre of authorised targets.

b. **Line of Sight (LofS).** The LofS is the line from the weapon sight to the point of aim on a target. Clear vision parameters are applied to the LofS. Structures close to the firer may not block the LofS but are directly in the LofF Structures at the target end of the range are designed by applying the CofF to the LofS.

c. **Firing Postures**. All current service shooting is carried out in an unsupported firing position (see Reference C). In the design of ranges, no account is taken of the respective stability of the three postures listed below. However it is acknowledged that supported firing positions provide a more stable weapon platform and this is often used as a restriction on non standard ranges. Supported practices allow smaller CofF to be used (see Table 3).

d. **Posture Heights**. The following posture heights are used as standard design criteria. There will inevitably be some variation due to individual physical characteristics, however as these are not predictable, a standard has been adopted for design purposes.

(1) Standing unsupported - 1500mm (C).

(2) Kneeling / sitting / squatting - 800mm (C).

(3) Prone / standing in a fire trench - 300mm (C).

e. **Clear Vision Line (CVL).** Although primarily used in the development of indoor shooting facilities it is also a good principle to apply to outdoor ranges. A CVL is projected from each firing posture to avoid distractions directly in front of the firer and to help minimise the risk of backsplash from protruding structures down range. The CVL should extend:

(1) **Vertically.** The upper line is projected from 600 mm above the highest firing posture used on the range to 250 mm above the highest target centre. The lower line is projected 300 mm below the lowest posture height used on the range to 250 mm below the lowest target centre (see Figure 3-3).

(2) **Horizontally.** 500 mm clear range space should be allowed parallel to the flank LofF at all firing points down the complete length of the range.

**Note**: The CVL does not apply when the barrel is clamped or specifically positioned within an aperture e.g. in a test or tube range.

f. **Trajectory.** The trajectory of a bullet on the LofF is used to determine the position of down range structures to minimise attrition.

02098. **Range Components**. Specific component details provided in this JSP are derived to provide confidence that the required level of safety is provided irrespective of location and detail of any particular range. See details in respective range chapters. Common to all ranges are;

a. **Firing point**. Firing points could be at almost any distance and height although each needs careful consideration to determine the appropriate lines of fire for subsequent application of criteria to establish requirements for protective structures. Each firing point should be accurately positioned and marked on the ground to assist in maintaining correct lines of fire in accordance with the original design. Distance markers should be provided on both flanks. Where elevated fire towers are provided it is essential to ensure that the elevated LofF will not expose mechanised target systems to direct strike. The standard firing point for outdoor ranges is shown at Figure 2 – 13.

b. **Firing Point Spacing/ Lane Widths**. To establish sufficient space for the firer taking account of distraction, ejected cases, smoke and noise the following guidelines are provided. Standard details are provided in respective range chapters.

(1) Rimfire rifle (single shot bolt action) - 1000mm

(2) Rimfire & centrefire pistol / carbine semi automatic - 1000mm with benches & screens, 1800mm without.

(3) Centrefire rifle - 1800mm (SS), 2500mm (A).

c. **Backsplash and Ricochet Protection**. On all ranges exposed hard surfaces, services and the like must be protected from direct fire and ricochet. Traditionally timber is added to the face of hard surfaces and steel baffles to prevent backsplash and excessive ricochet but other materials may be just as suitable. The material used must prevent the

bullet backsplashing or ricocheting back out from the protection. To reduce attrition, the protection material is off set from the hard surface to allow the bullet to break up on the hard surface without causing excessive damage to the protection material. Where softwood timber is used the following will be deemed compliant:

(1) **Rimfire.** 25 mm boarding on 25 mm battens. (C)

(Backsplash zone 50mm boarding on 25 mm battens. (C)).

(2) **Centrefire**. 50 mm boarding on 50 mm battens (C)

(Backsplash zone 75mm boarding on 50 mm battens. (C)).

Note: The use of oval nails in fixing such boarding will minimise potential backsplash hazards.

d. **Target Positioning**. The design target centre height and flank target positions should be permanently marked. Such marking ensures the correct relationship with defence structures is maintained. As the structure size is directly related to the target position, the targets should be positioned as close as is practicable to the base of the bullet catcher/stop butt to minimise construction requirements. Positioning of targets in accordance with the following guidelines should assist in providing sensible parameters for target positioning and enable realistic lines of fire whilst not compromising the safety of the range.

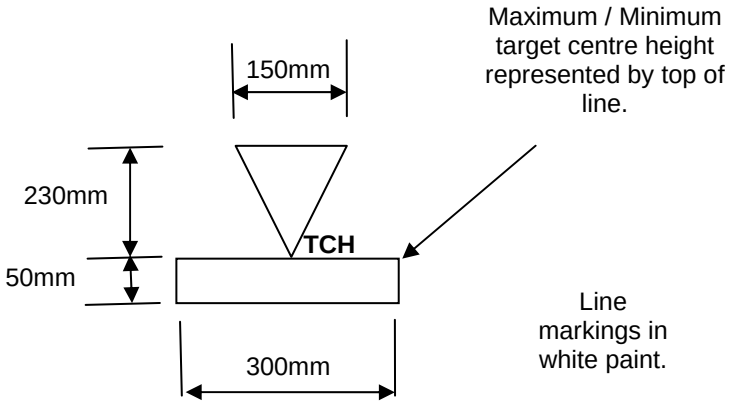
(1) **Target Heights**. The target centre should generally correspond to the height of the weapon to achieve a near level line of fire, although there are circumstances which may demand either elevated or depressed lines of fire. Typical target centre heights of between 450mm (T) lowest and 1500mm (T) highest are recommended. Standard details are provided in subsequent chapters.

(2) **Target Spacing.** The target centre spacing should generally correspond to the spacing of the firers although converging lines of fire are acceptable. Typical spacing may be as close as 600mm (T) from centre to centre with the usual maximum spacing being parallel to the firer spacing (diverging lines of fire are not normally used as this would increase the size and cost of protective structures and danger areas).

(3) **Multi Point Targets & Target Screens.** Multi point targets are mainly used only on 0.22" and air pellet ranges. Target screens are often used on outdoor 1908 barrack ranges. Where such targets are used the minimum defence structure dimensions provided in Table 6 are applied from the centre of the target for those authorised targets illustrated in Chapter 29 and from the highest or flank point of aim as illustrated in Figure 5 for other multi point targets. Once established the max target centre height and flank target positions should be clearly marked.

(4) **Target Positional Markings**.

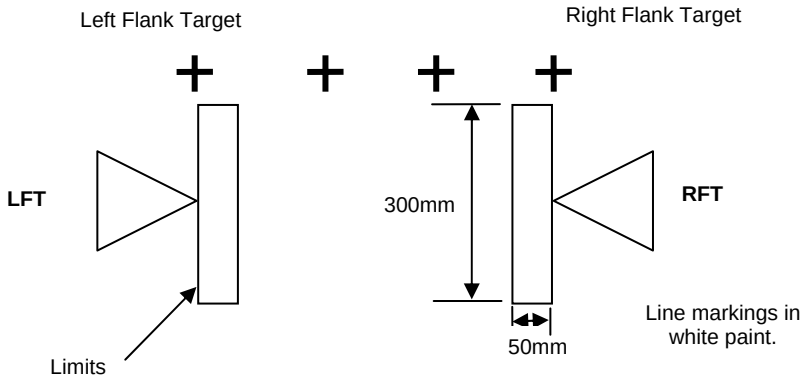
(i) **Maximum and Minimum Target Centre Height.** The highest and lowest permitted target centre height should be indicated at the target line on both flanks (a recommended method of marking can be seen below). These markings should be in a highly contrasting colour paint and permanent.




**Recommended target centre height markings.**

Figure 3

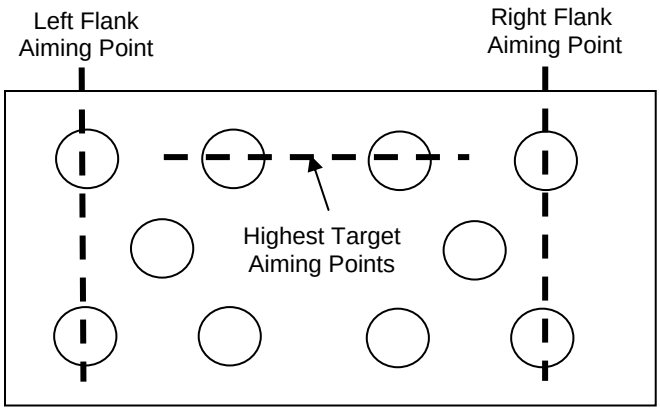
(ii) **Target Flank Markings**. These should be clearly indicated at the target line, for both left and right flank most targets. These markings should be in a contrasting colour paint and permanent. No target should be positioned outside of these marks. The flank target markings should be marked, either on the floor or the mini mantlet, but in front of the target line. The markings should be easily visible to all range users, a recommended method of marking can be seen in Figure 4.




**Recommended flank target markings.**

Figure 4

(iii) **Multi Point Targets & Target Screens**. The target centre height, left and right extent markings must be applied to the highest, left and right flank most aiming points as shown in Figure 5.




