NATIONAL RIFLE ASSOCIATION

NATIONAL RIFLE ASSOCIATION RANGE MANAGERS GUIDE

Issue 1 – Sept 2018

Compiled by Maj (Retd) F S Compton MBE for the NRA based on the ballistic safety principles contained in JSP 403.

More detail on each of the areas covered in this Guide can be found in Handbook of Defence Ranges Safety - JSP 403 Volume 2 (https://www.gov.uk/government/publications/jsp-403-volume-2)

The following organisations have contributed to the content of JSP 403;

World Forum on Sport Shooting
International Range Safety Advisory Group (IRSAG)
Institute of Naval Medicine
Army Medical Directorate
Defence Infrastructure Organisation (DIO) Range Safety Conferences.
MOD Test facilities.
Range material suppliers / Range consultants.

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PREFACE

Planning a shooting range facility is a major undertaking. The safety requirements are unique and require detailed planning. This document contains information recommended for use during the design, construction and operation of shooting ranges, or when assessing the suitability of existing ranges.

Ranges must be designed to prevent injury to personnel and damage to property from misdirected, or accidental, shooting and ricochets. The design must also:
- promote safe and efficient operation
- include provisions for ease of maintenance
- be affordable to construct and maintain

This Range Managers' Guide is to be used with the NRA Code of Practice, the NRA Handbook, and MOD's JSP 403 to provide safe and well maintained ranges. This guide is aimed at the safety of existing outdoor and indoor ranges. For new or modified ranges further advice should be sought. In order to ensure ranges are safe there is a requirement to understand a little about external ballistics including;
- Cone of Fire (CofF) accuracy of the firearm and the firer
- Ricochet
- Backsplash (ricochet over 90deg)
- Penetration potential
- Trajectory (potential range at a given barrel elevation)

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References

A	Joint Service Policy (JSP) 403
B	NRA Handbook 2015
C	World Forum on Sport Shooting (WFSA)

ABBREVIATIONS

CGR	Converted Gallery Range (Fitted with electric targets)
CLAW	Control of Lead at Work (HSE Guidance)
CofF	Cone of Fire (accuracy of the firearm and firer around a point of aim)
CSR	Civilian Service Rifle
ERV	Emergency Rendezvous Point (Provided for emergency responders)
FDA	Full Danger Area (2900m based on a maximum QE of 150 mils)
FEDA	Full Energy Danger Area (Maximum range a firearm can reach)
fp	Firing point
fpi	First Point of Impact
GR	Gallery Range (as defined in JSP 403)
JSP	Joint Service Policy
LDA	Limited Danger Area (A danger area less than 2900m)
LofS	Line of Sight
ME	Muzzle energy
mils	Military Mil (6400mils in a circle)
MOD	Ministry of Defence
MPI	Mean Point of Impact
MV	Muzzle velocity
NRA	National Rifle Association
OEL	Occupational Exposure Limit
PAM	Pamphlet
ph	Posture Height
QE	Quadrant Elevation
RAU	Range Administering Unit
RDA	Range Danger Area
RCO	Range Conducting Officer
TAN	Tangent
TCH	Target Centre Height

PART 1 - EXTERNAL BALLISTICS

1. **Cone of Fire (CofF) accuracy of the firearm & firer**. The Cone of Fire (CofF) represented in Figure 1 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 1 are applied around each Line of Sight in elevation, depression and azimuth. The CofF allows for acceptable deviation caused by errors associated with the firer and firearm machining or manufacturing tolerances, and allows an additional margin for unacceptable firer error.

The height of the protection required on No Danger Area (NDA) ranges can be determined from the CofF as well as the First Point of Impact (FPI) to consider the ricochet implications. Table 1 lists the potential CofF applicable on NRA ranges.

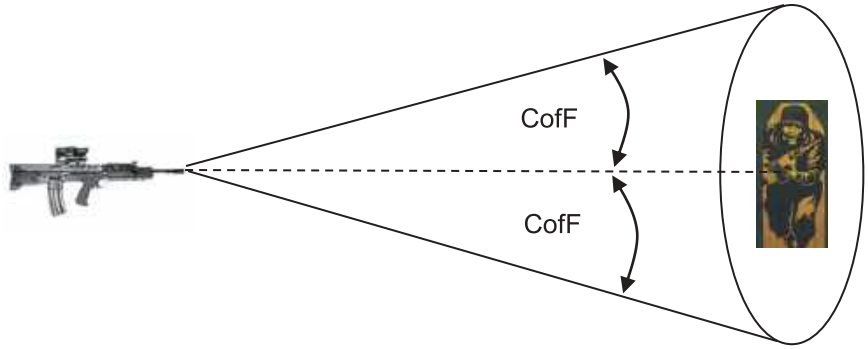


Figure 1 – Cone of Fire around Point of Aim

Ser	Practice	Cone of Fire (mils / deg)	
	(All single shot deliberate shooting)	Azimuth	Elevation
1	Rifle / Carbine static to static unsupported	40 / 2.25	40 / 2.25
2	Rifle / Carbine static to static supported	21.5 / 1.15	21.5 / 1.15
3	Rifle / Carbine moving to static or static to moving	120 / 6.75	60 / 3.38
4	Rifle competition target shooting	12 / 0.6	12 / 0.6
5	Pistol double hand static to static	135 / 7.7	135 / 7.7
6	Pistol single hand static to static	190 / 10.7	190 / 10.7
7	Pistol double hand static to moving or moving to static	250 / 14	190 / 10.5

Table 1 - Cones of Fire (NRA practices*) adapted from JSP 403

**Note; Range staff should monitor all fall of shot, bullet strike and target grouping to confirm the detail in this table and where necessary increase safety measures if there is evidence of a larger CofF.*

2. **Ricochet Definition**.

> "*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 surfaces.

Ricochet greater than 90^0 is regarded as backsplash. 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 virtually eliminated from slopes of 56^0 or more. 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 (CofF + Ricochet) design principles.

On all ranges, projectiles that impact a surface within the range may:

a. Be captured by the ground or structure.

b. Break up on impact and fragment over a small area.

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

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

e. Deflect off target frames or other range components with little loss of energy.

3. **Backsplash** is bullet, bullet fragmentation or target debris thrown backwards at any angle produced by the impact of a projectile. Anti backsplash curtains set clear of the impact surfaces can prevent backsplash enabling closer engagement. Where no such protection is provided the backsplash distances in Table 2 apply:

Ser	Firearm	Fragment / Earth Throw distance hard surface. (m)	Fragment / Earth Throw distance soft surface. (m)
1	Rimfire, centrefire pistol and carbine	22	10
2	Centrefire rifle (<7000J - 5160ft lbs)	50	22

Table 2 - Backsplash distances

a. Backsplash from well-maintained stop butts into the gallery on gallery ranges should not exceed 5m. 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.

b. 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 probable backsplash distances but ammunition occasionally exceeds these distances. There is an additional hazard on indoor, tube, test or other ranges where anti splash curtains are used, 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 retaining a hazardous velocity.

4. **Penetration of range structures**. British and International standards for protection allow a test to resist penetration that involves up to 5 rounds impacting in a small area. For most ranges this is not a suitable test as range structures may take many thousands of rounds in a very small area. Each firearm/ ammunition type will generate different penetration potential from a variety of ranges. The only accurate data for penetration will come from field trials. As an indication of minimum protection requirements data from JSP 403 has been included in Table 3 below.

Ser	Ammunition	Concrete	Solid brick	Concrete block	Timber	
Main points of impact						
1	Rimfire	75mm	100mm	100mm	125mm h/w 125mm s/w	h/w = hardwood s/w = softwood
2	Centrefire pistol / carbine	150mm	215mm	215mm	175mm h/w 200mm s/w	
3	Centrefire rifle	200mm	215mm	215mm	250mm h/w 375mm s/w	
Defence zone / back wall - only occasional impact at 90^0						
4	22"	25mm	75mm	50mm	125mm s/w	
Defence zone / back wall - only occasional impact at 7^0 (side walls etc)						
5	22"	25mm	75mm	50mm	12mm s/w	

Table 3 - Minimum thickness of construction materials considered to be impenetrable to bullet strike (<7000J - 5160ft lbs)

Ser	Ammunition	Defence Zone		Defence Zone		Bullet Catcher
		Flank	Direct	Flank	Direct	
1	Rimfire	3mm	4mm	4mm	5mm	6 or 4 armoured
2	Centrefire pistol / carbine	4mm	5mm	5mm	6mm	8 or 6 armoured
3	Centrefire pistol / carbine jacketed	5mm	6mm	6mm	8mm	12 or 8 armoured
4	Centrefire rifle	12 or 8 armoured		Proprietary systems only		

Table 3a - Minimum thickness of steel plate considered to be impenetrable to bullet strike (<7000J - 5160ft lbs)

5. **Hidden Attrition**. High velocity rounds penetrate soft material such as timber losing very little energy and leaving only a slight indentation at the point of entry. When a round strikes the dense material behind the protection 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.

