CHAPTER 5

OPEN NON STANDARD NO DANGER AREA RANGE

INTRODUCTION

0501. **Aim**. The aim of this chapter is to describe the design and construction details for an Open Non Standard NDA range. In particular it covers:

0502. **General.** The No Danger Area (NDA) range is defined at in Chapter 2 at paragraph 0232. The Non Standard NDA range requires particular attention as each will differ in the way compliance is achieved dependant upon many factors. Therefore this chapter will define in some detail the process of design to achieve compliance with current authorised criteria. Design principles in Chapter 2 are applied to determine the extent of defence structures. However, no defence structure will be specified less than that established for the criteria shown in Fig.2-2 and 2-3 that have proven to be safe over a long period of use.

DESIGN PROCEDURES
(NEW OR MODIFIED RANGES)

0503. **Range Safety Advice.** For MOD facilities, any work affecting PTR ranges, whether new build, major refurbishment, modification or major repair is to be co-ordinated with TAS as the Technical Authority for compliance and functional aspects. For non-MOD facilities where JPS 403 is used as the design standard, advice on range safety, ballistic resistance and functional aspects may be obtained from TAS(RE).

0504. **Structural Advice**. For MOD facilities, DE should be consulted for all aspects of structural integrity and stability as the Technical Authority for all structural engineering and works aspects. For non-MOD facilities those

responsible for the work need to satisfy themselves as to the suitability of the overall design and the competence of those involved in all aspects of design, building or refurbishment work.

0505. **Preliminary Planning**. Consultation at an early stage enables provision of advice regarding individual locations and also ensures that planned work complies with functional requirements and standards of ballistic resistance. Detailed ballistic designs, specifications and all relevant details should be submitted prior to works commencing. All submissions should be forwarded to the local Authorising HQ who can then, if necessary, seek TAS(RE) advice. New MOD ranges are initiated by the Defence Training and Requirements Organisation (DTRO).

0506. **Non Standard NDA Ranges in Operational Theatres.** Commanders may authorise NDA ranges to enable zeroing of weapons in secure operational bases. Although there is no requirement for such ranges to comply fully with the criteria in this Chapter those involved in construction of such ranges should be aware of the safety issues relating to bullet catchers and stop butts. Refer also to Chapter 11 for operational Tube Ranges.

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DESIGN

0510. **Siting.** During the preliminary planning process the following hierarchy of factors should be considered for the initial siting of an NDA range:

a. **Population**. The orientation of the range should be such that where possible the direction of fire is away from habitation.

b. **Sunlight.** To avoid direct sunlight affecting range users, firing in a northerly direction is preferred. (South in the southern hemisphere)

c. **Noise.** Since impulse noise such as that produced on an open range is difficult to contain, siting the range at the greatest possible distance from populated areas is the most effective way of reducing noise nuisance.

d. **Environmental Impact**. Consideration should be given to bullet containment and recycling, the type of structure, materials used and overall appearance of the completed facility.

e. **Ground Profile.** Ideally NDA ranges should be sited to achieve a Line of Fire (LofF) which is approximately horizontal or slightly depressed from firing point to target.

f. **Local Factors.** Full consideration should be given to local factors, conditions, risks and any other relevant information when formulating site specific design solutions. Distraction visible from the firing point beyond the bullet catcher for instance should be avoided.

g. **Access**. Access is required for range users and for maintenance works. The range boundary should have controlled access with respective areas suitably signed and, where appropriate, fenced or otherwise marked as described in Chapter 2. Local assessment of site specific risks is required to determine additional control measures necessary.