**10 Bull Aiming Card.**

Figure 5

(iv) **Range Floor Markings**. To assist effective control of practices, each lane has corresponding firing point and target numbers numbered from the left for commonality. For specific range markings refer to the respective range chapter.

e **Bullet Catcher/Bullet Trap.** Bullet catchers or traps are provided in all cases. The bullet catcher or trap is designed to capture the majority of rounds fired at each target. Bullet catchers are normally traditional sand/earth bank/ granulate steel plate design. Bullet traps are normally those of proprietary design, such as the Snail Trap or vertical granulate trap. For economic, logistical and environmental reasons, indoor bullet traps are often constructed with a combination of a bullet catcher and an area of protection to capture wide shot. Granulated rubber traps provide cost effective and environmentally friendly trap solutions as rounds do not tend to break up causing lead dust. This form of trap is suitable for indoor or outdoor use. It will be seen that the use of a bullet trap and backplate indoors provides the same dimensions overall as sand bullet catchers used on outdoor ranges. The dimensions of the bullet catcher/ trap components for standard ranges are provided in the respective range chapters. Where details are not provided the details in Table 6 may be used.

f. **Stop Butts.** Stop butts are located around or behind bullet catchers to capture wide shot and low ricochet. Where stop butts are provided the criteria to determine height and width are contained in the respective chapters. For Non Standard NDA ranges the minimum criteria is provided in Table 6.

g. **Outdoor Range Floor**. On fixed ranges where troops move forward with loaded weapons all trip hazards are to be removed. On fixed ranges grass cutting is to be maintained to enable the retrieval of live rounds ejected from weapons, the location of hard rock or stone coming to the surface and to ensure full visibility of all targets.

| Ser | Range | Axis | Height And Width (C) | | | |
|---|---|---|---|---|---|---|
| | Component | Measured from the LofS | Rimfire | | Centrefire | |
| | | | Rifle | Pistol | Pistol | Rifle |
| (a) | (b) | (c) | (d) | (e) | (f) | (g) |
| **Indoor Ranges (see Note 1)** | | | | | | |
| 1 | Defence zone | Vertical (mils)<br>Horizontal (mils) | 125<br>75 | 200<br>125 | 215 | 215 |
| 2 | Backplate | Vertical (mils + mm)<br>Horizontal (mils + mm) | 3 + 700<br>3 + 450 | 6 + 850<br>6 + 600 | 6 + 1500<br>6 + 1400 | n/a |
| 3 | Bullet catcher<br>Indoor | Vertical (mils + mm)<br>Horizontal (mils + mm) | 3 + 250<br>3 + 250 | 6 + 400<br>6 + 300 | 6 + 450<br>6 + 450 | 1 + 1700<br>3 + 1400 |
| **Outdoor Ranges** | | | | | | |
| 4 | Bullet catcher<br>Outdoor | Vertical (mils + mm)<br>Horizontal (mils + mm) | 3 + 700<br>3 + 450 | 6 + 850<br>6 + 600 | 6 + 1500<br>6 + 1400 | 1 + 1700<br>3 + 1400 |
| 5 | Stop Butt Criteria | Vertical (mils + mm)<br>Horizontal (mils + mm) | 20 + 2500<br>30 + 1000 | 60 + 3500<br>60 + 2000 | 60 + 4000<br>60 + 4300 | 77 + 4700<br>60 + 4000 |

**Note 1. Including Tube Ranges where the bullet catcher is not designed to capture all shot and ricochet.**

**Table 6 - Defence Structure Dimensions**

02099. **Range Materials.** Many materials have been tested for resistance to bullet penetration providing some evidence that may be used in the design of defensive structures. Below are performance details of the ballistic materials known to date.

a. **Steel Specifications.** Where proprietary systems are not provided the requirement is for the following BS or MOD DEF STAN specification or similar performance steel:

- Mild Steel –BS EN 10025: S275JR
- Armoured Steel –DEF STAN 95-13, AR 500 or similar has proven effective where high velocity ammunition is used. Through hardened armoured steel is normally used in areas of direct bullet impact. Trials have shown that 5.56 mm may penetrate armoured steel when extreme close grouping is achieved and with impact velocities in excess of 920m/s

| Ser | Ammunition | Defence Zone Plate Thickness (mm) (C) | | Backplate Plate Thickness (mm) (C) | | Bullet Catcher Plate Thickness (mm) (C) |
|---|---|---|---|---|---|---|
| | | Flank | Direct | Flank | Direct | |
| (a) | (b) | (c) | (d) | (e) | (f) | (g) |
| 1 | Rimfire | 3 | 4 | 4 | 5 | 6 or 4 armoured |
| 2 | Centrefire pistol/carbine | 4 | 5 | 5 | 6 | 8 or 6 armoured |
| 3 | Centrefire pistol/carbine jacketed | 5 | 6 | 6 | 8 | 12 or 8 armoured |
| 4 | Centrefire rifle | 12 or 8 armoured | | proprietary system only | | |

**Table 7a - Steel Protective Plating for Ranges**

b. **Other Material**. Table 7b provides minimum depth of the material required to prevent penetration on ranges dependent upon angle of strike. Minimum material specification for concrete is 20Nmm$^2$ , Solid (void free) Class B engineering brick, 15Nmm$^2$ dense concrete block or hollow block filled with min 15Nmm$^2$ concrete. Concrete, brick and block defence structures shall prevent bullets penetrating more than 10% into the surface of the structure.

| Ser | Ammunition | Concrete (C) | Solid brick (C) | Concrete block (C) | Timber (C) | Remarks |
|---|---|---|---|---|---|---|
| (a) | (b) | (c) | (d) | (e) | (f) | (g) |
| **At all angles multiple strike.** | | | | | | |
| 1 | Rimfire | 75 | 100 | 100 | 125h/w or 150s/w | h/w = hardwood<br>s/w = softwood |
| 2 | Centrefire pistol carbine | 150 | 215 | 215 | 175h/w or 200s/w | Monitor effect of 4.6mm steel ammunition on all structures. |
| 3 | Centrefire rifle | 200 | 215 | 215 | 250h/w or 375s/w | No AP ammunition permitted. |
| **Defence Zone - Single shot at $90^0$ (1600 mils) to surface or less. (C)** | | | | | | |
| 4 | .22" | $25^1$ | $75^1$ | $50^1$ | 125s/w | See Note 1 & 2 |
| **Defence Zone - Single shot at $7^0$ (124 mils) to surface or less. (C)** | | | | | | |
| 5 | .22" | $25^1$ | $75^1$ | $50^1$ | 12s/w | See Note 1 & 3 |

**Table 7b - Minimum thickness (mm) of construction materials considered to be impenetrable to bullet strike.**

**Notes:**

1. These dimensions have been rounded up to reflect sizes available.
2. Or combinations of MDF25mm + Redland plain tile, Plywood 25mm + Redland plain tile, s/w50mm+ Glasuron terracotta tile should contain one .22" round.
3. Alternate Material Indoor Range Defence Zone only - 0.22" ammo **-** Roof or wall material which includes: Redland plain tile, Natural slate, Double roll tile, Glasuron Terracotta tile, Plasterboard 12.5mm, T&G board 12mm, Plywood 12mm, Chipboard 12mm, MDF12mm, Strandboard 18mm.. Condition of materials may be variable: this table reflects material in perfect condition.

c. **Bullet Proof Glass**. Where bullet proof glass is required refer to BS EN1063, Class BR1 to BR7.

02100. **Materials Trials**. All ballistic trials are to be co-ordinated and authorised with DOSG. Refer to Reference A for details.

02101. **Maintenance.** Where range structures are maintained within the ballistic envelope they must be maintained to retain the original properties. The maximum depth of attrition that should be permitted before repairs are affected is 10%. Back walls above the sand for instance are generally at least 225mm thick. Attrition up to 22mm should not adversely affect the performance of that component. Repairs to anti splash curtains could cause backsplash if more than two layers are in the line of fire, ie repairs where sheet overlap occurs. If in doubt refer to TAS RE for advice.

02102. **Environmental Hazards and Sustainability.** Range design must take account of the effect of lead, carbon monoxide, unburnt propellant and noise. Below in Table 8 are indications of the design issues to be addressed. Note compliant ranges are expected to fire less than 1 million rounds a year

on any one range. At this rate of fire DGM IPT predict no unacceptable environmental or health hazard impact. Ranges with enclosed or semi enclosed firing points that have rates of fire in excess of this should be assessed for emission hazards.

| Range Type | Lead | Carbon monoxide | Unburnt propellant | Noise |
|---|---|---|---|---|
| **1. Compliant Ranges** | | | | |
| LFTTA, ETR, MMTTR, IBSR | Maintain MOD Form 906 record of rounds fired on each range for future Land Quality Assessment. | No issue | No issue | Note 1 & 2 |
| GR all types | Majority of lead is removed periodically from the range. | No issue | No issue | Note 1 , 2 & 4 |
| Barrack ranges | All lead is removed periodically from the range. | No issue | No issue | Note 1, 2 & 5 |
| Tube ranges with enclosed firing room. | Lead will be present in any dust.<br>All lead is contained and recovered during deep clean. | With mechanical ventilation no issue. Without ventilation CO monitor required. | In any dust | Note 1 |
| Other ranges with enclosed or semi enclosed firing points. | Lead will be present in any dust.<br>Maintain MOD Form 906 record of rounds fired on each range for future Land Quality Assessment. | With mechanical or sufficient natural ventilation no issue.<br>With insufficient ventilation CO monitor required. | In any dust | Note 1 & 5 |
| Indoor ranges | Lead will be present in any dust.<br>All lead is contained and recovered during deep clean. | With mechanical ventilation no issue. Without ventilation CO monitor required. | In any dust | Note 1,3 & 5 |
| **2. Sand Stop Butts & Bullet Catchers** | | | | |
| | Lead in sand butts is generally stable in terms of leaching.<br>Where steel ammunition is fired into a butt that has lead rounds in it, there is a possibility of the lead leaching caused by the rusting of the steel ammunition in contact with it. | | | |

**Table 8 - Environmental Hazards and Sustainability.**

Notes:

1. Hearing protection is to be worn on all firing points during practices.
2. The siting board is to ensure new ranges are sited as far away from populated areas or offices as possible. MOD freehold land around ranges extending for 300m (Nugent ruling) should be retained to preserve this separation from potential development.
3. For indoor ranges and non standard ranges with enclosed or semi enclosed firing points refer to Chapter 30.
4. Where 7.62mm is fired regularly (more than 50,000 rounds per lane per year) on a range into sand or earth stop butts the RAU should commission an analysis of the MPI to determine levels of antimony against current EU limits.
5. Where close engagement (15m or less) takes place on ranges with granulated rubber RAU should be aware that if the granulate is exposed it could absorb unburnt propellant that will increase the risk of fire.

02103. **Noise**. It is MOD policy that all those exposed to weapon noise must wear suitable hearing protection. There is a requirement to reduce noise levels further by applying additional control measures. Such control measures generally take the following two forms:

a. **Noise Containment.** The building fabric, doors, ducting etc, are designed to reduce transmitting noise to the outside environment and to the surrounding structure. Dense materials should be selected for the building fabric of the firing points and bullet catcher chambers. Doors, ducts and other openings can be specified to give a similar level of noise insulation. See also Chapter 31.

b. **Noise Attenuation**. The nature and treatment of internal surfaces are selected to attenuate reflected noise (reverberation) but these measures will not reduce the initial high level of noise produced by the weapon. There are many materials available, such as wood, wool slab, rockwool and glass fibre, which are very effective in reducing reflected noise. However, these materials will also harbour lead dust and unburnt propellant, and are difficult or impossible to clean as the fibrous materials are susceptible to damage. Whilst these materials may be suitable for ceilings, walls should be clad with a material which withstands knock and abrasion, and which can be appropriately cleaned. Granulated rubber tiles and tiles of resin bound flint sand have been found effective. Proper selection and detailing of the noise attenuation system will further enhance noise containment. Particular care is required for tube ranges. See also Chapter 31.