Figure 2. Example of hidden attrition

6. **Trajectory**. Trajectory is an important issue on outdoor ranges with limited danger areas. Each firearm system has a maximum potential range generally at a barrel elevation of around 35^0. JSP 403 range templates are based on maximum trajectory of 70mils (4^0) for gallery ranges and 150mils (8.5^0) for other high velocity ranges. These elevation limits are reduced to take account of the expected CofF to determine maximum barrel elevation.

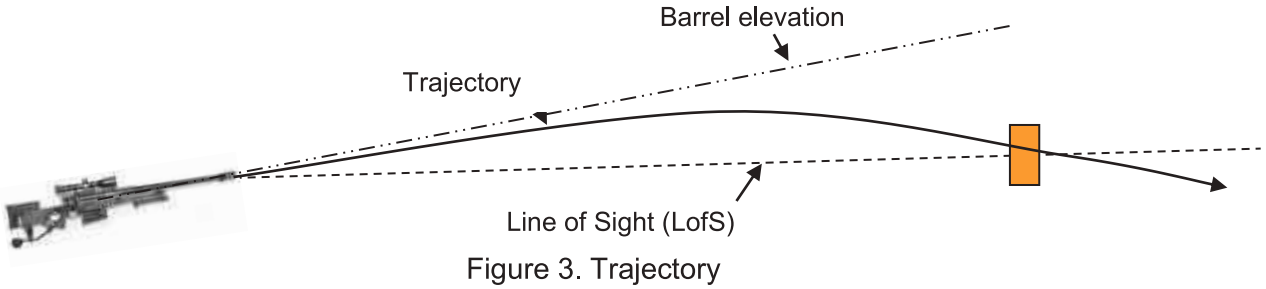


Figure 3. Trajectory

The safety margins on maximum trajectory for limited danger areas is very small. The difference for example between the gallery range limit of 1830m and 2900m danger area limit is just 4^0.

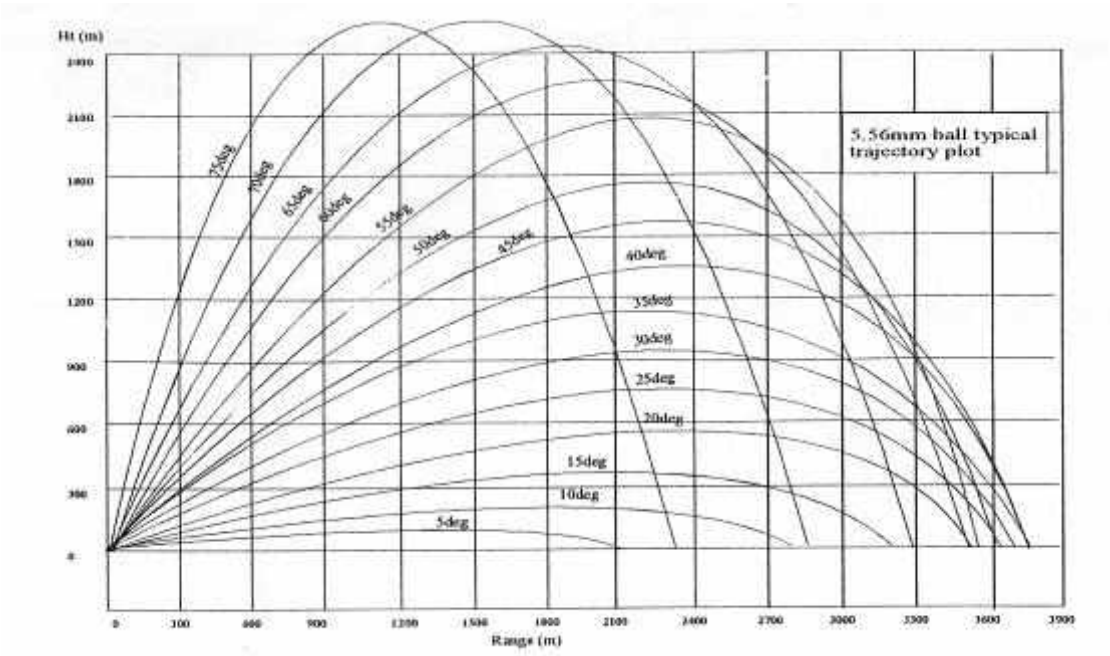


Figure 4. Trajectories for 5.56mm ammunition

PART 2 - OUTDOOR RANGES

1. **General principles.** Open NDA and other open ranges are not designed on the absolute worst case. They are designed to capture all properly aimed projectiles within the CofF 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. Compliant ranges such as gallery ranges have given no cause for concern and continue to meet the current minimum MOD level of safety.

2. **Outdoor ranges generally.** In order to contain all predicted shot a range is either No Danger Area (NDA) or has a danger area based on the permitted barrel elevations based on target heights. 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.

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

4. **Limited Danger Area Ranges (LDA).** 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.

5. **Full Danger Area Range.** A Full Danger Area (FDA) range is an open range where hazard is only limited by the elevation of the delivery system and the skill of the firer.

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

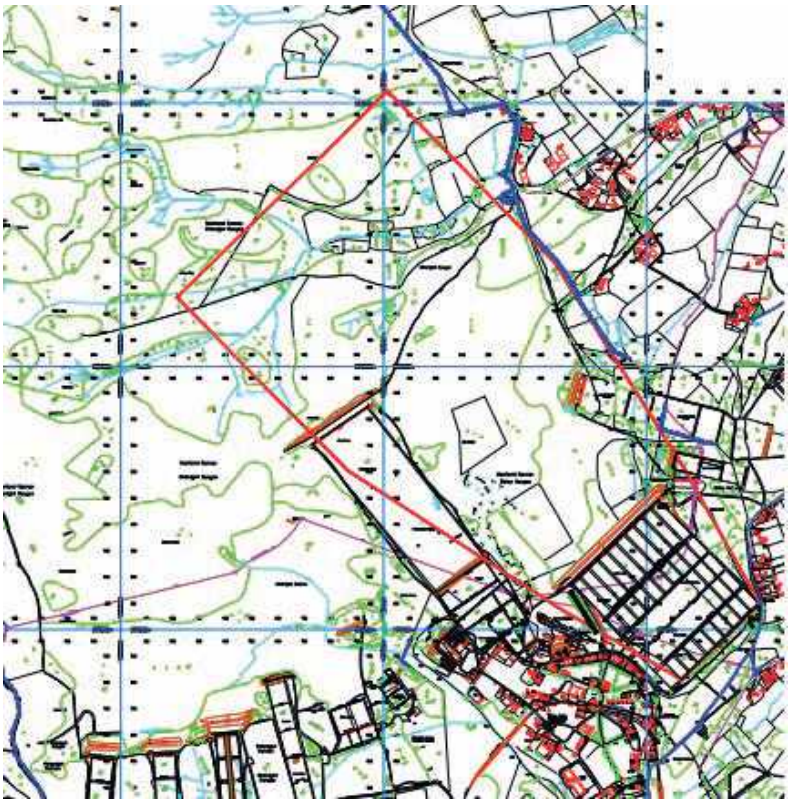


Figure 5. Limited Danger Area Range (LDA) Template

Figure 6. Stickledown Range at Bisley (FDA)

PART 3 - GALLERY RANGES (GR)

Figure 5 - Typical Gallery Range

1. **General.** Gallery ranges are covered in great detail in JSP 403. Providing the key elements are maintained these ranges remain an established safe range solution. New gallery ranges should be constructed to the metric standard detailed in JSP 403. The key elements of a Gallery Range are:

   a. Stop butt and mantlet maintained at 34^0 or greater and at the required height.

   b. Targets presented above and clear of the mantlet.

   c. Firing points raised by 450mm or more.

   d. No hard surfaces on the range floor or within the ballistic envelope.

   e. Regular de-leading of the stop butt and mantlet.

   f. Controlled RDA.

2. **Principles**. The GR design is based on principles that have evolved since about 1909. Current design of the stop butt is based on firing from the 100 firing point on the basis that firearms are normally zeroed from this distance and minimum grouping is achieved before firers move back to the other firing positions.

3. **Target Height**. Targets are placed above the mantlet so that the CofF is raised above the range floor and thereby reduces the incidence of ground ricochet. Some ricochet is inevitable but it will be either stopped by the mantlet or stop butt, or contained within the RDA. To ensure that on existing ranges with 1.8m mantlets where there is the occasional predicted shot passing over the stop butt the rounds will fall within the RDA providing the barrel elevation (Quadrant Elevation) (QE) is limited. For this reason it is necessary to apply a QE restriction as described below.

4. **Limiting QE.** There is a limiting QE max of 70 mils (3.94^0) for GR with 1.8m mantlet as the design allows some rounds to pass over the stop butt. Where the QE max is limited to 70mils (3.94^0), rounds will fall inside the RDA at around 1800m from the target line. With an 40mil CofF the QE max of 70mils equates to a QE tch of 30mils (1.690). It is the QE tch that can be measured on site.

