

influenced by several factors including use, see below, weapon type, use of fixed weapon mounts or handheld, and target positions.

2106. Usage. A test range may be used in several ways. The designer must take into account the worst case of intended use in providing ballistic protection. There are several possible combinations of use that will affect the design listed below in sequence of degrees of difficulty to provide effective design solutions.

- a. All firing from a protected area using clamped bore sighted weapons at targets mounted directly in front of the bullet catcher.
- b. Firing from protected areas and within the range with clamped weapons at targets mounted directly in front of the bullet catcher.
- c. All firing from a protected area using clamped bore sighted weapons at targets mounted at fixed points down range.
- d. Firing from protected areas and within the range with clamped weapons at targets mounted at fixed points down range.
- e. Test firing from protected areas and within the range with clamped and handheld weapons at targets mounted directly in front of the bullet catcher.
- f. Test firing from protected areas and within the range with clamped and handheld weapons at targets mounted at fixed points down range.
- g. Test firing from protected areas and within the range with clamped and handheld weapons at targets mounted at random points down range.
- h. Test firing from protected areas and within the range with clamped and handheld weapons at targets mounted at random points down range and dual use of range with training or familiarisation shoots authorised.

2107 – 2109. Spare

RANGE DESIGN

2110. The Design Aim. The design aim for all indoor and no danger area (NDA) ranges is to ensure all predicted direct fire and ricochet rounds are effectively captured without excessive attrition to the capture structures.

2111. Design Process. Application of both traditional established design principles and logical design using predicted CofF and ricochet data is required taking the worst case as the solution. This process is described in Chapter 3 and 5 using data from Chapter 2.

2112. The Design Relationships. When attempting to produce a design the relationship between all firing points, targets and ground level throughout the length of the range and the weapons, ammunition and practices used are critical to achieving compliance.

2113. Design Factors. The design of any test range must consider each of the following factors:

- a. **Line of Sight (LofS).** The line from the weapon sighting system to the point of aim. For example, SA80 fitted with SUSAT the LofS is about 90mm above the LofF.

- b. **Line of Fire (LofF).** The theoretical straight line between the muzzle of the weapon through the point of aim at the target. This is critical to design as safety criteria are then applied from every firing position and posture to determine proportions of defence structures.
- c. **Cones of Fire (CofF).** For weapon systems that are clamped, bench mounted or locked in a weapon mount a suitable cone of fire will need to be established. This will be developed by adding together several factors such as; weapon inaccuracy (manufacturer data may give a guide), stability of weapon system in the mount, stability of the mount (for example a mount of a vehicle. For bench rest and hand held firing the CofF in Chapter 2 Table 3 are applied around the line of fire for predicted shot and contain acceptable and some unacceptable weapon deviation, the latter producing a margin of safety.
- d. **Ricochet.** When bullets strike the range floor or a hard target there is potential for ricochet up to 45° which, in turn, presents the potential for rounds to escape from the boundary of the range or strike equipment or unprotected structure elements. Hard flat surfaces without damage or distortion are known to minimise ricochet to approximately half the incoming angle of strike. See Chapter 2 for more details.
- e. **Backsplash.** This may be caused when a bullet strikes any object and rebounds towards the range users or equipment. Details are provided in Chapter 2 Table 2.
- f. **Penetration.** The designer must consider the long term effect of bullet strike on all exposed range structures. Of particular concern is the possibility of hidden attrition. High velocity bullets will pass through timber losing little energy. All energy will be expended on any hard surface behind the timber or other soft material used to prevent ricochet and backsplash.
- g. **Clear Vision.** It is necessary to ensure that there is sufficient room between each LofF and the structure or equipment within the range. Designers should where possible provide adequate clearance as illustrated in Chapter 3 Figure 3-3.

2114. Spare

RANGE CONSTRUCTION

2115. **Siting.** A number of factors affect the suitability of a potential range site; these include location and orientation (open ranges), intended use and proximity to habitation.

- a. **Population (open ranges).** The orientation of the range should be such that where possible the direction of fire is away from habitation.
- b. **Sunlight (open ranges).** To avoid direct sunlight affecting range users, firing in a northerly direction is preferred in the northern hemisphere.
- c. **Noise.** Since impulse noise such as that produced on a range is difficult to contain, siting the range at a distance from populated areas is the best way of reducing noise nuisance. For indoor test ranges the use of a sound proof firing room provides the best protection. More information on range noise and engineering controls is provided in Chapter 31.

d. **Environmental Impact.** Consideration should be given to the long term use of an open test range in relation to the effect of emissions at the firing point and environmental impact of rounds that are not captured and recycled.