02104. **Lead Pollution, Unburnt Propellant and Carbon Monoxide**. The requirements to control lead pollution, unburnt propellant and carbon monoxide in ranges are given in Chapter 30. The provisions of Reference E (JSP 375) apply to ranges that do not meet the criteria in Chapter 30.

02105. **Hill Backgrounds.** Hill background for GR, CGR and ET(LDA)R criteria are illustrated in Figure 2-5. Before a reduced RDA is authorised for use, the following must be confirmed by TAS(RE) or the issue assessed by WDALab:

a. **For Hills or Cliffs (>56$^0$) directly behind the Target Line.** The hill has a minimum mean slope of 56$^0$ (996 mils rounded to 1000 mils) rising immediately behind the target line and has a minimum height of 50 m above the point at which the LofS from the 100 m firing point meets the perpendicular from the summit. When such a slope spans the full width of the RDA trace, the reduced probability of escapement enables the length of the trace to be reduced to the 50 m point.

b. **For Hills or Slopes (>30$^0$) behind the Target Line**. Alternatively, the hill has a minimum mean slope of 30$^0$ (533 mils rounded to 530) rising behind the stop butt and has a minimum height of 100 m above the point at which the LofS from the 100 m firing point meets the perpendicular from the summit. When such a slope spans the full width of the RDA trace, the reduced probability of escapement enables the length of the trace to be reduced to the 100 m point described.

02106 – 02109. Spare

## SAND BULLET CATCHERS

02110. **General**. Sand has been generally used in bullet catchers and stop butts on many of the ranges described in this Volume. This section specifies the quality of the sand, its profile and maintenance that are necessary to capture shot without causing ricochet or backsplash. Wet sand will have the tendency to form tunnelling on ranges where tight grouping is expected which may result in penetration of the bullet catcher.

02111. **Quality.** It is recommended that sand conforming to BS EN 12620: 2002 description "0/4 Concrete Sand". Grading should conform to BSI PD 6682-1 Table D1, "0/4 Concrete Sand CP" with angular shape for slope stability and sound physical properties to resist natural breakdown.' This grade is fine enough not to cause ricochet yet coarse enough to retain the required profile effectively without likelihood of setting or forming a surface crust; it is also relatively stable in high winds. This specification also provides for a material that will not readily breakdown naturally, such material should not crush to fine dust when rubbed between the hands. Over time bullets pounding the sand reduce it to fine dust behind the MPI, at this point the sand will need to be replaced.

02112. **Construction**. The core of the bullet catcher or stop butt may be constructed of any stable inert fill material. However, the surface is to be covered by sand as specified in the relevant Chapter for the range. Generally the depth of sand is related to the type of weapon fired. For high velocity weapons (see Table 4), the depth of sand measured on a line parallel to the LofS should be 1000 mm (S) 900 mm (C) For low velocity weapons the depth should also be 750 mm (S) 500 mm (C) in the direction of the line of fire.

02113. **Profile**. $34^0$ (600 mils) (C) is the recommended slope for the front face of the bullet catcher in order to reduce the risk of ricochet. Rounds impacting into, or the natural settlement of the sand, may reduce the slope which must never be allowed to fall below $30^0$ (530 mils) (C); as this may cause ricochet to leave the RDA.

02114. **Maintenance**. Regular maintenance of the sand is essential to the range remaining safe for use. There are several factors to be considered and these are described below. Renewal or replacement of the sand may be achieved by rotating the sand in situ or by replacing it with sand from another section of the bullet catcher. The following measures are particularly important.

a. **Profile**. Sand in the bullet catcher is to be raked to prevent tunnelling at the MPI behind targets to keep the surface of the sand in a loose state and to restore the profile to the slope stated in paragraph 02113.

b. **De-Leading**.

(1) **7.62 mm**. When large quantities of 7.62 mm rounds are fired or there are excessive quantities of jacket and bullet debris, balls of lead and other hazardous debris build up in the sand. The bullets tend to remain intact after impacting into the sand and can fuse together into a ball, which often occurs below the surface of the sand at the MPI behind the target after about 20,000 rounds have been fired in a lane. When subsequent bullets striking the ball no longer drive it deeper into the sand, backsplash and ricochet become hazards. So it is important that any such build-up of lead is removed before the hazards arise.

(2) **5.56 mm.** This round tends to break up on impact at close range causing debris which is often smaller than the sand particles in the bullet catcher. In this case the sand cannot always be sieved without altering its stability. Provided the lead particles and debris are small and well spread over the area behind the MPI, the sand will remain stable and the probability of ricochet or backsplash will remain low. It is prudent to rotate the sand to ensure that the smaller particles are well spread. If there is any sign of lead balling and debris building up to the extent that a backsplash hazard is perceived, the sand is to be treated as described in sub-paragraph (1) above.

(3) **Other Ammunition Natures**. When other ammunition natures have been fired (such as 9 mm, black powder ball or bullet, shotgun slugs etc), the sand is to be monitored regularly to ensure lead does not build up around the MPI. As a guide, the sand should be checked for lead build-up when the slope is raked after heavy use to restore its profile. For a range that is only used occasionally, the sand should be checked monthly or after 20,000 rounds have been fired on a lane, whichever occurs first.

c. **Weathering**. In time, continuous impact by shot will break the sand down to a fine powder which will blow away in the wind or bake hard in the sun. Fine sand will also cause the slope to loose its stability. When this occurs, which will be evident by inspection, the sand will no longer be of the prescribed grade and should be replaced. The following additives and reinforcements have been found useful in maintaining the shape of the sand:

(1) **Wood Shavings or Chips.** A mixture of wood shavings or chips in proportions by volume of about 2:1 sand/wood helps retain moisture and stability of the mass in sand under canopies. The wood will itself break down in time and more will need to be mixed in.

(2) **Salt**. Adding 1-2% of salt by dry weight of sand also helps retain moisture in the sand and will reduce the danger of freezing in winter.

(3) **Netting**. Mesh netting or geogrid, may be used to reinforce the face angle. The mesh is placed just below the surface of the sand and is held in place with wooden pegs. Light galvanised wire mesh may also be used as it is effective against burrowing rabbits.

(4) **Timber support.** Timber supports in the form of boxes or herringbone within the sand clear of the MPI can assist the retention of the sand profile.

d. **Cleaning**. Sand bullet catchers should be checked at least weekly to ensure surface bullet debris is removed and de-leaded as described previously. Local RAO representative may extend the period between de-leading where it is safe to do so. Rotation of the sand within the bullet catcher may prolong the life of the sand. The sand should be replaced when the maintenance of the $34^0$ face becomes difficult. The hazard of lead contamination when working on sand bullet traps must be considered. The RAU is responsible for:

(1) Observing the requirements of the Control of Lead at Work Regulations.

(2) The safety of working practices.

(3) Providing the appropriate personal protective clothing and, when necessary, respiratory protective equipment.

(4) Providing washing and changing areas which avoid cross-contamination of clothing.

(5) Disposing sand, soil and debris, which might contain or be contaminated by lead, as contaminated waste in accordance with the Local Authority Environmental Control Department's instructions and MOD Policy.

e. **Black Powder Weapons.** On ranges where firing black powder weapons is permitted, particular care is to be taken to avoid lead building up in the stop butt and mantlet.

02115 – 02119. spare

## GRANULATED RUBBER BULLET CATCHERS

02120. **Material description.** The granulated rubber should be used in the same form as sand traps, $34^0$ slope(S), $30^0$ (C) with profile line marked on barrack range side walls. The rubber elements are shredded from rubber that has no steel or fabric reinforcement.

a. **Shape.** Shredded rubber with elongated elements removed to produce angular rubber fragments that are of regular shape approximately 10 – 25 mm in any direction producing tight interlock properties. There are sufficient suppliers who are able to meet this specification so the RAU should not accept granulate for bullet traps with any visible contamination or elongated rubber.

b. **Durability**. The rubber material will start to break down to fine particles after around 20,000 rounds per lane unless there is an exceptional high rate of fire over extended periods where the material

may break down sooner. The granulated rubber traps are to be de-leaded regularly (see below) and any fine particles removed and replaced by topping up with new material. With effective maintenance these traps should never need total replacement.

c. **De leading**. The material should take up to 20,000 rounds per lane before inspection is required to ensure there is no build up of lead behind the MPI and that the rubber at the MPI is not converted to fine particles. Frequent prodding of the area behind the MPI will extend the interval for de-leading. On ranges where black powder weapons or shotguns are fired, more frequent de leading may be necessary. Contractors involved in de leading are to ensure all bullets, bullet debris, fine rubber dust and target debris is removed from the granulate.

d. **Fire hazard**. Unless the supplier provides “fire proof” material rubber granulate is susceptible to fire in certain conditions. The risk of fire may be minimised by good maintenance and minimising the accumulation of fine rubber particles, target debris and exposed fabric reinforcement in the granulate. The depth of granulate is to be kept to the minimum specified in this chapter as heat will increase with the depth of material. Shooting in boxes will limit the amount of granulate needed and these are to be used in gallery range stop butts. A light hessian type cover may be used to contain the granulate as this will allow heat to dissipate more readily. Dense rubber tiles are not to be used for this purpose. On ranges where engagement closer than 10m is permitted, a light rubber sheet over the granulate is essential to prevent unburnt propellant falling into the granulate increasing the risk of fire. On ranges where high rates of burst weapon practices are undertaken, water for dousing the granulate after firing is to be provided. Full automatic practices exceeding 200 rounds per minute and two hours in any 24 hours may generate a fire in the granulate. Tracer is not to be fired into granulated rubber traps.

e. **Stability**. Due to the interlock properties the $34^0$ slope should be maintained throughout many days of use without raking. Only with a high rate of fire on one lane will a depression become apparent behind the MPI.

f. **Frost resistance.** The material may be used outside during frost conditions without any change in performance.

g. **Washout resistance**. The material allows water to pass through it without disruption of the slope.