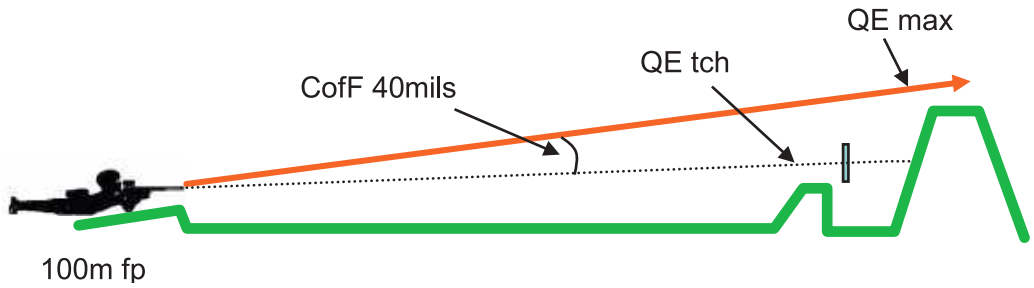
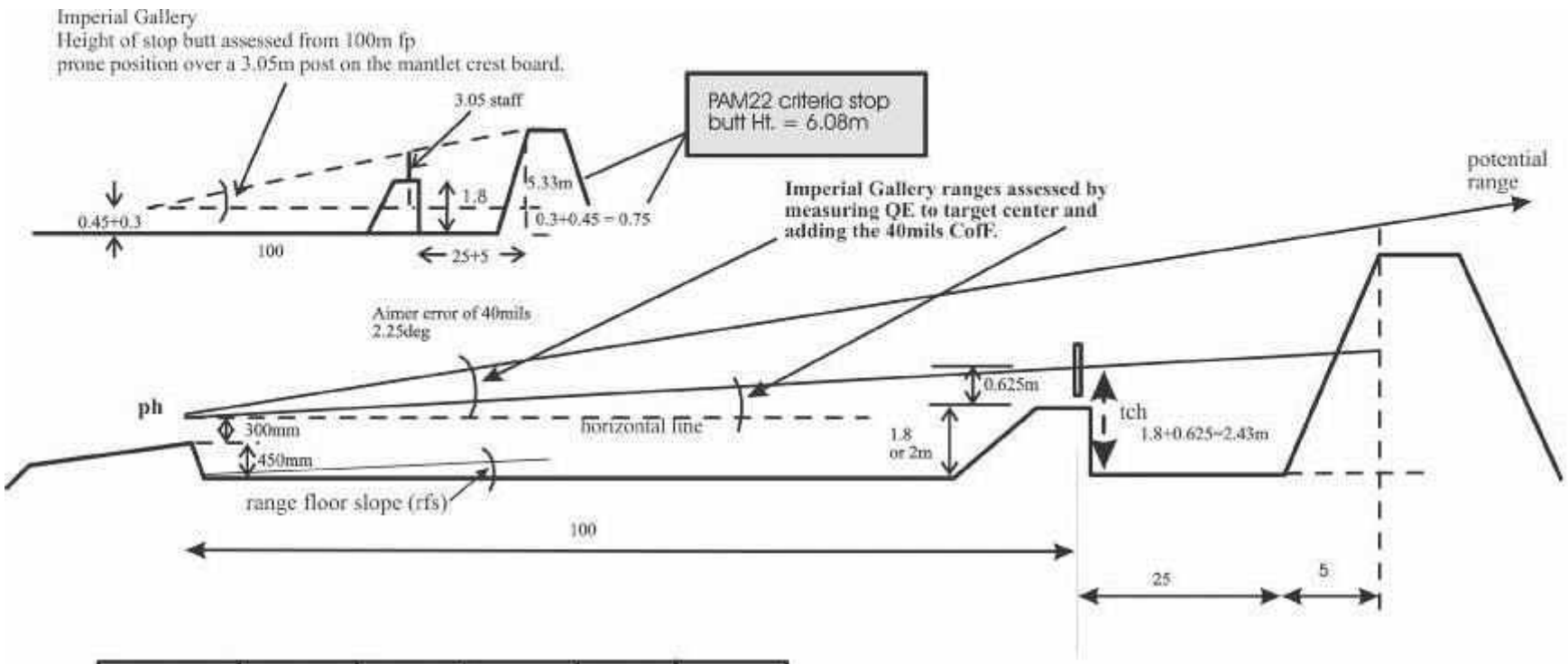


Figure 6 - QE Limitation on a Gallery Range



range floor slope	QE to target centre	range from fp	QE with CofF	range fm fp	range ft target line
-0.5deg	8mils	750m	48mils	1650m	1550m
0deg	17mils	1250m	57mils	1750m	1650m
0.5deg	26mils	1275m	66mils	1850m	1750m
1deg	35mils	1450m	75mils	1975m	1875m
1,5deg	44mils	1600m	84mils	2050m	**1950m**
2deg	53mils	1700m	93mils	2150m	**2050m**
4deg	**70mils**	**1900m**	**110mils**	**2300m**	**2200m**

Note - It is not necessary to assess the range floor slope as this will be relflected in the QE measurement to target centre.

Note; Metricated gallery ranges have a stop butt height assessed by placing a 5m pole on the mantlet crest board. These enhanced stop butts capture the CofF and therefore QE is not an issue.

QE on Gallery ranges

qe.cdr

Figure 7. QE on Gallery Ranges

5. **Stop Butt Purpose**. The stop butt contains most aimed direct shots and low angle ricochets. It also allows the firer and coach to observe the fall of shot. Sand or granulated rubber bullet catchers may also be incorporated into the stop butt behind the target positions for ease of maintenance However, a stop butt is not a mandatory requirement if a 2900m danger area is available and the QE does not exceed 150 mils (8.50). A reduced stop butt is however still useful to observe fall of shot and it will capture the majority of shot fired enabling recovery of the lead. On ranges where the stop butt is less than 25m back from the targets provision must be made to prevent backsplash into the gallery.

6. **Stop Butt Height**. The height of the stop butt is determined by setting a 3.05m boning rod on top of the mantlet and, when viewed from the prone position (worst case), at the 100 firing point, the crest of the stop butt, should not appear lower than the boning rod, along the whole length of the stop butt. Where a GR exceeds the QE restriction, lifting the stop butt and mantlet to capture the CofF may provide a solution. The minimum height for the stop butt boning rod is to be 5m though on existing imperial ranges it may be 3.05m as illustrated in Figure 15-3. It must however be established that the mantlet is the correct height. The height of the stop butt is based on criteria applied from the 100 firing point only for the following reasons:

a. The QE to the maximum target centre height being greater from the 100 firing point than from further distant firing points.

b. The greater deviation of firearms being zeroed at the 100 firing point.

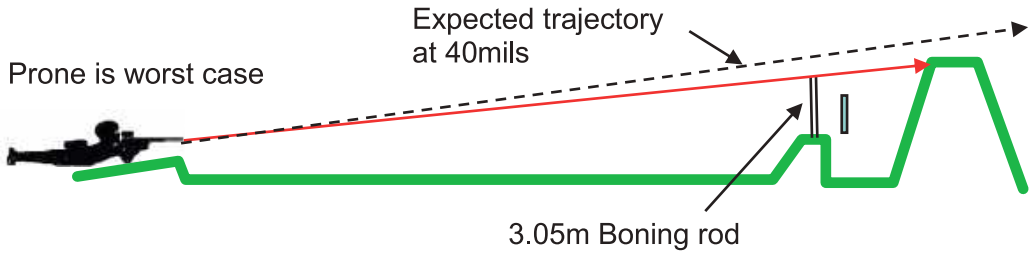


Figure 8 - Determine stop butt height on an old GR

7. **Stop Butt Profile**. The slope of the stop butt face reduces the probability of ricochet from shot fired at the target centre from the 100 firing point. The angle of impact increases from the firing points at greater ranges. The face profile of the stop butt is constructed and maintained at an angle of 600 mils (34^0) to the horizontal (2:3). This ensures the minimum bullet impact angle of 533 mils (30^0) is achieved, which is the minimum angle required to limit ricochet. The rear of the stop butt and its ends should be constructed at the natural angle of repose for the soil type. Stability can be enhanced with geotextiles, geogrids or a combination of the two, and the surface should be seeded to assist stability.

8. **Bullet Catcher or Material Boxes**. A sand or granulated rubber bullet catcher may be formed on the face of the stop butt. With sand, this will help with identifying the fall of shot and with either, will simplify de-leading. An area behind the target is excavated to 500 mm deep and filled with coarse sand or granulated rubber. To assist in maintaining the profile, these boxes may be constructed of timber and set into the stop butt. The height and width of the box in the stop butt is to be such that when a 1.22 m^2 ($4ft^2$) target is installed, at least 0.3 m of material all around it is visible to the firer from the 100 firing point. In mantlets a margin of material should be visible to the firer around the target from the 100m firing point. Granulated rubber should not be placed over the whole stop butt due to the fire risk. It is easier to control a fire in smaller shooting in boxes. Light rubber sheet or shredded rubber tiles may be used to stop granulate jumping out of the boxes following bullet strike. This also helps prevent grass from grass cutters and other debris getting into the granulate.