0511. **Range Components**. Full descriptions of range components are provided in Chapter 2. Specific to Open Non Standard NDA ranges are the following;

a. **Firing points**. For longer engagement distances elevated firing points will help avoid ground strike within the predicted CofF.

b. **Targetry.** A suitable target area with clearly defined target positions provides easily identifiable points of aim. In the design process it is the aiming point of a target that is important. There may be more than one aiming point on a single target therefore worst case LofS must be applied to each from all possible firing positions. See Chapter 2 paragraph 0298d.

c. **Range Floor**. The range floor includes the length from the rear of the furthest firing point to the toe of the bullet catcher and the width between the flank firing points to the extents of the stop butt. The area of the range floor should be constructed to eliminate, so far as is reasonably practicable, any hard ricochet inducing materials and surfaces. The layout of the range floor requires detailed consideration; particular attention is required for each firing point, the likely first point of impact and potential for ricochet from the surface of the range floor.

d. **Ricochet pit**. A potential for ricochet exists where the appropriate cone of fire criteria coincides with the range floor. The use of ricochet pits or sloping range floors may reduce the impact of designing to capture ricochet.

e. **Bullet Catcher**. The bullet catcher is the area directly behind the target position which is subject to constant attrition; its purpose is to continually stop bullets in free flight and low ricochet while providing a structure which is easily maintained and cost effective. Sand is currently the most common material used for bullet catchers although granulated rubber is now authorised for use and may provide a far more cost effective bullet catcher. See Chapter 2 for recommended details and specifications for both types. For low velocity ammunition environmentally friendly and cost effective in use proprietary traps exist; refer to TAS for details.

f. **Stop Butt.** The stop butt is the area extending above and to the sides of the bullet catcher and should be subjected to lesser concentrations of fire. Its purpose is to stop direct shot in free flight within maximum predicted aimer deviation margins and ricochet from the predicted first point of impact. Where banks form the stop butt the minimum impact slope of 56^0 is required for NDA ranges. Details are provided in Fig.2-2, 2-3 & 2-4.

g. **Protection of Hard Surfaces**. Where exposed hard surfaces or objects are likely to be struck, there is a potential for high angle ricochet or backsplash to occur. Where the hard surface or object cannot be removed features should be incorporated to provide protection, for example by the use of timber, earth (sloped at a minimum of 56^o) or other suitable material to cover the area of concern. This minimises the risk of injury to those within the range from

backsplash and to those outside the boundary from ricochet. Care must be taken to avoid situations where hidden attrition may occur. Rounds passing through soft material leave almost no mark of their passing. However when high velocity rounds impact on a hard surface, that surface may break up. It is important that all defence structures can be inspected for such attrition to ensure the protection required is maintained.

0512. **Design Factors.** Every element within the range shall be constructed in a way to ensure the capture of shot within the range including direct fire, ricochet and backsplash.

a. **Direct Fire**. Chapter 2 provides details of the CofF in which all direct fire is expected for MOD shooting practices. Alternative CofF may be appropriate under certain conditions but reductions in the MOD CofF must be authorised in each case to enable TAS(RE) to utilise such reductions in the provision of ballistic safety advice.

b. **Ricochet**. (see also Chapter 2 paragraph 0240) Ricochet from the range floor has proven to be a hazard and must be accounted for in the design. A ricochet may occur when a round strikes any part of a range surface, other than ricochet inhibiting slopes (56 deg or more) within the predicted cone of fire criteria. Apart from the sand bullet trap which should be 34^0, all other slopes on NDA ranges should be 56^0 (56 deg or more) to eliminate the potential for ricochet.

c. **Backsplash**. Backsplash is a hazard to which firers, and others present on a range, may be exposed. It is caused when a bullet strikes any object and results in whole bullets or fragments (of the bullet, targetry, ground or structure) being thrown back towards the range users. Details are provided in Chapter 2 Table 2. The risk of injury from backsplash is affected by proximity to the hazard, with the level of risk being dependent on the following factors:

(1) **Target Type**. Penetrable (soft) target such as thin plywood, or impenetrable (hard) target such as steel.

(2) **Surface Type.** Nature of surfaces surrounding the target and the range floor - soft or hard. Soft ground and materials include earth, turf, sand, timber etc; hard ground or materials include stone, rock, steel, concrete etc.

(3) **Weapon/ammunition**. Type used - low or high velocity.