02121**. Environmental Impact.** Rounds are captured either intact or in constituent parts, lead dust is not generated in the trap to the same degree as in a sand trap. The rubber granulate should not break up into fine dust like sand so there is no particulate thrown into the air during firing or maintenance of the trap. Like sand, there is no impact noise. The granulate may be recycled many times on site to remove spent bullets the granulate is then placed back into the trap.

02122**. Maintenance.** As the material has good interlock properties so the compliant slope is maintained without slip at the MPI this will reduce the

maintenance effort considerably. As there is little or no lead dust, any maintenance of the trap will not expose range staff to significant levels of lead in air. The material will not breakdown so readily as sand so replacement or rotation of the trap need not be so frequent. Rabbits do not like tunnelling in this material. Most suppliers are able to provide a de leading or replacement service using a re cycling process on site. To ensure the granulate is not contaminated by wood and paper debris from targets on barrack ranges it is advisable to provide a light rubber sheet, plastic hessian or similar covering the granulate. Regular and effective maintenance as recommended by the supplier is essential as rubber dust generated at the MPI mixed with bullet and target debris will increase the risk of fire. To ensure the maintenance cycle is maintained on ranges where use of only one or two lanes are regularly in use the range warden is to record such use in the MOD Form 906 to ensure the bullet count per lane is recorded.

02123. **Potential Use.** This material may be used in outdoor ranges or indoors. When used on gallery type ranges it should be used only in shooting in boxes fitted into the stop butt to minimise costs and reduce the area affected should there be a fire. For use near environmentally sensitive or populated areas the addition of a suitable fire retardant should be considered. Complete bullet catches on barrack ranges may be converted to this material. No additional works are required except to retain the material at the base of the bullet catcher. This material is suitable for indoor ranges including test facilities and tube ranges. It will reduce considerably the amount of lead dust in the range. Some German and US ranges used the material sandwiched between rigid plastic sheets in the vertical form. These have proven very expensive to maintain due to the need to dismantle the trap when the supporting sheets are shot out at the MPI.

02124. **Depth of Granulate**. The granulate is expected to stop 5.56 mm and 7.62 mm rounds within 300-400 mm. The depth of the granulate in line with the line of fire at the top of the trap for high velocity ammunition is to be maintained at 900 mm. For low velocity weapons the minimum depth should be 750 mm (S) 500 mm (C) in the direction of the line of fire. For shooting in boxes in stop butts the depth perpendicular to the surface should be maintained at 400 mm (T).

02125. **Disposal**. This material may be recycled by the supplier. At no time should the granulate as a whole need to be removed for disposal as the regular maintenance will remove and replace broken down granulate.

02126. **Contact Details**. For further details and potential suppliers contact TAS (RE).

02127. **Risk assessment**. A formal site specific risk assessment is to be produced on each range where rubber granulate is used to ensure all fire prevention measures have been implemented. Advice from the Defence Fire Risk Management Organisation (DFRMO) may be sought where necessary.

02128 – 02129. Spare

## IMPACT AREAS

02130. **General.** An impact area/zone is a space on a RDA authorised and applied permanently, or at the time of firing, in which specified projectiles may impact, detonate, break up or operate. The impact area must be large enough to contain ricochet but have its edge no closer to the DA/Z boundary than the authorised BSD or other hazard distance. In pursuance of the policy set out in Reference A1 (Volume I) to protect the public from the hazardous effects of weapon firing, access to the area has to be controlled as directed by the Range Authorising HQ or the RAU. Firing has to cease if a member of the public or other unauthorised person is detected entering the impact area. This section outlines the principles of the measures required but the degree of their provision will depend on the risks assessed by the Authorising HQ or the RAU for the particular range.

02131. **Closed Impact Area**. A closed impact area is that part of the impact area known to contain or is suspected of containing unexploded ammunition (blinds) which is not designated a controlled impact area. The whole area, including firing points, should be fenced to prevent access and a demarcation fence or structure is provided to separate the cleared area from the impact area. (see paragraphs 02141 & 02146) and the appropriate warning signs displayed. Access beyond the demarcation fence is prohibited to all persons except those involved in the clearance of ordnance. Where the area has to be grazed for environmental or fire reasons, animals are allowed in, but under no circumstances must they be followed in by humans. Approved Prohibition and Warning signs on the demarcation fence should direct "No Entry to Impact Area" and "Warning UXO" or similar wording (The symbol is regulated, the text is not). RAU should ensure personnel do not enter the area before EOC is completed. Injured animals must be destroyed from outside the Closed Impact Area.

02132. **Controlled Impact Area.** A controlled impact area is one which is known or thought to contain surface or sub-surface blinds but due to public rights of way and the like, access to the public cannot be totally denied. During firing the impact area is closed. When the absence of red flags or lights signify that firing has ceased and the range paths have been cleared, controlled access is permitted. MOD personnel and farmers who have good reason to enter the area must be fully briefed on the specific dangers in the area. The control of access to these areas is provided by a combination of well sited warning signs and notices together with flags and, where necessary, way marking or fences to direct or funnel the public away from danger. Actual siting and detail will vary from range to range and is very much dependant upon local awareness and activity.

02133. **Open Impact Area**. This is an impact area where, with a high degree of confidence, all identified blinds are destroyed after firing has ceased. The range cannot be opened to the public until all blinds are found and destroyed unless the known area of the blind is secured against access until the blind is destroyed. There must be sufficient provision to ensure that during firing the public are warned that firing is taking place and that firing can be stopped when necessary. The range boundary should be clearly and appropriately signed with red flags and lights to indicate when the range is in use.

02134. **Impact Area Siting**. An impact area is sited so as to ensure that the probability of a projectile falling outside the impact area is minimal. Target siting and topography need to be carefully considered. When topography cannot be relied upon to capture all projectiles, constructing a stop butt should be considered. Any fence line should, as far as possible, be sited out of the firer's field of view. Where the fence passes through close country, a clear strip is to be maintained on the outside of the fence to ensure that the safety signs can be seen and the public will not be encouraged to cross the fence.

02135. **Firing Points**. Where weapons are fired that have a rear danger area firing points should be provided inside the fenced area. In closed impact areas such firing points are located clear of the actual impact area and the fence is extended around them. To ensure troops on the firing point do not move into the actual DA, a smaller demarcation fence should be provided (with warning signs) to separate the two areas.

02136. **Gates**. Fenced impact areas will require gates of a suitable size to be sited at strategic points. Gates are particularly obtrusive and only the minimum number should be provided. Where possible they should be out of the firer's field of view. Gates will be required for:

a. **Clearance and Disposal of Blinds**. Clearance and disposal of blinds, including those in designated areas for public access on controlled impact areas, will be necessary. This may involve armoured earth moving plant.

b. **Servicing Targets.** How targets are moved into and out of the area needs consideration, i.e. towing or winching.

c. **Grounds Maintenance.** Tree, shrub and grass growth may need to be controlled.

02137 – 02139. Spare

## CONTROL OF ACCESS

02140. **General.** This section specifies the various measures available used to control access. Which method is best suited to a particular site will be

apparent from the site specific risk assessment. In some cases the measures are influenced by local Byelaws**,** sea danger areas and local tradition. The risk assessment will determine the minimum requirement to ensure adequate control measures are in place to effectively control public access into the range danger area. Control of access between ranges on range complexes should also be included in local risk assessments. Where public access is permitted between the MOD boundary and a Range Danger area boundary, warning triangles should be used on the outer boundary indicating troops training and where horses are known to use the area, sudden noise. Prohibition signs and flags / lights in this case are placed at the range danger area boundary. See also Reference A (Volume 1) that includes more information on Risk Assessments.

## FENCES

02141. **Classes of Fences.** Four classes of fencing are specified for various conditions and levels of access control onto open ranges. All are used in combination with signs. The levels of access control are:

a. To provide demarcation.
b. To discourage access.
c. To prevent access.
d. To provide security.

02142. **Selection.** The selection of the type of fence or marking will depend upon local risk assessments. Factors that will influence the choice will include;

a. Extent of public access. - Authorised, unauthorised, children.
b. Nature of the hazard and the degree of risk.
c. Ground conditions - practicalities of constructing a fence.
d. Possible overreaching the fence from trees or ground.
e. Whether the fence will be shot away.
f. Whether animals or bird life will be caught in the fence.

02143. **Demarcation**. Demarcation of the range boundary may be all that is necessary in remote areas where there is no immediate threat to life and limb. However, thought should be given to the marking of impact areas and to denote designated routes for public access. Three strand fences or marker posts may be used to denote particular areas. A demarcation fence is also used inside closed impact areas to separate the firing point from the impact area (see para 02135). Inter-visible safety signs are to be provided on fencing. Colour coded demarcation posts may only be effective where there is no public access and all MOD personnel are fully briefed on the location and colour coding of the posts. In areas prone to deep snow or snow drifts, the posts may have to be taller.

02144. **To Discourage Access**. In a controlled impact area and in areas where occasional public activity may be expected, a fence to discourage access is to be provided. Such fences should not be crossed or climbed through easily. Consideration should be given in the risk assessment for the protection of minors. In farming areas where animals graze, stock fencing should be provided. BS 1722 provides guidance on fence systems.

02145. **To Prevent Access**. In areas where the hazard is such that the risk assessment determines that uncontrolled access must be prevented, a more substantial fence is required. Chain link is designed in such a way that it is difficult to climb but it is easily cut and unwound. Weld mesh fencing is a more substantial barrier but is more expensive. A suitable fence or barrier must be provided to discharge liabilities in preventing access.

a. **Type of fence.** If there is no evidence of vandalism or of children breaking through existing fencing a chain link fence may be suitable. Where such problems are known to exist a more substantial fence or combination fence may be needed.

b. **Height of the Fence**. The fence must be high enough to prevent access by all but the determined trespasser. In low risk areas a 1.4m fence is sufficiently high to prevent an adult stepping over it from flat level ground. In high risk areas where children are known to climb existing fences, more substantial fencing will be required.

02146. **To Provide Security.** Security fences are normally 2m high with canted top section. Refer to local Command security advisors for details.

## SIGNS & NOTICES

02147. **General**. MOD ranges and training areas present a variety of hazards that may affect all those entering the area. Risk assessments should identify the hazards and their level of risk. Byelaws place a legal duty on the public to comply with access control measures. Safety signs are provided clear of the hazard to prohibit and warn those at risk of the hazards. When it is impracticable to use signs within a training area to separate areas with different levels of hazard, demarcation posts may be used. Notices are also used to provide additional information and clarification but they must not replace safety signs.