Figure 9 - Example of rubber granulate shooting in boxes on the stop butt.
(Hessian cover keeps the granulate in)

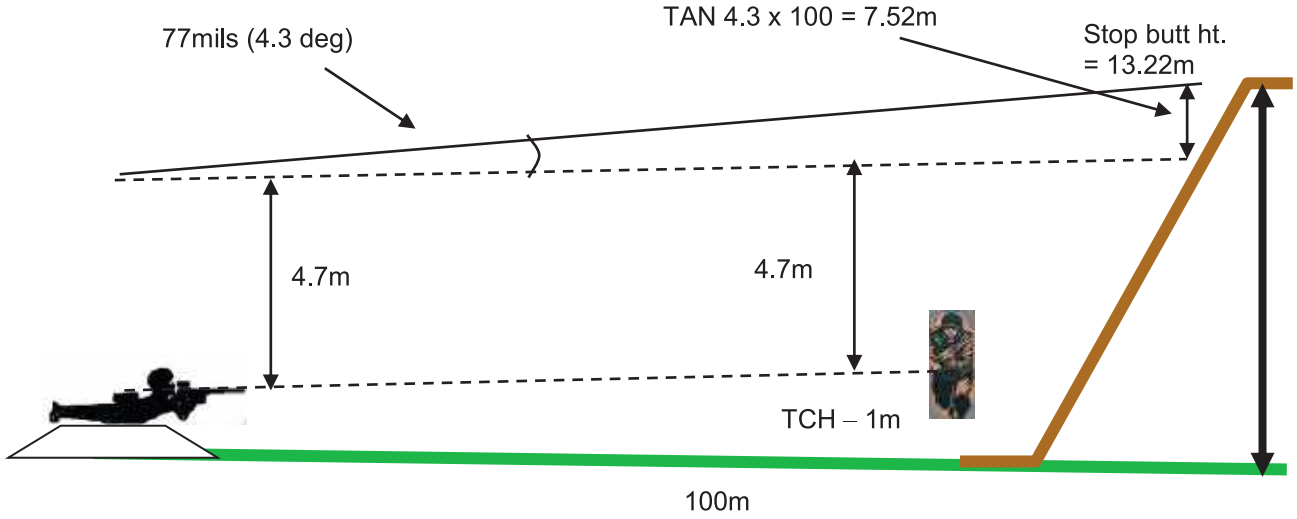
9. **Mantlet Length and Height**. In terms of safety it is the mantlet that determines whether the range is an imperial or metric range. Whenever possible, the mantlet length should be extended beyond the flank targets to protect structures at the ends of the gallery. As a guide the flanks of the mantlet should be in the LofS from the 100 firing point to the flanks of the stop butt. The minimum height of the mantlet is to be 2m. On existing imperial ranges it may be 1.8m. The full minimum height must be visible from all firing points in the prone posture. For mantlets that are higher, it is only necessary to see the minimum height from the crest board down from each firing point, not the whole mantlet. The mantlet and the stop butt height are key factors in justifying confidence in the capture of direct aimed shot and low, long ranging ricochets.

10. **Falling Plate Targets**. Falling plate shooting-in boxes set into the face of the mantlet lower the CofF, which increases the risk of ricochet off the range floor and therefore requires the 2900 m RDA template to be applied. To avoid lowering the CofF, shooting-in boxes may be set into the stop butt between target frames on the normal LofS. However, as this creates a backsplash hazard, the markers' gallery should not to be manned. To fire falling plate practices on gallery ranges without the need to increase the Gallery RDA, falling plate boxes or covers over the steel plates mounted on the mantlet may be used.

PART 4 - OPEN NON STANDARD RANGES

Figure 10 - Flat Range Floor

1. **NDA, LDA or FDA ranges.** The only MOD flat range floors with a limited or no danger area are the few baffle ranges and 25m ranges detailed in JSP 403. In order to operate a safe NDA or limited danger area range it is necessary to apply the traditional and logical criteria to determine safe engagement distances. The traditional method was adopted from PAM 22 for which there is no recorded logic. The logical method uses predicted CofF and ricochet with a margin based on the skill of those using the range added for safety.



Ser	Component	Axis from LofS	Height & width			
			Rimfire		Centrefire	
			Rifle	Pistol	Pistol	Rifle
1	Bullet catcher	Vert (mils/mm) Horiz (mils/mm)	3 + 700 3 + 450	6 + 850 6 + 600	6 + 1500 6 + 1400	1 + 1700 3 + 1400
2	Stop butt	Vert (mils/mm) Horiz (mils/mm)	20 + 2500 30 + 1000	60 + 3500 60 + 2000	60 + 4000 60 + 4300	77 + 4700 60 + 4000

Figure 11. - Traditional Range Designs for a flat range floor

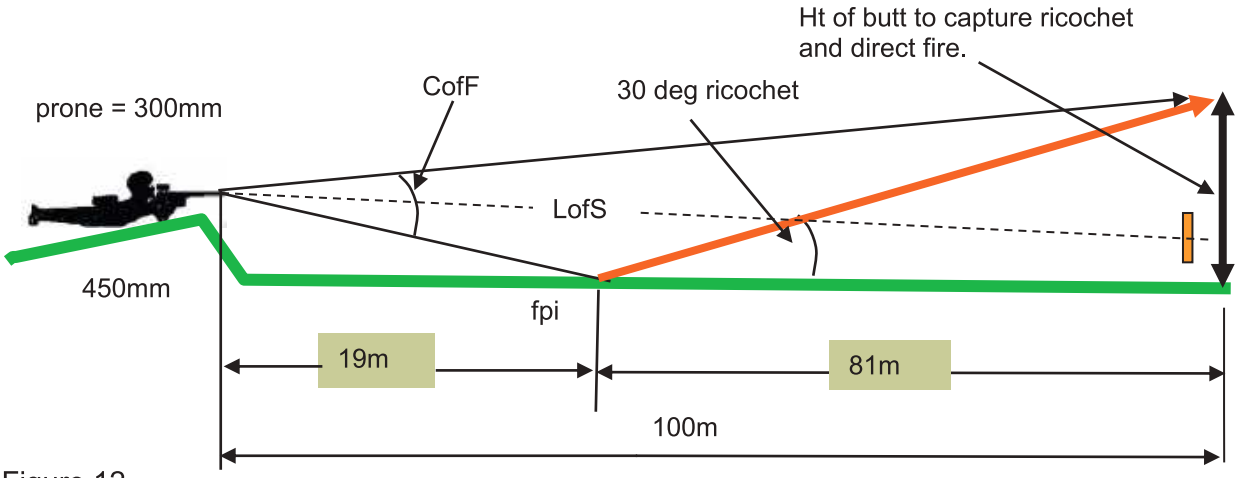


Figure 12. - Logical Range Designs for a flat range floor

2. **Danger Area.** Where it cannot be established that all predicted shot (direct fire and ricochet) is captured an area beyond the butt will be needed as a danger area (LDA or FDA).

3. **Baffle Ranges**. Baffle ranges are used extensively in Germany to reduce the risk of rounds escaping. This is an expensive option that has no guarantee that round will not escape the range.

4. **Hill background.** Some ranges use a quarry wall or natural hill background. Providing the slopes are capture slopes (>56^0) this is a viable option. The height required or maximum engagement distance is calculated as illustrated in Figures 11 and 12 above.

Figure 13. – NDA Range with built in canopy

PART 5 - ENCLOSED RANGES

Figure 14. - A Typical High Velocity Indoor Range

1. **General Description**. Enclosed ranges are constructed to meet many requirements. The main advantage of enclosed ranges is that they provide protection from the elements and external environmental noise can be reduced. The main disadvantage is that noise is more of a problem for range users and firearm emissions become a key safety issue. These disadvantages also affect any range with enclosed or semi enclosed firing points. Enclosed ranges may be constructed to meet specific ballistic requirements and practices. Ranges are at times constructed in tunnels or in existing buildings converted for range use. Proprietary purpose built indoor ranges are available provided in modular sections or constructed on site.