2116. **Range Envelope - Indoor Test Ranges.** The range floor shall be smooth and sealed to minimise unwanted ricochet where handheld weapons are used and to aid cleaning. Proprietary sheet rubber loose laid or synthetic tiles with tight joints to avoid dust collection are also suitable finishes. Where ranges are located on upper penetrable timber floors with occupied rooms below the floor must be protected to prevent any ammunition fired on the range penetrating the floor. Walls and ceiling shall have a minimum specification to prevent penetration in all areas where rounds (direct fire or ricochet off targets) might strike. Any material that might harbour dust and prevent effective cleaning shall not be used. Fire resistant materials shall be used throughout.

2117. **Outdoor Test Ranges.** Ideally ranges should be sited to achieve a Line of Fire (LofF) which is approximately horizontal from firing point to target. For hand held firing, a potential for ricochet exists where the appropriate cone of fire (CofF) criteria coincides with the range floor. The use of ricochet pits or sloping range floors may eliminate or reduce the possibility of this occurring. Impact slopes exceeding 30° minimise occurrence of ricochet while slopes exceeding 56° are expected to eliminate ricochet.

2118. **Range Floor.** The range floor should be prepared in such a way to eliminate excessive ricochet and backsplash. Careful consideration is necessary to ensure adequate provision is made for target holders, monitoring equipment and any floor mounted lighting. Some test facilities find that the range floor becomes cluttered with target rigs, target material, cables etc. The design should include sufficient storage space alongside the range clear of the range floor to avoid this.

2119. **Firing Points.** Constructed firing points and firing rooms provide suitably prepared and demarcated areas from which the range users are able to fire appropriate weapons. Test ranges firing points are normally enclosed with weapons fired through an aperture from a bench mount clamp. Other test range firing points may be inside the range from bench rests or hand held. Firing points for hand held firing at pre determined target positions should be clearly marked to ensure the protection measures are effective. Where weapon testing is undertaken from bench mounted clamps a movable protection baffle should be provided between the breech and the operator to deflect any fragments from a breech explosion.

2120. **Firing posture.** For the purpose of design where firing points are provided for hand held firing in or on the range the posture heights used to determine protective measures are provided in Chapter 2.

2121. **Firing Point Spacing.** Where a test facility is to have more than one firing point the spacing between firers is provided in Chapter 2 where it provides figures to establish sufficient firer spacing related to weapon and ammunition type.

2122. Targetry. Where targets are required this often involves target frames for mounting objects to be tested against a variety of ammunition types. Unlike traditional training ranges, targets may be located anywhere within a test range. In test ranges targets are not always required where barrel proofing is undertaken. In other test facilities targets may be equipment or clothing to be tested and may be hard or soft in terms of ricochet potential.

a. **Positioning.** Theoretically targets may be positioned anywhere within the range. The designer however must take account of the implications of each target position. Unlike the targets used for training practices that are made of light penetrable material, test range targets may generate backsplash and ricochet. Targets should be placed down range as close to the bullet catcher as possible, the need to provide ricochet protection to the structure is then limited. On outdoor ranges the target position in relation to the firing point will dictate the size of any danger area associated with the range.

b. **Marking.** Where the designer provides ballistic protection around specific target locations these locations should be marked on the range to ensure users do not breach the protection provided.

2123. Stop Butt (Outdoor ranges). An area extending above and to the sides of the bullet catcher which is subjected to lesser concentrations of fire. Its purpose being to stop direct shot fired at maximum predicted aim deviation and ricochet from the predicted first point of impact on the range floor or down range target. More detail on NDA stop butts is provided in Chapter 5.

2124. Bullet Catcher (Outdoor ranges). A sand or granulated rubber bank at the back of the range which is subject to constant attrition; its purpose being to contain the majority if not all of shots fired on the range. Other solutions are possible; refer to TAS(RE) for details. Details of sand and granulate traps are provided in Chapter 2.

2125. Bullet Trap (Indoor). A trap at the back of the range which is subject to constant attrition; its purpose being to contain the majority if not all of the shot fired on the range. Sand is not generally used indoors due to the dust it generates. Consideration should be given at the design stage not only to the supply and fitting of a suitable bullet trap but also the long term maintenance of the selected system. Some bullet traps require larger footprints than others.