02148. **MOD Policy and Current Legislation.** Signs and notices are used in conjunction with fences on boundaries and demarcation lines to prohibit, warn and inform people of the potential consequences of entering MOD ranges and training areas. MOD policy is set out in Reference A1 (Volume I) and in Reference E (JSP 375). Current legislation, on which MOD policy is based, is The Health and Safety (Safety Signs and Signals) Regulations. Overseas MOD policy is to comply with the local or host nation's procedures on signs and sign posting; however, if that level of safety is less than that provided in the UK, additional signs may be necessary to warn British military personnel. Where there is an interface between British families and a British managed range, it will be necessary to have British signs as well as host nation signs, especially if those signs are in a foreign language. When undertaking Training On Private Land (TOPL) the appropriate regulations are to be read. Signage covering Public Access Legislation is covered in JSP 362 Chapter 7. The requirement in JSP 362 is to ensure that training area and range safety signs permit access when it is safe to do so. Signs that have the message " Keep Out" or "No Entry" without qualification should only be used where it is necessary to prohibit access at all times.

02149. **Definitions and References**. There are a number of sign systems in place, each supported by different legislation or regulation. Notices are not regulated and should only be used to inform or supplement safety signs, and not to replace them. The following types of sign may be required on ranges and training areas. The list is not exhaustive and more details may be found in Reference E (JSP 375).

a. **Byelaw.** The local byelaw is a detailed explanation of the rights and measures by which MOD may legally control access to its property. Byelaws take time to come into force due to the consultative process between the local authority, local interest groups and DE which represents MOD interests. As byelaws are difficult to amend, every effort should be made to predict future changes and requirements at the consultation stage. Byelaws must be displayed at the interface between the track, path or route where it crosses the range boundary.

b. **Safety Signs**. Standard safety signs are to be provided when the risk cannot be managed by other means. Safety signs are covered in H&S (Safety Signs & Signals Regulations). A safety sign must include a symbol and may have text. However, text alone is incorrect. The proportion of symbol colour against the overall size of the sign is

provided in brackets below. The five types of safety sign, which are described in Table 9, are:

(1) Prohibition. (Symbol at least 35% of the area of the sign).

(2) Warning. (Symbol at least 50% of the area of the sign).

(3) Mandatory. (Symbol at least 50% of the area of the sign).

(4) Safe condition. (Symbol at least 50% of the area of the sign).

(5) Fire. (Symbol at least 50% of the area of the sign).

c. **Demarcation Posts.** When it is not practicable to sign an area where two levels of risk exist within a range or training area, demarcation posts may be used. These should be clearly visible, and their meaning and location explained to those entering the area.

d. **Traffic Signs**. To avoid confusion, roads across MOD property used by the public should be signed as for national public roads. When on public roads these signs are subject to planning controls and are the responsibility of the Local Authority, the DLA is to be consulted. In the UK signs are regulated by the Traffic Sign Regulations and General Directions 1994, which is not subject to a EEC Directive.

e. **Notices.** Notices, such as "OUT OF BOUNDS", are not regulated and they are used to inform or provide additional information. MOD has traditionally used combinations of red and white for background and lettering but in rural areas MOD may be encouraged to use other colours. Notices are not to be used instead of safety signs but may supplement them (see also paragraph 02152).

f. **Night Signing.** Although red lights are used when a DLR is in use at night, it may be impracticable to use lights or illuminated signs around or across a training area. However, traffic signs on roads used by the public through a training area should be in reflective paint. There is no requirement to provide additional signs that a training area is used at night.

g. Way Marking of Public Rights of Way. (Refer to JSP 362)

02150. **Shape and Colour of Safety Signs**. BS 5499 defines the colours and shapes of safety signs. Safety signs differ from traffic signs. These are given in Table 9.

| Ser | Colour and Shape | Meaning or Purpose | Examples of Use | Contrast Colour | Symbol Colour |
|---|---|---|---|---|---|
| (a) | (b) | (c) | (d) | (e) | (f) |
| 1 | Red circle with diagonal band | Stop.<br>Prohibition | No entry, No Access | White | Black |
| 2 | Yellow triangle | Caution Warning Risk of Danger | Hazard indication (fire, explosion, chemical etc) | Black | Black |
| 3 | Blue circular | Mandatory action | Obligation to wear personal safety equipment | White | White |
| 4 | Green square | Safe condition | Identification of safety.<br>Fire escape routes | White | White |
| 5 | Red Square | Fire | Fire equipment<br>Fire point | White | White |

**Table 9 - Safety Sign Colours and Shapes**

02151. **Approved Signs.** The prohibition and warning signs for use on range boundaries are shown in Figures 2-7 and 2-8. Other common range and training area signs are shown in Figures 2-9 to 2-11. If an appropriate symbol is not shown, other symbols may be used provided they are as simple as possible and omit details not essential to their understanding. To maintain conformity on ranges and training areas in the UK, any new symbol should be approved by the LRSSC. Supplementary text may be added below the symbol to denote one of the categories given in Table 9 above.

02152. **Supplementary Text and Notices.** Supplementary text may be used in conjunction with a safety sign to aid understanding. Where there are known concentrations of people who may not fully understand English, dual or even triple language notices may be necessary. A supplementary notice is oblong or square. The background colour is the same as the safety colour used on the safety sign it is supplementing with the text in the relevant contrasting colour. Supplementary text is provided on a rectangular background, colour coded to match the sign. For example, it is wrong to supplement a prohibition sign with the text "Danger", which is the subject of a warning sign. In this case it may be appropriate to display two signs, an example of which is shown in Figure 2-8, of:

a. A prohibition sign with supplementing text prohibiting entry under certain conditions.

b. A warning sign with a symbol and supplementing text which warns of the danger.

02153. **Lettering Style**. The preferred letter style is Helvetica Medium or similar. The initial letter of a sentence or proper noun shall be upper case and the remainder in lower case. However, all the letters of a heading, an imperative or a cautionary word may be upper case.

02154. **Sign Size**. Neither the Health and Safety Executive nor BS provide guidance on safety sign sizes. However, both state that the size must be sufficient so that the safety sign is clearly seen by those to whom it is directed. Therefore, as each sign has to be judged on its importance, the size is to be agreed between the chain of command and DIO. Figure 2-12 gives the proportions of the elements to a sign.

02155. **Positioning of Signs.** Care has to be exercised in positioning safety signs to ensure that they are displayed where people might reasonably expect to find them, such as at barriers, gates, junctions, clearings, footpaths etc. On long runs of fencing the interval between signs will be dictated by the importance of the information displayed on the sign. In any event people should not be expected to follow a fence for too long before being informed of its significance. MOD policy (Reference A1) requires boundary signs to be inter-visible provided normally at 100 m intervals. When demarcation posts are used, these should be inter-visible. Safety signs must not be obscured by vegetation, open gates, parked vehicles or other obstructions, and must be checked and cleaned at regular intervals. Too many signs can be confusing and should be avoided. Byelaws should provide all necessary details leaving safety signs to emphasise the major areas of concern. Where the public are permitted onto MOD land between the MOD boundary and any range danger area, warning signs with “Troops Training” or similar should be used on the outer boundary and prohibition signs flags and lights at the range danger area boundary. The aim is to ensure a clear message is passed to the public to ensure their safety.

02156. **Retrospective Action**. Providing the safety signs exist, the obligation to comply with the Health and Safety (Safety Signs and Signals) Regulations or this JSP does not require retrospective action but when signs are changed or replaced, they are to conform. To avoid confusion, signs that do not conform to the Regulations or this JSP should not be mixed with those that do.

02157. **Boundary Responsibility**. Normally DIO Land Management Services will be responsible for fencing, signs and byelaw notices around the boundary of ranges and training areas. In any event the DIO's advice should be sought before fencing and signs are erected as local planning and conservation regulations may have to be observed.

## FLAGGING / RED LIGHTS

02158. **General**. There are three common use red flags used on MOD ranges: (Red lights are normally provided for use at night).

a. **Boundary Flags.** - It is best practice to fly red flags, and at night show red lights, around a RDA to indicate that a range is in use and/or a residual hazard remains. They are normally located in areas of maximum visibility or next to main access points where signs and notices provide an explanation. The policy is set out in Reference A1 (Volume 1).

b. **Range in Use Flagging**. The range in use flag is hoisted to indicate that the range is in use by troops training. Respective chapters provide advice on the location of these flags. It is important that they are flown in prominent positions on a particular range. Local conditions will dictate

the most appropriate position where they are most easily seen by those approaching a range. Where there are a combination of range types such a one range half converted to CGR only one range in use flag is required unless the ranges are allocated separately.

c. **Butt Flag.** Used to indicate safe access from and into the butts. See Reference B – PAM21.

## SURVEILLANCE AND SENTRIES

02159. The policy for surveillance and posting sentries on ranges is set out in Reference A1 (Volume I). The requisite works requirements for barriers and towers will be specified in the project brief for the particular range or training area.

## WORKS RANGE STRUCTURE INSPECTIONS

02160. The range structure is classed as any structure from the furthest firing point to the bullet stop or stop butt including any structure on the range floor that may be struck by bullets. This includes isolated structures on training areas used for live firing such as overhead firing towers. The RAO annual inspectors look only at the ballistic safety of a range. Where bullet attrition, weather or age may effect the stability of a structure it is the local works organisation who will identify issues relating to legislation or the stability of range structures. A range works inspection guide is provided by TAS(RE) for all works officers that have ranges in their areas of responsibility.