2. **Range Components**. The capture of bullets fired in an enclosed range relies upon defence structures, the sizes of which are deduced from a series of safety distances and angles. The required degree of protection increases with the probability of strike. The structures (safety features) which produce the level of protection are called components. These and their purpose are:

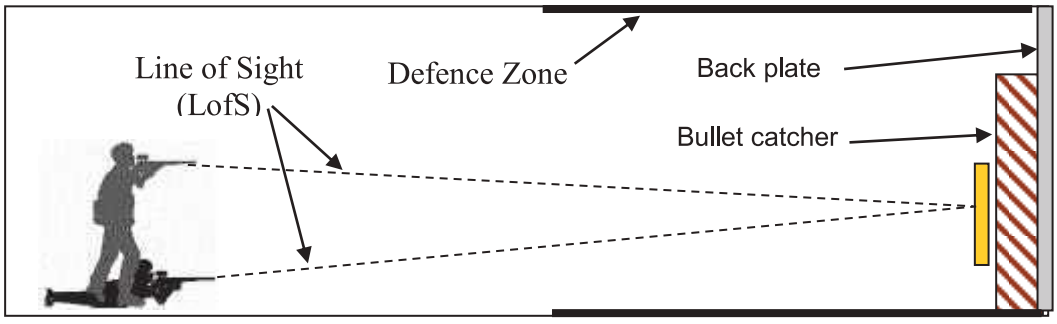
a. **Defence Zone**. The defence zone is the part of a range which may be struck by unintentional shot, ricochet or backsplash. The zone is specifically designed to resist penetration of the occasional single shot.

b. **Backplate**. The backplate is constructed behind and around the bullet catcher, and is designed to capture predicted shot that misses the bullet catcher. Therefore the backplate must resist the penetration from multiple direct fire and ricochet.

c. **Bullet Catcher**. The bullet catcher is designed to stop and contain the majority of direct fire and ricochet and must withstand continuous attrition.

d. **Floor**. The floor of the range is to have a smooth surface free of any protrusion or indentation which could generate a high ricochet or backsplash.

3. **Component sizes**. The data given in Figure 15 below is used to calculate the required sizes of the bullet catcher, back plate and defence zone.



Ser	Component	Axis from LofS	Height & width			
			Rimfire		Centrefire	
			Rifle	Pistol	Pistol	Rifle
1	Defence Zone	Vert (mils Horiz (mils	125 75	200 125	215	215
2	Backplate	Vert (mils/mm) Horiz (mils/mm)	3+700 3+450	6+850 6+600	6+1500 6+1400	n/a
3	Bullet catcher	Vert (mils/mm) Horiz (mils/mm)	3+250 3+250	6+400 6+300	6+450 6+450	1+1700 3+1400

Figure 15 - Sizing components for enclosed ranges from each line of sight

a. Each component may be sized using the LofS to determine the maximum and minimum target centre height to be permitted on the range and all firing postures applicable to that range:

i. Standing 1500 mm.

ii. Kneeling 800 mm.

iii. Prone 300 mm.

b. If a raised firing point is to be used, its height is to be added to the firing posture height.

c. The LofS from all firing postures is projected from all firing distances to target centres. From the line so produced, the distance and angle or angle taken from Figure 15 is struck to determine the height of the appropriate range component.

d. The range component is taken to extend down to the range floor in all cases. Where there are penetrable floors with occupied rooms or services below the defence structure must extend over the floor area concerned.

4. **Bullet Trap**. The bullet catcher must safely stop and contain all correctly aimed shot. There are many variations available. This section covers traditional down range in lane shooting bullet traps where there is an MPI (Mean Point of Impact) behind each target. For practical shooting bullet catchers see JSP 403 Volume 2 Chapter 6. For low velocity ammunition modern environmentally friendly bullet catchers are available and should be used. For high velocity ammunition there are modern trap systems available but only the "Snail", sand and granulated rubber traps have been successfully tested by MOD. There are many bullet catchers available commercially, more for low velocity than for high velocity. Whichever trap system is selected it must meet the following safety criteria:

a. It must be fit for the purpose for which it was intended. It must capture all rounds safely without inducing ricochet or backsplash.

b. Where centre bull targets are used the trap must be able to withstand heavy localised attrition without excessive deterioration. Sacrificial plates can be used in heavy use ranges.

c. The catcher must be easily inspected in depth to provide assurance that penetration resistance is effective.

d. The bullet catcher ideally should capture rounds intact eliminating lead dust problems in the bullet catcher.

e. Impact noise should be minimised.

f. The bullet catcher should require only occasional maintenance and there should be no element that cannot be maintained by range staff.

g. It should be cost effective in use.

Bullet catcher type	Ammo type	Advantages	Disadvantages
Sand	All	- Traditional system Inexpensive - No noise - Fall of shot visible	- Dust in range and catcher (lead & propellant) - Maintenance costs - Lead breaks up - Environmental hazard - Disposal costs - Attrition at MPI
Flat steel plate & Anti - backsplash curtain	Low velocity only	- Traditional system - Inexpensive - Small foot print	- Dust in catcher (lead & propellant) - Lead break up - Cost of Linatex - Fall of shot not clear. - Attrition at MPI
Snail escalator trap	All	- Low cost in use - Minimal maintenance	- Lead break up - Noise - High initial cost - Large footprint - Fall of shot not clear. - Older versions suitable for lead ammo only.
Granulated rubber	All	- Little round break up - No lead dust - No noise - Low maintenance - Low cost in use	- Same footprint as sand - Fine rubber dust on high use ranges. - Fall of shot not clear. - Cover sheet attrition at MPI - Fire risk particularly when not fully maintained
Curtain (Open) Polymer / PVC Compound sheet	Low velocity only	- No round break up - No lead dust - No noise - Very low maintenance - No cost in use - Low cost in use (Target shooting) - Effectiveness visible	- Large footprint - Low velocity use only
Curtain / herringbone Rubber recycled conveyor belt	All	- No noise - Smaller footprint	- Attrition at MPI - Rounds captured in rubber - Effectiveness not visible - Anti backsplash sheet required - High maintenance cost

Table 4 - Bullet Catcher Characteristics

5. **Backsplash**. Care is needed to ensure any structure down the range either stops the bullet or is sufficiently weak to allow the bullet to pass through without great loss of energy. Where a low velocity bullet is decelerated on it's way down range it may not penetrate the anti-backsplash curtain and therefore may bounce back to the firing point. To minimise this hazard targets should be fixed with light material, timber less than 25mm, plastic, cardboard, string, netting or Hessian. Where timber is increased in thickness to capture bullets, be sure there is no chance of a round cutting through the corners of the timber generating a backsplash hazard.

6. **Backsplash Curtains**. Any bullet catcher that may generate backsplash towards the firing point must always be provided with an anti-splash curtain. Only the sand bullet catcher, the Snail Bullet Trap and granulated rubber traps may be used without a curtain. The curtain material is 6 mm thick soft latex rubber or similar material. It is required to resist penetration by a deflected round and to contain backsplash without damage to the rear of the curtain. It is known that where there are more than two layers of this 6mm material, 0.22" ammunition may not fully penetrate presenting a backsplash hazard. Patching in areas of overlap is therefore not permitted. The use of

wadcutter and similar ammunition may render the anti-splash curtain unsafe. These materials are available in a variety of colours, painting proprietary anti splash curtains is not permitted as it may alter the ballistic performance. The anti-splash curtain is clamped to or fitted with hooks and eyelets to hang it onto the pelmet to cover the complete area of the bullet catcher in such a way that deflected rounds or backsplash cannot escape. Alternatively, the anti-splash curtain may be fitted into a timber ply sheet covering only the expected area of impact on or around each target. Curtains should be hung in such a way to enable rotation of worn sheets and ideally shifting the MPI to extend the life of the curtain. The curtain hangs approximately 300 mm in front of the bullet catcher to ensure the rear of the sheet is not damaged by the break up of the rounds on the steel plate. Each sheet overlaps the adjacent sheet by approximately 150 mm ensuring that even if the hanging curtain is not exactly vertical full coverage will be achieved.

7. **Anti-Splash Curtain Repair**. Latex rubber curtain is expensive. It can however have a very long service life, even on a heavily used range. The curtain should be moved around to prevent holing at MPI. Holes in the curtain can be patched **once** with material cut from another sheet and fixed with a suitable adhesive available from the manufacturer. Precautions must be taken when handling lead contaminated sheets. Latex rubber is inflammable and must be kept clear of heat sources such as target lights.

8. **Baffles**. Baffles are used on an indoor range to protect fixtures and fittings from strike and prevent rounds escaping where the walls or roof in the defence zone are not sufficient to prevent penetration by shot. The effect of baffles is however limited. Baffles are generally placed only to prevent direct shot escaping or to protect fixtures and fittings. They will not completely eliminate the danger of ricochet in the range due to the random nature of ricochet angles. The range structure within the defence zone must in all cases be impenetrable to ricochet. Baffles may be vertical or horizontal. They are designed with respect to each firing point and from each firing posture for which the range is designed: standing, kneeling or prone. It must not be possible for the firer to see any item protected by a baffle or to see between baffles which are protecting the defence zone. Baffles protecting the defence zone are designed so that the soffit of each baffle overlaps subsequent baffles by at least 150 mm when viewed as just described. The clear vision height should be maintained below the soffit of each baffle. Baffles will disrupt laminar air flow but are an essential element in a range.

9. **Angled Baffles**. Any baffle in the defence zone within the backsplash distance of a firing point is angled to prevent backsplash and to ensure that strike will ricochet down-range and not towards the walls or roof. Due to the proximity of the hazard and to provide greater backsplash protection, angled baffles should have an enhanced timber cladding.