(4) **Engagement Distance.** Target engagement distance or distance between personnel and the object likely to be struck.

(5) **Obstructions**. Objects in the CofF between the firer and target.

d. **Weapon.** The cone of fire varies according to type of weapon. This affects the predicted initial point of impact with the range floor.

e. **Ammunition Characteristics**. Ricochet and backsplash potential varies with ammunition type; the departure angle and

remaining velocity being affected by a number of factors including calibre, muzzle velocity and energy, nature and slope of the range floor, impact angle, exit velocity ratio, projectile damage and ability to re-stabilise in post ricochet flight.

f. **Posture.** The firing posture adopted affects the relationship between the line of fire and the range floor. Variation in firing point height has less effect on the target centre height as the CofF rotates around the target centre.

g. **Trajectory.** The line of fire is a theoretical straight line taken from the muzzle of the weapon through the point (or points) of aim at the target (the target centre). Bullets do not travel along the theoretical line of fire due to ballistic curve or trajectory; however, for the purposes of calculation the curve is ignored over short distances Longer ranges with overhead baffles or partially enclosed tube ranges may be effected by trajectory.

h. **Application of Criteria**. To determine lines of fire, each firing posture height/ spacing at all firing distances shall be linked to each relevant target aiming point in accordance with the planned shooting practices. As the constructed elements of a range are affected by application of criteria to these lines, it is essential that every line of fire is considered.

0513. **Component Design**.

a. **Bullet Catcher**. The bullet catcher size requirements can be established by application of a parallel distance and an associated angle to the `worst case' LofF In Chapter 2 Table 6.

b. **Stop Butts / Back Walls**. The required height and width of stop butt for a specific range can be determined by applying existing range criteria (Chapter 2 Figures 22-2 and 2-3) and relevant cones of fire and ricochet allowances (see Figure 2-4). . Application of all these elements is necessary as in some circumstances the calculations for cone of fire and ricochet may result in smaller stop butt dimensional requirements than needed using previous NDA criteria. As a reduction in the level of safety cannot be accepted, the criteria for existing ranges are also applied and whichever the greater is to be adopted (See paragraph 0502).

(1) **Cones of Fire (CofF**). These are applied to all LofF to determine the extent of direct fire and predicted initial points of impact on the range floor. The stop butt should be sized and positioned to capture all predicted direct shot and ricochet from the range floor. Authorised CofF are provided in Chapter 2 Table 3.

(2) **Ricochet Allowance**. To determine the extent of predicted ricochet, an angular allowance is applied from the initial point of impact where the appropriate cone of fire strikes the range floor. In many cases the resultant height and width of ricochet departure angle exceed the direct shot element of the cone of fire. With careful design of the ground profile it is possible to eliminate or minimise the effects of ricochet by providing a combination of

sloped range floor, ricochet pit, and/or raised firing points. The ricochet angles to be used are 15^0 for low velocity weapons and 30^0 for high velocity weapons. Angles are to be measured from the range floor or any point forward of each firing point where ricochet is possible.

(3) **Existing Range Criteria**. Chapter 2 provides the details necessary to determine stop butt heights and widths using existing range criteria. This range criteria shall be used in addition to the cone of fire and ricochet criteria with the resultant highest and widest dimensions used to determine the stop butt requirements.

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CONSTRUCTION

0515. **Firing Point**. Construction may be of grassed earth, aggregate or external quality soft durable surfaces. For natural firing points only a treated timber board, set on edge flush with the ground, is needed to show the actual position; while for aggregate typical construction should be 10mm (T) single sized aggregate to a thickness of 100mm (T), laid on a suitably compacted, free-draining base. Aggregate should be surrounded by treated timber boards, set on edge flush with the surrounding ground level, to assist in retaining the firing point area surface. Where the prone posture is adopted, the ground level should be raised to elevate the weapon above the range floor. This reduces potential ricochet by increasing the distance to predicted first point of impact. A standard firing point is illustrated in Chapter 2 Fig.2-13. For enclosed or semi enclosed firing points refer to Chapter 3.