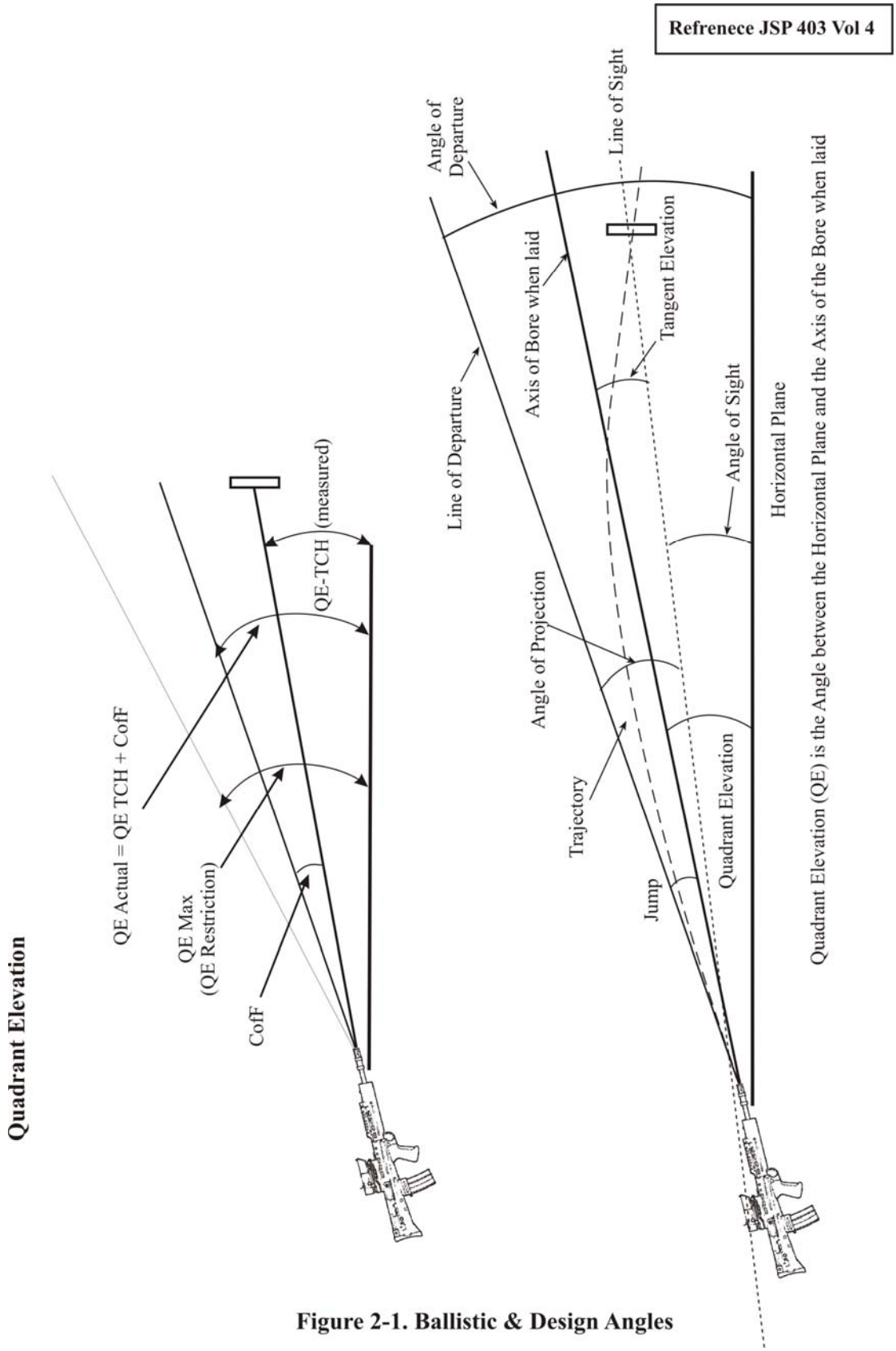



**Figure 2-1. Ballistic & Design Angles**

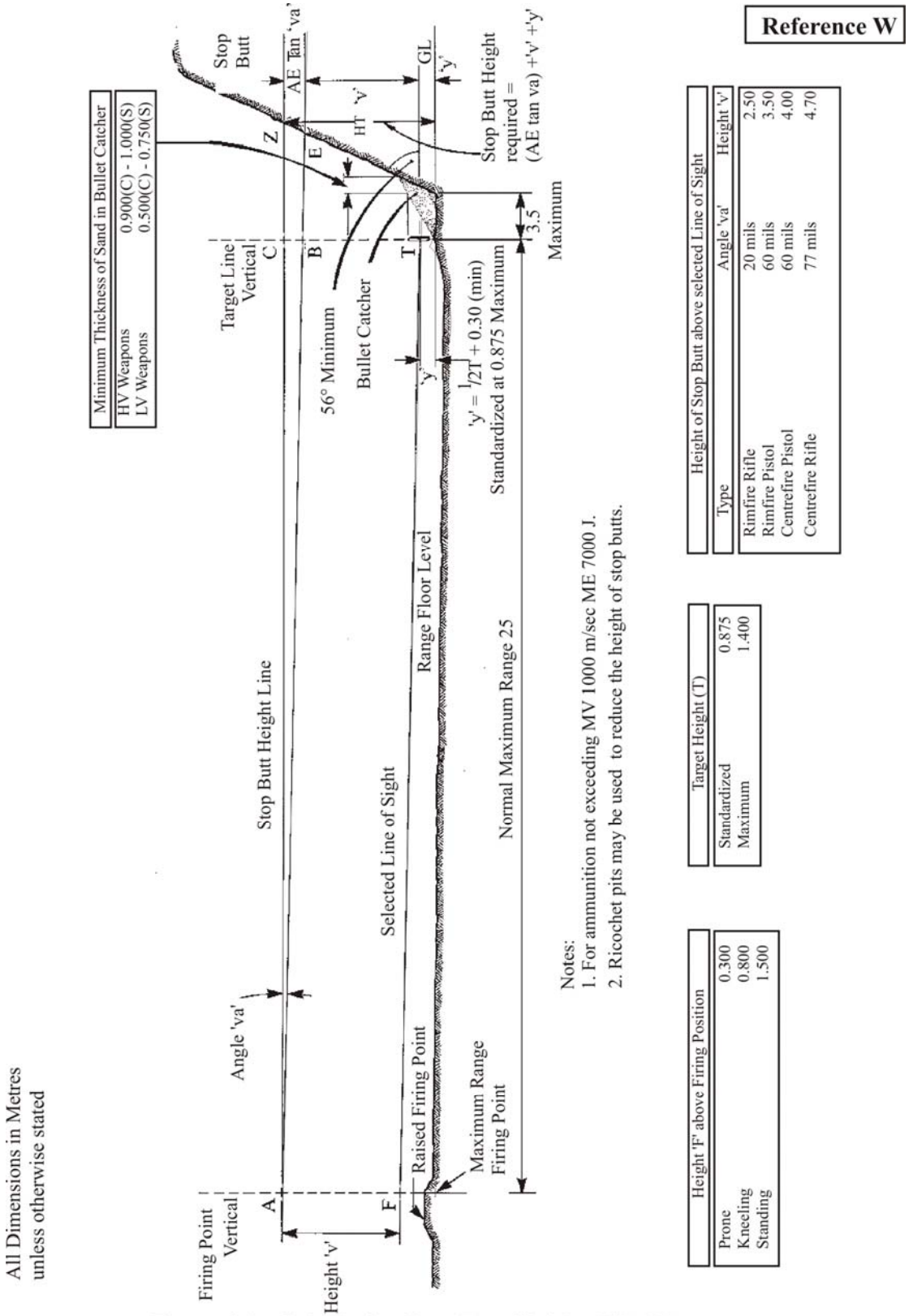
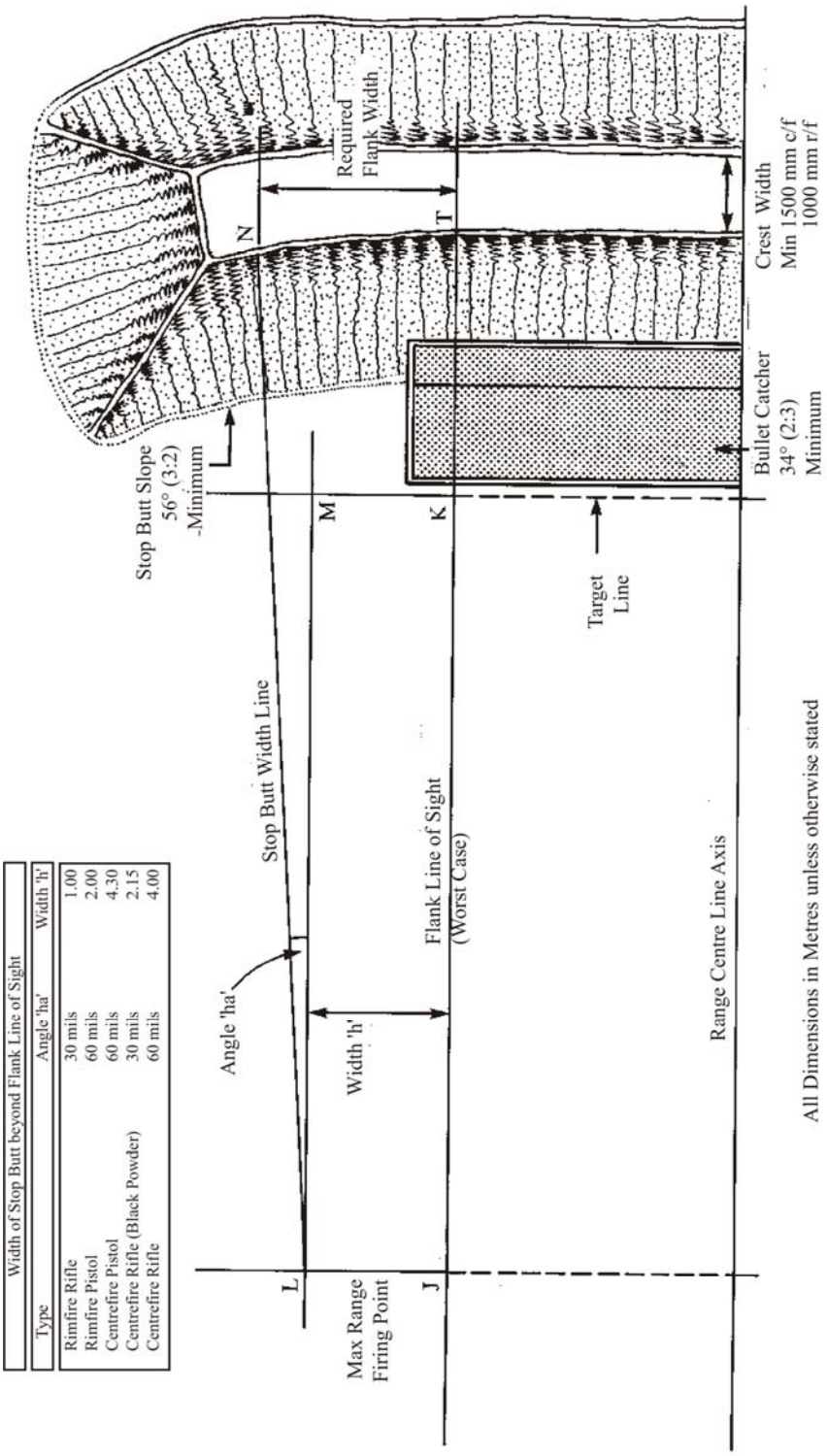