PART 6 - FIREARM EMISSIONS

Figure 16 – Lead emissions

1. **Lead in Air.** A small amount of Lead dust is generated each time a firearm is fired. Lead is present in the ammunition primer and in the bullet. As a round is a fired, gas containing lead escapes from the ejection port, gas vent and muzzle. Lead dust may also be generated from base burn on uncapped lead bullets and from the rifling in the barrel when unjacketed rounds are used. Lead dust is also generated at the target end of the range if bullets break up on impact with the bullet trap. A small percentage of this dust is airborne contaminate. Effective air handling will move the airborne contaminates clear of the main firing point and provide fresh air dilution down range over other firing points.

2. **Range Managers Responsibilities**. Managers should risk assess each of the indoor ranges in their area to determine the level of exposure to lead in air by monitoring to establish the Operational Exposure Limit (OEL) for that particular range and for each particular use. The lead exposure assessment should take into account the nature of all activities taking place in the range including dry training, inspecting, maintaining, monitoring and cleaning, as well as all shooting practices. The assessment should consider both users and visitors. Personnel such as RCOs, supervisors and coaches, who are employed routinely in the range are potentially at the greatest risk as they may be in the range for extended periods whether or not firing is taking place. Cleaners, and inspectors are likely to be exposed to higher levels of lead for shorter periods

3. **Air Monitoring Requirement**. Full lead in air monitoring is to be carried out in accordance with current CLAW Regulations where the risk assessment indicates that anyone using the range is liable to receive significant exposure to lead and in the following circumstances:

   a. When a new or a refurbished full time use indoor firing range is commissioned.

   b. An existing indoor range has a change of use that may expose users to significant levels of lead.

4. **Air Monitoring**. Air monitoring may be carried out by a specialist contractor. Air filters are placed on the firers and at several points down range during peak maximum capacity firing in the range. The amount of lead collected by these filters is then measured to determine the lead in air levels for that range. A certificate giving the results should be provided and displayed following each measurement of lead in air from air monitoring stating the conditions, if any, under which the range may operate.

5. **Significant Levels of Lead in Air**. If following lead in air assessment of a range indicates that exposure to lead is significant, ie greater than 0.075mg/m^3, then advice should be sought to determine the way forward. Where an assessment finds that there is a significant level of lead at the target end of a range personnel who maintain and inspect the bullet trap shall if not already doing so, undergo medical surveillance.

6. **Unburned Propellant.** In addition to lead dust, a small amount of unburned propellant is expelled from the firearm as it is fired. Short barrel and black powder firearms are particularly

prone to this problem. Air firearms do not generate un-burnt propellant. Providing such dust is not allowed to accumulate in the range it will not represent a hazard. However designs that include joints in the fabric of the range behind which dust may accumulate out of sight is a particular hazard that shall be avoided. Extract systems shall also be specified to take account of this explosive dust.

Figure 17 – Fire damage caused by unsuitable range infrastructure

SAFETY WARNING - Any dust allowed to accumulate in a range is an explosive hazard. All those who need to work in the area of the bullet catcher must be warned of this hazard.

PART 7 - DESIGNING VENTILATION

1. **Design Concept**. The aim of the design should be to provide sufficient fresh air into the range to ensure that lead particles generated on the firing point(s) are taken clear of the breathing zone. It will not be possible to take all lead dust out of the range as most will settle out between the firing point and bullet catcher. The range envelope should be designed in such a way to minimise air turbulence and have surfaces that are easily cleaned.

2. **Design Solution**. Each range will have different problems to address. Clearly the ideal solution is to remove contaminants at source with local exhaust ventilation. Where this might be possible in test ranges with fixed firing benches it will not be possible for variable firing positions on several firing points. A combination of local control (directed airflow) and dilution should be achievable in most circumstances.

3. **Air Flow within the Range**. The ideal air flow is a laminar flow pulled down range with an extraction system rated 10% greater than the inlet producing a negative pressure down range. The optimum design to deliver steady air flows across a single firing point is to bring air into the range through a full cross sectional grill. This is clearly an expensive proposition as such volumes of air will need to be heated. An alternative solution is to provide positional grills behind the firers. Where firing takes place from prone, kneeling and standing positions directional vents may provide the solution. All solutions should ensure there are no "dead zones" or excessive turbulence generated within the range.

4. **Air Speed**. During trials it was observed that the greater the air speed over the firers the more turbulence in front of the firers breathing zone. Optimum air speeds to minimise such turbulence recorded were 0.15 - 0.2m/s. Air speeds of 0.1m/s or less will not provide sufficient fresh air in the range. Air speeds in excess of 0.3m/s may need to be heated. In ranges with more than one firing point it may be necessary to increase the air flow at the rear of the range to ensure adequate air flow over the firing points down range. Complex solutions involving intermediate air intakes should only be considered in ranges that are heavily used on a daily basis. In low use ranges where there is a simple fan input (single or multiple) and simple extract fan (single or multiple) it is sufficient to ensure the fan is inputting air at the firing point and extracting air at the target end. A wet hand or strand of cotton is all that is required to check this. With these simple fans efficiency is not such an issue. Where there is air handling plant, ductwork and filters the inspection of the air handling system should be undertaken by competent mechanical engineers in accordance with the manufactures recommendations.

5. **Air Changes**. Domestic and office designs often revolve around the number of air changes per hour to establish comfortable conditions. In ranges the issues are local air flow and dilution. Air changes can of course be likened to dilution but it will not ensure local airflow over the firing points has been achieved. It is expected that for most ranges air change rates of between 6-10 changes/hr will deliver adequate dilution.

6. **Extraction System**. The air extraction system should provide an air extraction rate that is at least 10% greater than the air input to assist in pulling a laminar air flow down range. The extractor unit(s) will need to handle dust and unburnt propellant safely. Access for maintenance and inspection is essential. Air systems are to be switched on 20 minutes before use of the range and left on 30 minutes after use to ensure the systems are running to optimum capacity and that any residual dust is removed from the system after firing ceases. The extract filter system where fitted must be suitable to hold unburned propellant safely. Replacement instructions must be clearly displayed warning of the hazards presented by filters containing lead dust and unburned propellant. Refer also to Building Regulations Part F for location of the extract.

Much more information on emissions in indoor ranges can be seen at;
http://www.wfsa.net/pdf/WFSA_2005.pdf

PART 8 - ENVIRONMENTAL NOISE

1. **General.** This section provides advice on environmental noise related issues as they relate to outdoor ranges. The Chapter is primarily aimed at those with issues related to noise reduction around ranges. Noise is a particular issue for many ranges that are located close to populated areas.

2. **Sound in the Open Air**. As an observer moves away from a sound source, the sound pressure level diminishes. The rate which this occurs depends on the nature of the source itself and this principle is true as long as the observer is not too close. Most practical situations may be described in terms of two 'ideal' sources: point sources and line sources:

a. Point Source. The sound source is represented by a point and sound is radiated equally from it in all directions. Every time the distance from a point source is doubled, the level decreases by 6dB. A point source, such as a firearm, which produces a level of 130dB at 10m will produce a level of 124dB at 20m. At a distance of 30m, the level will have fallen by 10dB. In other words, when the distance is trebled, the loudness is halved.

b. Line Source. A line source, such as a heavy traffic, which produces a level of 70dB at 10m, will produce 67dB at 20m. For a 10dB reduction, half as loud as the level at 10m, the observer must retreat to a distance of approximately 100m from the source or ten times the original distance.

3. **Attenuation in Open Air**. Attenuation due to distance has already been discussed. Wind and temperature gradients also effect sound. Sound travels faster in air as the temperature increases. The absolute speed also increases with wind speed (downwind propagation). In addition to the effect climate has on sound, there are often buildings or similar objects which lie between the source and the observer and prevent line of sight between them. When a sound wave meets an obstacle like a fence or a building, a proportion of it is reflected, and the rest of the wave carries on past the edge of the obstacle. However, the 'bare' edge of a sound wave cannot sustain itself in free space - the vibrating air molecules at the end start themselves to act like sources and radiate in all directions. The result is, that a sound wave which has passed the obstacle, bends or diffracts round it into the shadow zone behind the obstacle.

4. **Natural & Engineering Controls.** Distance is a simple inverse square law relationship, which at frequencies between 300-600 Hz, would give attenuations of 66 dB and 68 dB at 1500 metres and 1650 metres respectively. Other controls:

a. Ground Absorption. Sound travelling close to grass covered ground is attenuated as follows:

Distance from sound source in metres		Frequency (Hz)			
	37-75	75-150	150-300	300-600	600-1200
	Attenuation (dB)				
1500	4-5	15-0	34-0	45-0	34-0
1650	5-0	16-5	38-0	50-0	38-0

Table - 5 Ground Absorption

b. Trees. When trees are sufficiently dense, so as to mask a highly visible object at 60 metres, the following attenuations apply:

Frequency (Hz)	37-75	75-150	150-300	300-600	600-1200
Attenuation (dB)	2	3	5	6	7

Table - 6 Attenuation from trees

c. Earth Banks. Although these block the direct path of sound between firearm and complaint area, earth banks have a complicated effect:

5. For example, the attenuation due to banks at 3 metres and 30 metres from the firearm would be 18dB and 9dB respectively. Should the side of the bank nearest the firearm be vertical the above attenuation would be reduced.