Unless the test facility is only authorised to test low velocity weapons there are only a limited selection of suitable bullet traps for high velocity weapons. Granulated rubber or proprietary traps such as the Savage Range Systems Snail trap are more suitable for use on indoor test facilities. Other solutions are possible; refer to TAS(RE) for details.

2126. Defence Structures (Indoor). The area around the bullet trap that includes a back plate where occasional shot is expected and a defence zone where no rounds are expected but specified to stop single round penetration. Refer to chapter 3 for details.

2127. Explosive hazard. Dust in ranges will contain unburnt propellant and lead that will collect in ducts, recesses and in and around floor mounted electrical equipment. Any dust collecting in the range therefore may generate an explosive hazard. The risk of explosion may be increased by the proximity of electrical equipment. The elimination of unnecessary recesses and sharp

corners will aid cleaning and effective cleaning will significantly reduce this hazard.

2128. **Electrical Specification.** – Electrical installations within the range shall comply with the requirements of BS 7671, and due to the type of dust expected in the range all accessories, supply sockets and connections located within the range shall comply with BS EN 60309 Parts 1 and 2 and have a minimum IP rating of IP5X. In areas where there is heat generated such as high intensity lighting advice from Defence Estates Construction Support Team or the Fire Officer should be sought.

2129. Spare

ENVIRONMENTAL & SAFETY ISSUES

2130. **Control of Dust.** Dust in indoor ranges is a potential fire and health hazard. Such dust will contain elements of lead and unburnt propellant which if allowed to accumulate will become an explosive hazard. All materials specified within a range should be easily cleaned and should inhibit dust. Materials that absorb dust are to be avoided. Joints in the fabric of the range are to be sealed and fittings and fixtures installed in such a way that dust cannot accumulate behind or in such fittings. Refer to chapter 30 for more detail on dust control and cleaning regimes.

2131. **Control of weapon emissions.** Lead and carbon monoxide are the main emissions in a range that can affect health. Full details of control measures are provided in Chapter 30.

2132. **Fire prevention.** When specifying materials for range construction their fire rating must be considered. Materials such as rubber compounds and timber can present a fire hazard. This, combined with factors such as heat from target lighting and the presence of unburnt propellant, require careful consideration at the design stage.

2133. **Escape routes.** Means of escape should conform fully to the regulations. Attention is drawn to the Regulatory Reform (Fire Safety) Order for England and Wales; the Fire Safety (Scotland) Act and the Fire Safety (Scotland) Regulations, the Fire and Rescue Services (Northern Ireland) Order. The requirements include a general duty to carry out a risk assessment and take precautions against fire. Fire safety is also covered by the respective Building Regulations (England and Wales; Northern Ireland; Scotland). The advice and approval of the MOD Fire Officer is mandatory for all new or reconstructed indoor ranges.

2134. **Control of access.** If the Range Conducting Officer (RCO) is unable to observe outside the range, facilities are required to prevent access to the range when it is in use. Audio-visual warnings should be provided in the event down range doors are opened when the range is in use. See Chapter 3 for more details.

2135. **Safety Signs.** Safety signs used to control access, warn of hazards etc are described and illustrated in chapter 2. Notices are not regulated but safety signs are.

RANGE MAINTENANCE.

2136. **General.** The design of new facilities should take account of future maintenance issues. Below are some of the issues to be considered.

a. **Materials.** Materials selected for the respective defence structures should withstand expected bullet strike without serious damage. Those components that will break down following strike, particularly in areas of repeated strike, must be fitted in such a way that they are easily repaired or replaced.

b. **De-leading.** There are two aspects of de-leading to be considered, lead dust and the build up of lead bullets such that a backsplash hazard may develop. Most traps cause lead bullets to break up generating lead dust in the area of the trap. Any work in this area will involve the use of PPE. Bullet traps that do not cause bullets to break up have a minimal dust problem. Designers should build in good access to all parts of the trap to allow effective cleaning and maintenance of the trap.

c. **Weapon mounts and blast shields.** Any weapon bench, clamp or mount and associated breech blast protection are to be inspected against a service schedule to ensure they remain safe and serviceable.

d. **Protective glass observation windows.** Inspectors are to ensure any glass or other material used in observation windows remains fit for purpose and the frames in which they sit are sound.