**Figure 2-2. Calculating Stop Butt Heights NDA Range (Existing Range Criteria)**

**Reference W**




| Width of Stop Butt beyond Flank Line of Sight | | |
|---|---|---|
| Type | Angle 'ha' | Width 'h' |
| Rimfire Rifle | 30 mils | 1.00 |
| Rimfire Pistol | 60 mils | 2.00 |
| Centrefire Pistol | 60 mils | 4.30 |
| Centrefire Rifle (Black Powder) | 30 mils | 2.15 |
| Centrefire Rifle | 60 mils | 4.00 |

**Figure 2 - 3. Calculating Stop Butt Widths NDA Range (Existing Range Criteria)**

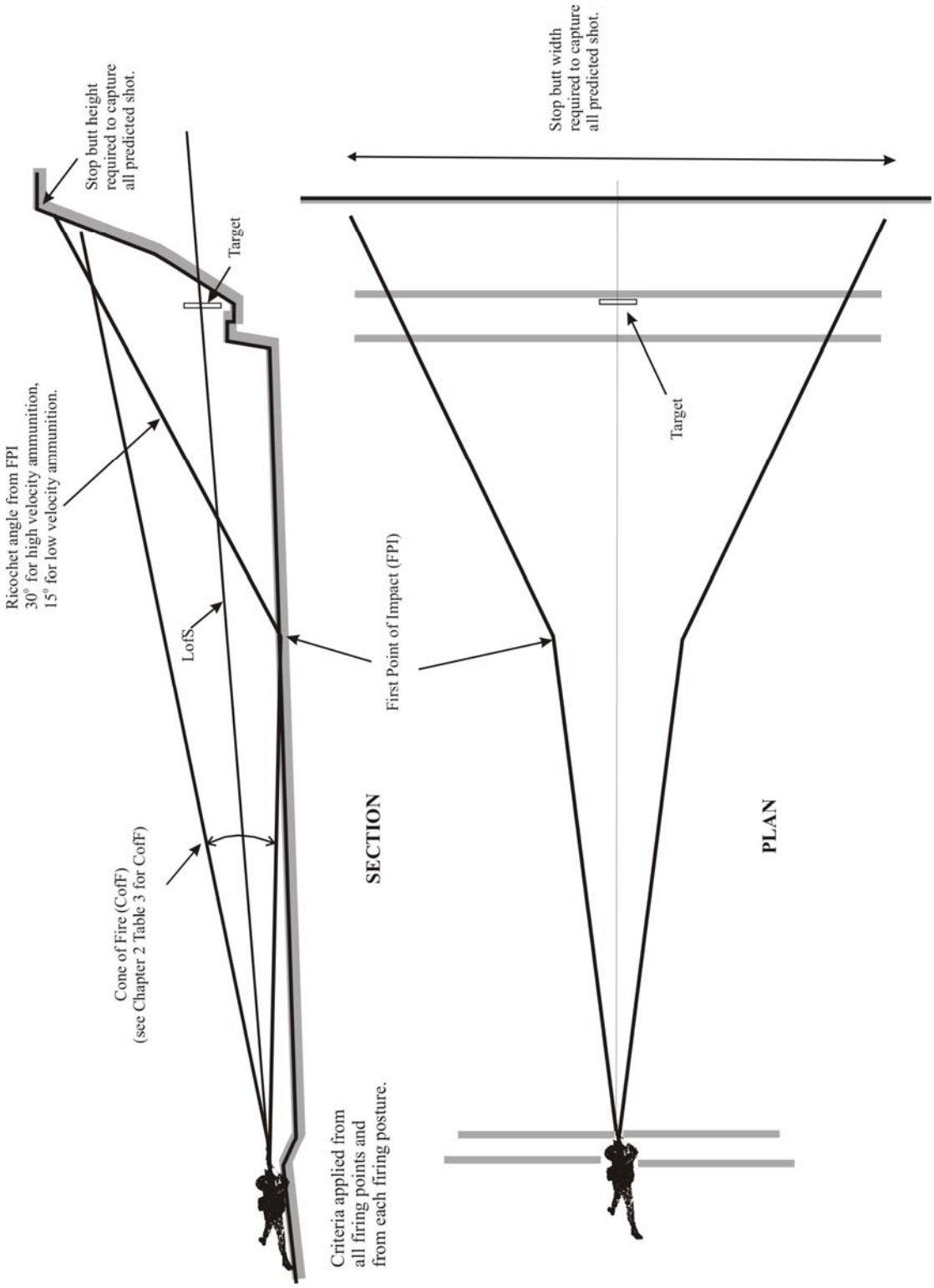
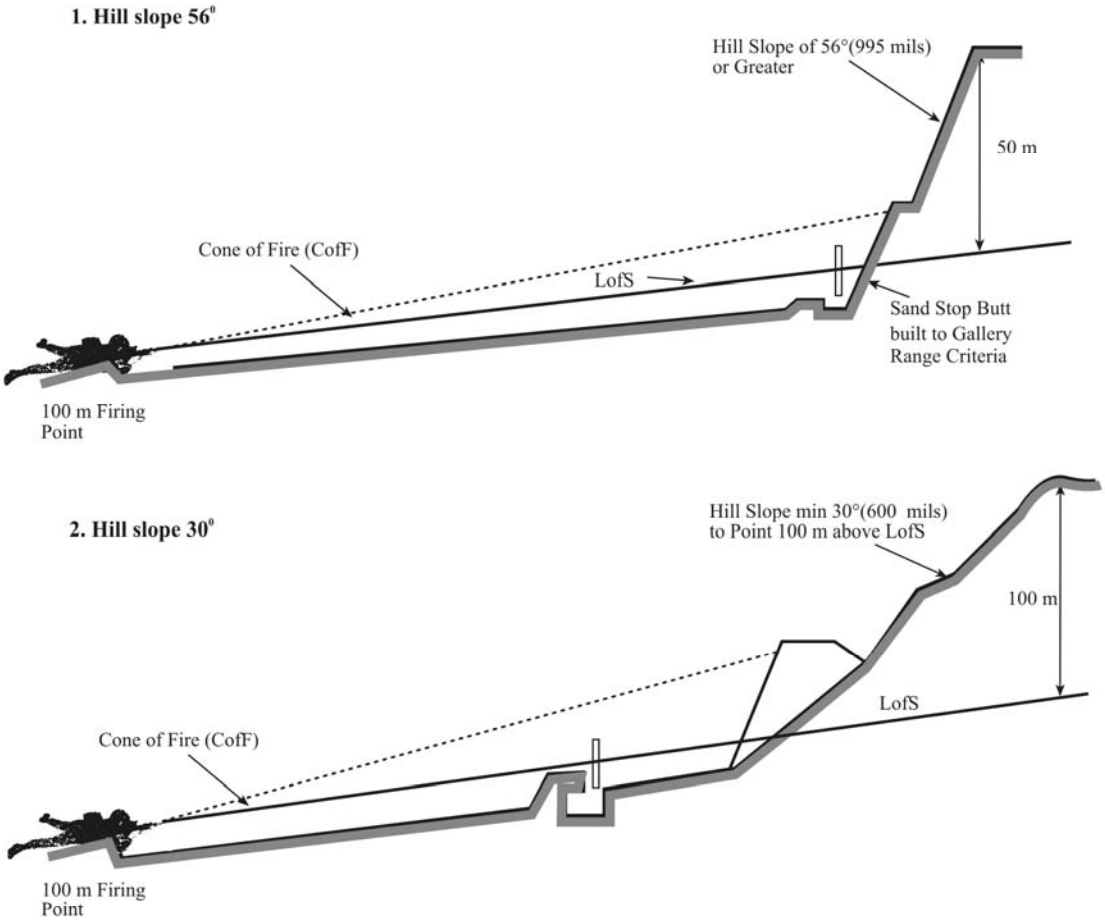



**Figure 2 - 4. Cone of Fire Criteria Illustration.**

**Derived from OB PROC P125(1)**




Notes:

1. The logic behind the hill background criteria applied to standard ranges (ie GR, CGR & ET(LDA)R) is that the hill will capture any rounds without inducing further ricochet. No hill provides an even slope. However, to prevent ricochet the slope must exceed $30^0$ (533mils). Slopes around $30^0$ (533mils) will generally have areas where ricochet might occur, hence the increased height requirement. Slopes that average $56^0$ (995mils) are unlikely to have ricochet inducing surfaces and therefore the height is reduced to 50 metres.

2. Trees and scrub cannot substitute for a hill background. There is no proven data on the ability of trees and scrub to capture high velocity projectiles.

3. On hill backgrounds that rise directly behind the stop butt, all backsplash or ricochet inducing material in the hill should be removed or screened.

**Figure 2 - 5. Hill Background Criteria**

# Reserved

**Reference BS 5499 - Safety Signs and Colours**


Normally used around the Range Danger Area (RDA) in conjunction with red flags and red lamps at main access points. Where there is sufficient land around the RDA for dry training and or public access, these prohibition signs are placed around the actual RDA with warning signs around the outer MOD or training area boundary. Where this is not the case, these signs are normally placed clear of the actual RDA using natural features such as fences and hedges to help define the controlled area.

**Figure 2 - 7. Range Danger area Boundary Prohibition Sign with Example Text.**

**Reference BS 5499 - Safety Signs and Colours**


This example shows a sign that might be used around controlled impact areas or training areas where military debris such as pyrotechnics, smoke canisters etc may be found.

**Figure 2 - 8. Range Prohibition and Warning Signs with Example Text.**

**Reference BS 5499 - Safety Signs and Colours**


Assault course and confidence circuit combination sign.

**Figure 2 - 9. Prohibition Signs**

**Reference BS 5499 - Safety Signs and Colours**

## 1 - SPECIFIC WARNING SIGNS


Where a particular hazard is reflected in the specific warning sign examples provided, these should be used. Where there is no specific warning symbol available, use the non specific examples illustrated below.