6. A bank may however cut out, or reduce, the sound travelling close to the ground and hence reduce the ground absorption by about half. To gain 18dB attenuation by means of a bank 3 metres from the firearm, one could therefore lose between 22-5 and 25dB attenuation in lost ground absorption. This effect is uncertain, especially where the ground cover is bushy rather than grassy.

7. The effect of a bank and its likely effect on ground absorption depends upon many factors. The effect of ground absorption is lost as soon as sound waves are lifted into the air. However a near vertical wall covered with shrub will absorb much of the sound. This principle is used extensively on German Autobahns passing close to urban areas. If large smooth backs are used they have the ability to lift the sound waves off the ground and provide the potential for them to travel further. Crops and woods provide effective ground absorption, the taller the crop the more effective it is.

	Frequency (Hz)				
Bank sited at 3m from firearm	37-75	75-150	150-300	300-600	600-1200
Attenuation due To bank (dB)	9	12	15	18	21
Loss of ground absorption, in dB, due to bank:					
at 1500 m	2.3	7.5	17	22.5	17
at 1650 m	2.5	8.3	19	25	19

Table - 7 Attenuation from earth banks

8. **Theoretical Prediction**. An example is given below of a theoretical prediction of sound attenuation, at distances of 1500 metres and 1650 metres from a 7.62mm firearm. As high frequencies, ie above 1000 Hz, will be unimportant in the case of small arms, the octave 300-600 Hz is used in the example. Attenuation for sounds in the 300-600 Hz octave:

	See paragraph as under	Distances from Firearm			
		1500 metres		1650 metres	
		Without Bank	With Bank	Without Bank	With Bank
Distance	6a	dB 66	dB 66	dB 68	dB 68
Ground absorption	6b	45	22.5	50	25
Trees	6c	6	6	6	6
Earth bank 3 m from firearm	6d	-	18	-	18
Wind and Turbulence (assumed 32 kph)	6e	-8	-8	-8	-8
Temperate and Relative Humidity	6f	3	3	3	3
TOTAL Attenuation		112dB	107.5dB	119dB	112dB

Table - 8 Attenuation for sounds in the 300-600 Hz octave

Note:
The sound peak pressure, at the firearm, for 7.62mm is 159dB. From the table above, it can be seen that at 1500 metres from the firearm the sound peak pressure would be: a. With Bank -(159-107-5)-51-5dB. Without Bank—(159-112)-47dB. These levels would be barely detectable in an average room and certainly not outside in a normal urban environment. It is emphasised that while these figures are theoretical, they were found to agree, within plus or minus 10%, with sound measurements taken in a similar situation.

SER	FIREARM/AMMUNITION	EAR POSITION									
		FIRER		LOADER		INSTRUCTOR OR ADJACENT PERSONNEL					
						0.3m to Side		1.2m Side		3.0m Side	
		dB	ms	dB	ms	dB	ms	dB	ms	dB	ms
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
1	7.62mm Live										
	0.3M above Ground	160	5.0	-	-	-	-	-	-	-	-
	1.5M above Ground	151	0.9	-	-	169	0.5	160	0.5	155	0.5
	7.62 Blank	150	10.0	-	-	-	-	-	-	-	-
2	5.56mm Live	158	-	-	-	-	-	-	-	-	-
3	Colt Armalite/5.56mm Live	151	1.0	-	-	165	1.0	155	0.5	153	0.5
4	9mm Live	157	1.0	-	-	162	1.0	154	0.5	151	0.5
5	7.62mm Live	162	-	-	-	-	-	-	-	-	-
6	Shotgun/12 bore	155	5.0	-	-	-	-	-	-	-	-
7	Pistol/0.38 inch	157	5.0	-	-	-	-	-	-	-	-
8	Pistol/9mm Live	157	1.0	-	-	-	-	-	-	-	-
9	Rifle/0.22 inch	138	2.5	-	-	-	-	132	2.5	-	-

Table – 9 Measurements of peak pressure leves (db) and pulse duration (milliseconds) for typical firearms systems

Note:
The pulse duration is the total time taken for the pressure fluctuations to decay by 20 dB from the peak pressure level.

Frequency Analysis - SA 80 5.56mm Ball.								
Hz	63	125	250	500	1000	2000	4000	8000
dB	127	138	140	145	151	144	147	145
SA80 5 Rounds Single Shot.								
Max Peak		158	157	157	156	157		
IEL		-	143	143	143	144		
SA80 Rapid Fire.								
Max Peak		158	158	158	157	158		
IEL		145	144	144	144	145		
Frequency Analysis - GPMG 7.62mm Ball.								
Hz	63	125	250	500	1000	2000	4000	8000
dB	129	140	148	148	148	150	150	150

Table 10 - Noise survey results for a typical centrefire indoor tube range

IEL - Impulse Exposure Level.

Useful links:

HSE Noise Protection - http://www.hse.gov.uk/pubns/indg362.pdf

HSE Noise at Work - http://www.hse.gov.uk/noise/

The Noise Org - http://www.noisenet.org/Noise_Enviro_intro.htm

Figure 19 - Ear protection warning notice

PART 9 - INSPECTION & MAINTENANCE

1. **General**. The proper maintenance of all land ranges is an essential requirement, both to ensure the maximum benefit for club members as well as to ensure that the safety features of the range design are kept up to the standards set by the NRA. A methodical system of regular planned maintenance and regular inspections is required, along with an emergency repair system to cover abnormal wear caused by intensive shooting or adverse weather conditions.

2. **Frequency**. Proper maintenance is dependent upon close observation of range structures 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 Staff 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.

3. **Range equipment.** Some range equipment, such as electric targets and their control mechanisms as well as the communication systems, is normally maintained and repaired or replaced under contract arrangements. It is the duty of the club to maintain such equipment in accordance with the instructions issued by the supplier and to ensure that contract repair and maintenance is carried out properly and at the correct intervals.

4. **Range boundary.** The club is responsible for ensuring that other items, such as boundary and Byelaw notices, which are essential for the safety of the range, are correctly maintained and regularly inspected.

5. **Pollution control.** Pollution control measures form part of the essential maintenance of ranges to keep them up to the standards of safety required by the environmental agencies. De-leading of sand filled bullet catchers is to be carried out and the waste sand disposed of in accordance with current regulations for contaminated waste. Measures relating to lead fumes, dust and particles in indoor training ranges and indoor ranges are covered in detail in JSP 403 Chapter 30 of Volume II and should be followed. Methods of cleaning should not create a risk from lead or unburned propellant to the cleaners or any other persons in the area, nor should they allow the spread of any contamination.

6. **Gallery Range**. The effects of weathering, soil movement and attrition will cause changes in the range profile. Range inspectors must monitor this and remediate when necessary.

7. **Bullet Catcher**. The detailed requirements for maintaining the bullet catcher sand, granulate and de-leading are given in JSP 403 Chapter 2.

8. **Mantlet Scooping**. Low shots can cause deep scooping to the front of the mantlet in line with the targets. This can generate high ricochet and may allow shot to penetrate through the mantlet to strike target frames. Maintaining the mantlets correct profile is essential. Where scooping occurs the range configuration should be checked, especially target clearance above the mantlet. Should the configuration be correct, shooters need to be made aware that they should be aiming correctly and should avoid low shot. As a final resort, timber or shredded rubber/polymer blocks may be used to minimise the maintenance effort though minimum target clearance must be maintained .

9. **Gallery Range Inspection.** The following areas are considered during a compliance check:

   a. Authorised firearms, ammunition and practices.

   b. Firing point dimensions, construction, lane identification, alignment and profiles.

   c. Visibility of required mantlet face from all firing points.

   d. Mantlet profile, height and width.

e. Full exposure of all targets from all firing points, spacing identification and target centre height.

f. Minimum clearance over mantlet crest board.

g. Minimum clearance over Hythe Frame.

h. Stop butt alignment, distance from target line, size and profile.

i. Falling plate target position and construction, if applicable.

j. Quadrant Elevation to target centre. (CofF then added to determine max QE).

k. Template alignment.

10. **Enclosed Ranges**. Inspection and maintenance of enclosed ranges used for firing between the annual and independent inspections the club is to ensure the following conditions are maintained:

a. The cleaning regime is effective. The cleaning regime must ensure there is no accumulation of dust in the range. Any visible dust will contain both lead and unburnt propellant.

b. There are no areas to harbour dust. Equipment, material, apertures or areas in the structure where dust may gather out of sight are to be avoided.

c. The bullet catcher is maintained to ensure backsplash will not result from attrition of the trap, a build up of bullets or bullets captured in the anti backsplash curtain where fitted. Cleaning the bullet trap including any anti backsplash curtain is to be undertaken only by competent personnel or specialist contractors.

d. The ventilation system, when fitted, works correctly and filters (where fitted) are checked and maintained at the intervals recommended by the manufacture by contractors appointed by the local works officers. Any change in use of the range or any increase in the amount of dust generated the RAU is to initiate a further risk assessment to determine if this results in a change in the level of lead exposure.