0516. **Targets.** Impenetrable targets are not normally used on NDA ranges as this creates problems with ricochet and backsplash. Typical target backing construction is thin plywood, corrugated plastic and hessian screens supported on timber framework; although any similar penetrable construction is acceptable. Only approved targets may be used on MOD ranges. Various forms of target support and mechanisms may be used. Examples include simple timber posts and sockets, hand operated swivel target mechanisms and radio/remote controlled and programmable turning target mechanisms. It is also possible to use pop-up target mechanisms. In all cases the mechanism shall be either penetrable, or suitably protected from strike if consisting of any hard surface. Refer to Chapter 29 for details on current MOD target systems.

0517. **Range Floor.** The range floor should be reasonably level, firm and free-draining to prevent ponding. It should have a depth of 150mm (T) topsoil, sand or other soft material free from stones >30mm (T). Soil should be seeded or turfed to prevent erosion. Particular attention is needed to cover any exposed hard surfaces / target mechanisms on the range floor.

0518. **Bullet Catcher.** The bullet catcher should be positioned immediately behind the targets to achieve its function; the distance may vary although a distance of 1000mm (T) from target line to bullet catcher toe-board provides sufficient space for access to targetry. As the distance from target to toe-board increases, the defensive structure requirements become greater.

Details and specifications of sand and granulated rubber bullet catchers are provided in Chapter 2.

a. **Profile**. Provided the profile is maintained the majority of bullets should be contained within the catcher, the exception is some high velocity rounds which have a tendency to 'pop-over' - see below.

b. **Canopy**. Where high velocity centre fire rifle ammunition is to be used, an anti-ricochet or `pop-over' canopy is required to prevent vertical ricochet from the bullet catcher sand leaving the range. The canopy shall be positioned to cover the full width and depth of the bullet catcher. Where the canopy is of timber constructions, the rear half of the underside is to be lined with steel minimum 5 mm thick across the full width of the canopy. The sides of the canopy are to be impenetrable to ricochet and any debris ejected from the bullet catcher sand, and is typically constructed of brick or block. Other materials, such as concrete may be used provided that they contain “pop-over”, are weather resistant and are low maintenance, noting that the rear half of the canopy underside will take the largest proportion of ricochet. The leading faces of the canopy and supporting walls should be clad to prevent backsplash. Where high velocity centre fire rifle ammunition is to be used without a canopy above the bullet catcher, a 100 m radius danger area is required to the sides and rear of the range (measured from the flank target positions at sides and stop butt for extent of DA to the rear). Alternatively the whole area of the bullet catcher may be constructed with a slope in excess of 56 deg thus preventing ricochet.

Bullet Catcher with Canopy.

0519. **Stop Butt**. Typical construction used for stop butts include vertical walls, natural earth embankments, manufactured bunds and cutting into natural hill features. The slope angle for an earth embankment stop butt is 56^0 (C) from the horizontal which is traditionally accepted as the angle which eliminates ricochet. Table 1 indicates the recommended thickness and type of materials often used in the construction of stop butts. Other solutions may also be possible - Refer to Chapter 2 paragraph 0258.

Weapon/Ammunition Type	Material Type			
	Vertical Wall			Earth Embankment
	Concrete Note 1	**Brickwork** Note 2	**Blockwork** Note 3	Notes 4 & 5
Rimfire Rifle and Pistol	75	102.5	100	1000
Centrefire Pistol/Carbine	150	215	215	1000
Centrefire Rifle	200	215	215	1500

Table 1 - Stop Butt Material Requirements for NDA Ranges (C)

Notes

1. Concrete - 20N/mm^2 20mm aggregate suitably reinforced.

2. Brickwork - solid, void-free Engineering quality bricks.

3. Blockwork - solid, dense aggregate blocks with a minimum compressive strength of 10 N/mm^2 and a minimum density of 1500 kg/m^3.