## 2 - NON SPECIFIC WARNING SIGNS


**Figure 2 - 10. Warning Signs**

**Reference BS 5499 - Safety Signs and Colours**

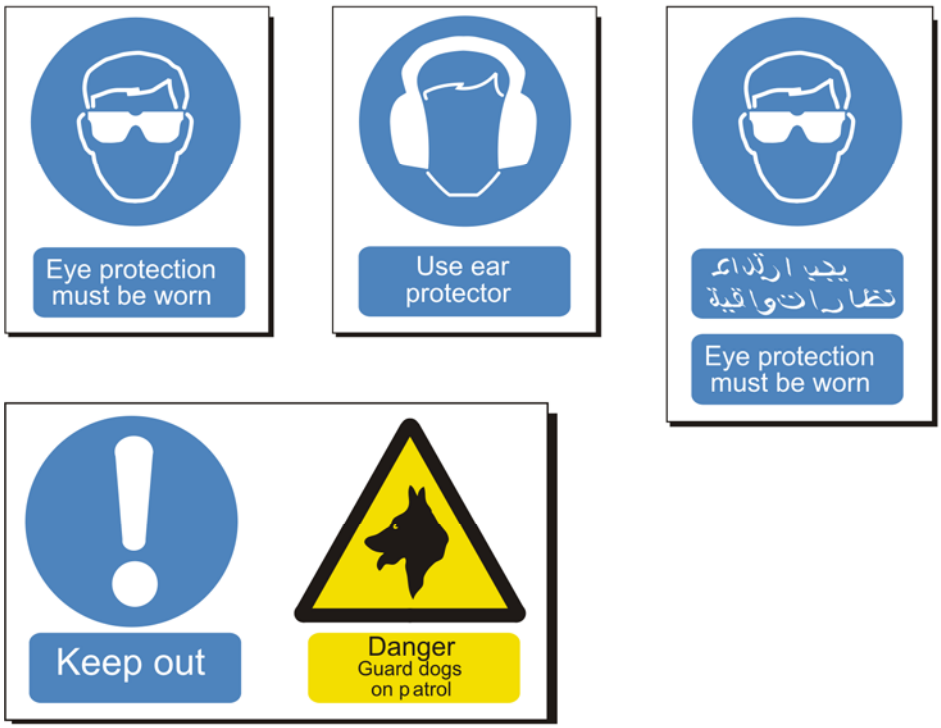
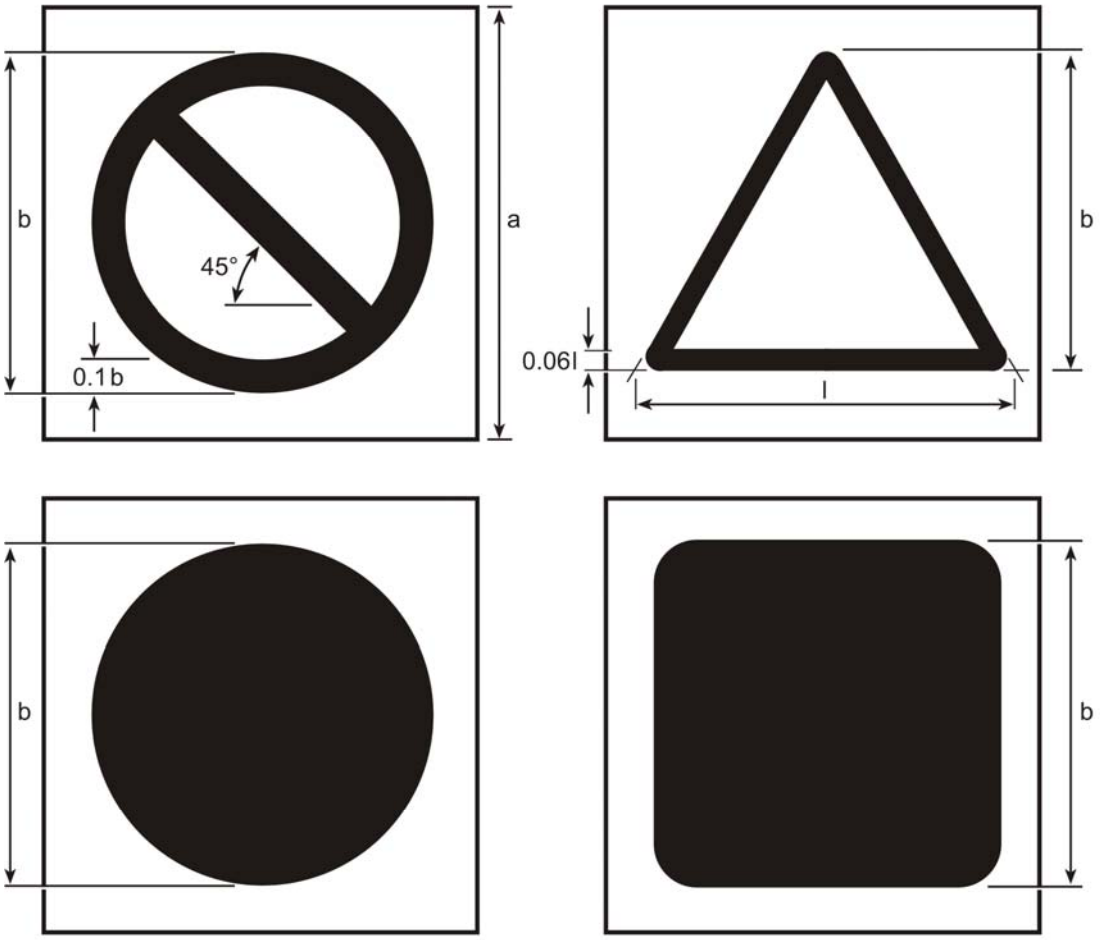



**Figure 2 - 11. Mandatory Signs**

**Reference BS 5499 - Safety Signs and Colours**

All Dimensions in Millimetres unless otherwise stated.

| Modular Height of Safety Sign Plate, a | Diameter or Height of Geometric Shape of Safety Sign Plate, b | Height of Lower Case Letters |
|---|---|---|
| 75 | 60 | 5.0 |
| 100 | 80 | 6.6 |
| 150 | 120 | 10 |
| 225 | 180 | 15 |
| 300 | 240 | 20 |
| 600 | 480 | 40 |
| 750 | 600 | 50 |
| 900 | 720 | 60 |
| 1200 | 960 | 80 |




a is the modular height of a sign plate, for a safety sign or supplementary sign.
b is the diameter or height of the geometric shape of a safety sign.

**Figure 2 - 12. Sign Size Chart**

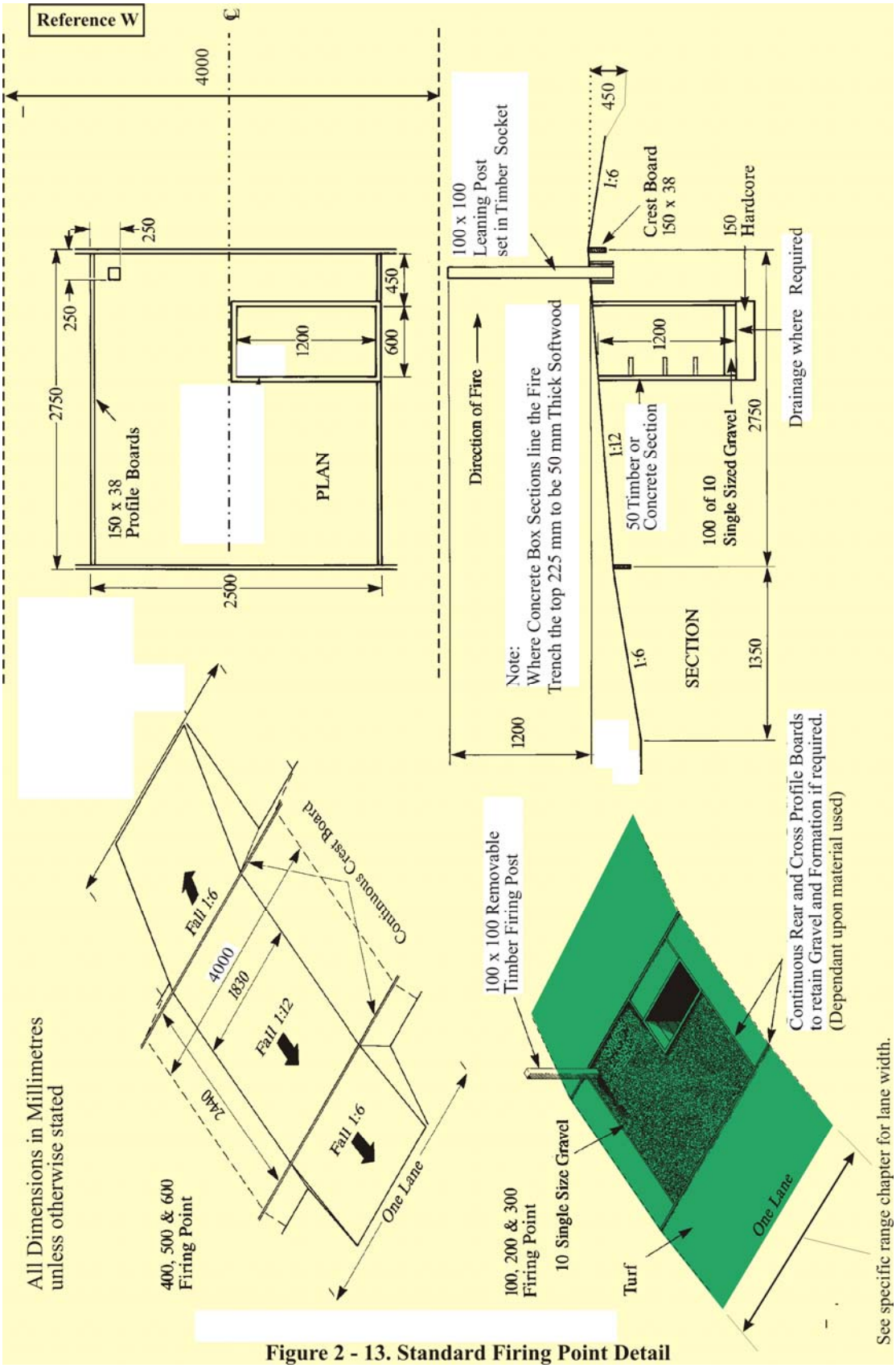



**Figure 2 - 13. Standard Firing Point Detail**