4. Earth embankment to be suitably compacted stone-free soil incorporating geo-textile reinforcement where appropriate.

5. The thickness indicated refers to the crest, where there is no additional protection or support behind. If a bank of greater thickness is faced with stone-free earth, it may be possible to reduce this dimension depending on anticipated ammunition usage and likely depth of penetration.

a. **Positioning**. The stop butt should be positioned as close to the target line as practicable. As the distance from the target line to the crest increases, the stop butt height and width requirement becomes greater to enable capture of all predicted shot.

b. **Protection**. Where a vertical wall is used for centrefire rifle stop butt construction, the area visible above the sand and within the canopy is liable to receive strike fairly regularly; and additional protection shall be provided to the front face. This is particularly important where the wall is near the backsplash distance.

(1) **Concrete or other hard back wall surfaces**. Stop butts constructed of hard materials, such as concrete, should be faced with a covering to prevent ricochet and backsplash. Typically 50mm softwood timber planks on 50mm thick vertical battens is used. Great care is needed to avoid creating potential areas of unseen structural damage, for example bullets may produce only small holes and timber cladding can appear undamaged on the surface, while severe unseen spalling occurs behind. In such cases the cladding should be fixed so that it can be easily and regularly removed to monitor vulnerable areas."

(2) **Brickwork**. Where brickwork is used to create the stop butt no additional ricochet protection is needed. However inside the canopy above the sand a render coat, 1:4 mix 20mm thick, is commonly applied. This is used to identify high shot, indicating problems such as incorrect target centre heights. Where sand bullet catchers are used the render

should be continued down behind the sand to prevent moisture seeping into the brickwork."

COMMUNICATIONS

0520. **External.** A means of summoning the emergency services is to be available. A land laid telephone should be provided in areas where mobile communication signal strength is suspect.

0521. **Interna**l. On ranges with permanent accommodation, communication between firing points and manned facilities should be provided.

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MAINTENANCE

0525. **Range Profile Survey**. The effects of weathering and soil movement will cause changes in the range profile. Periodic survey of the range is essential to ensure that the range geometry remains within design limits. The frequency of check surveys is dependent upon the natural foundation of the range its exposure and attrition; the requirement varies from 5 - 10 years. New ranges are to be re-surveyed 2 - 3 years after construction.

0526. **Responsibilities**. Maintenance is the responsibility of the RAU. Responsibilities may be divided as follows:

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

b. **Property Management**.

(1) Grounds.

(2) Fencing and sign posting. (See Chapter 2)

(3) Structures, roads and drainage including stability of slopes and erosion control.

(4) Water and electricity supplies.

(5) Periodic refurbishment of the range structure.

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

0527. **Frequency.** Proper maintenance is dependent upon good liaison between the Range Warden and the RAU, and on properly scheduled maintenance periods. A heavily used range may need one day's maintenance each week plus one or two days' maintenance by the Range Warden each month. Two closed periods of a week or so may be needed each year for building and earthworks repair; this work should be combined with the contract repair of equipment.

0528. **Bullet Catcher**. The requirements for maintaining the bullet catcher sand and de-leading are given in Chapter 2.

0529. **Hidden Attrition**. Where anti backsplash or ricochet protection surfaces have been added to hard defence structures, careful and regular inspection of the hard structure is required to ensure that the defence structure is not deteriorating behind the soft cladding. Such cladding must be readily moved to ease inspection.

COMPLIANCE CHECKS.

0530. The following compliance checks are detailed below

a. Authorised weapons, ammunition and practices.

b. Firing point alignment, size, positioning and height.

c. Range floor and ricochet pit profile, if applicable.

d. Mantlet height & profile.

e. Targets correctly sized, spaced and protected.

f. Target centre height and flank positions accurately identified.

g. Bullet catcher sizing and specification.

h. Canopy construction against `pop over', if applicable. .

i. Stop butt wall height, width, face angle and crest depth, if applicable.