11. **Dust**. The level of dust in the range is a matter of observation. Any dust generated from the firing of firearms must be considered a hazard from lead and unburnt propellant. Where this dust is gathered such as in a vacuum cleaner bag or permitted to accumulate, it becomes an explosive hazard. Only authorised spark free vacuum cleaners are to be used.

12. **Confined Spaces**. Inspectors and those maintaining the range may need to work in tubes and behind anti-splash curtains to complete their work. In such cases inspectors and contractors should refer to the local Authorised Person (AP) Confined Spaces. The risk assessment will also determine what Personal Protection Equipment (PPE) will be necessary. The club should ensure maintenance works and inspectors ensure all potential confined spaces are identified by an AP.

13. **Scope**. Maintaining a clean range is the single most effective way to ensure that the risk of exposure to both lead and unburnt propellant are minimised. This section refers to all types of enclosed ranges including tube, test ranges and ranges with enclosed or semi enclosed firing points. Ranges where dust from live firing is allowed to accumulate in the working areas, firing point and on surfaces down range due to inadequate cleaning, will potentially expose users to significant levels of lead in air and an explosive hazard. Local works inspections should undertake the necessary assessment to ensure Dangerous Substances & Explosive Atmospheres Regulations (DSEAR) requirements are met.

14. **Frequency of Cleaning**. The frequency of cleaning will be dependent on club risk assessment and how the range is used. Ranges used only one or two evenings a week may need only a weekly clean. Ranges used more frequently and where more rounds are fired may need cleaning after each use. The aim is to ensure there is no build up of dust in the range working areas and this is a matter of observation. Factors that will influence the frequency of cleaning necessary to keep the work areas of the range free of visible dust include:

a. The type of ammunition fired, e.g. centrefire pistols firing unjacketed ammunition will create a need for more frequent cleaning than rimfire rifle. Pistols eject a considerable amount of unburnt propellant and unjacketed ammunition will create more lead dust than jacketed.

b. The frequency of use and number of rounds fired.

c. The efficiency of ventilation and extraction.

d. The porosity of surfaces down range.

15. **Cleaning Methods**. So as neither to create a risk from lead and unburnt propellant to cleaning staff or other personnel nor to spread contamination, cleaning the range ceiling, floor and walls, and adjoining rooms is to be by damp sweeping or, preferably, by a vacuum cleaner approved specifically for indoor ranges and used in accordance with the manufacturer's instructions. Dry sweeping and dusting is strictly forbidden.

16. **Routine Cleaning**. Cleaning the range between deep cleans should only be undertaken by staff with adequate PPE and who have received sufficient training on the hazards in the range and use of the PPE. It is essential to ensure the firing point and the area behind and directly in front of the firing point is kept clean and free of visible surface dust. Where it is necessary for firers to move forward to targets, the range floor is also to be kept free of dust. Routine cleaning should not include confined spaces or restricted areas such as that between steel plate and anti splash curtains. Where there are small tubes (<600mm diameter) routine cleaning should extend as far as possible into the tube with wet wipe without entering the tube. Routine cleaning should include wet wipe of all exposed surfaces to remove any dust and removal of any lead or debris build up in the trap area. Spark free vacuum cleaners may be used for the range floor and dependant upon type, vertical surfaces in the range. All dust collected in authorised vacuum cleaners is to be disposed of as a hazardous waste. Young persons must not undertake any cleaning in the range where lead dust may be present. Routine cleaning should not include confined spaces or restricted areas such as that between the steel plate and anti splash curtain except in the following circumstances:

a. Where permanent staff ensure there is no build up of dust in the range and trap area by cleaning all surfaces after each shoot or regularly enough to ensure no accumulation of dust on any surfaces.

b. Where during the monthly inspections a build up of lead is identified as generating a potential backsplash or ricochet hazard or preventing the anti splash curtains from hanging freely.

See also: *http://www.wfsa.net/pdf/WFSA_2007.pdf*

NATIONAL RIFLE ASSOCIATION

CODE OF PRACTICE FOR SAFE USE OF NATIONAL RIFLE ASSOCIATION (NRA) AND ASSOCIATED CLUBS' RANGES

Issue 1 – Sept 2018


#NRAUK

PREFACE

This Code of Practice is Produced by the National Rifle Association of GB for the guidance of Range Managers of the NRA and the managers of affiliated clubs. It is to be used in conjunction with the NRA Handbook, MOD's JSP 403 and the Range Managers Guide to ensure the safe use of ranges.

Codes of Practice are considered to be of "Special Legal Status" not legally binding but the courts will expect an equivalent or more appropriate standard to be followed.

The detail in this CofP represents existing best practice and when applied to specific range facilities will provide a level of safety comparable with that accepted by the MOD. No range can be entirely safe due to the nature of ballistics and the wide range of competence of those engaged in shooting activities. The author and NRA disclaim any responsibility for any accidents or incidents deriving from shooting activity however caused.

Compiled by Maj (Retd) F S Compton MBE for the NRA with advice from experienced NRA staff and members. All detail contained in this CofP is based on the ballistic safety principles contained in JSP 403.

Record of changes

Name	Date	Change detail

JSP 403 - CONDITONS OF RELEASE

1. This information is Crown copyright and the intellectual property rights for this publication belong exclusively to the Ministry of Defence (MoD).

2. The guidance contained in this JSP relates solely to MoD weapon systems, practises and training procedures. It is not intended to be of general application and the MoD accepts no liability in the event that third parties suffer any loss as result of following any guidance contained herein.

NATIONAL RIFLE ASSOCIATION CODE OF PRACTISE

Contents

ABBREVIATIONS

BS	British Standards	NRA	National Rifle Association
CGR	Converted Gallery Range	NSRA	National Small Bore Association
CofF	Cone of Fire	RCO	Range Conducting Officer
CofP	Code of Practice	RDA	Range Danger Area
CSR	Civilian Service Rifle	SSS	Safe Shooting System
EEC	European Economic Community	UK	United Kingdom
ERV	Emergency Rendezvous Point		
H&S	Health & Safety		
JSP	Joint Service Policy		
m	Metre		
ME	Muzzle Energy		
MLAGB	Muzzle Loaders Association GB		
MOD	Ministry of Defence		
MV	Muzzle Velocity		
NGB	National Governing Body		

PART 1 - INTRODUCTION

The ranges used by NRA members and Affiliated Clubs may be those operated by the NRA at Bisley, Affiliated Club Ranges or MOD ranges. The ranges at Bisley may also be used by the military for training and competition, police for training and commercial organisations for trialling, testing or demonstrating products. In addition there may be corporate or guest days where novice shooters are invited onto a range.

The only way to ensure all rounds fired are contained on an open range is to provide a full energy danger area 360 degree around each firing point. Even in this situation the safety of those on the range is not guaranteed. Only by a system of controls, clear range orders, tight supervision and effective management, which reduce the level of risk to a level that is as low as reasonably practicable for those on the range and beyond the range boundary can a range be assessed as suitable for use.

The Range Danger Areas (RDA) illustrated in JSP 403 are possible only by limiting the barrel elevation by a prescribed system of training and in the case of Gallery ranges, by lifting the Cone of Fire (CofF) to minimise the incidence of ground ricochet.

All novice shooting should be undertaken at the shorter ranges (25m) with one to one supervision in order to develop the ability to shoot a tight group whilst providing a suitable stop butt to capture any wide shot or ricochet. Many accidents happen when a novice shooter experiences a stoppage and lifts his firearm to clear it. This and similar problems must be resolved by effective familiarisation with the firearm prior to live fire practices and close supervision during live firing until assessed as competent.

Once a member becomes proficient with his / her firearm, shooting over longer distances becomes permissible as by this stage complete familiarisation with the sighting and firearm handling has been achieved. This incremental progression developing the skill to group at increasing distances from 25m to 50m, 100m 200m etc will provide the confidence and competence to engage targets at greater distances without ground strike (ricochet) or excessive barrel elevation.

This Code of Practice, the NRA Handbook that covers competition shooting, the Range Managers Guide that illustrates the ballistic factors that affect range safety and JSP 403 will provide range staff with the information required to deliver a safe range.

PART 2 - FACTORS AFFECTING RANGE SAFETY

1. Safety on ranges is dependent upon several factors both general and ballistic:

    a. **Safe People** - The skill of the firer and level of supervision.

    b. **Safe Equipment** - Accuracy of the weapon & quality of ammunition.

    c. **Safe Practice** - The shooting practice and procedures.

    d. **Safe Place** - Design & maintenance of the range.

    e. **Safety Assurance –** Range management & inspection.

2. Ballistic factors that can influence the safety on a range:

    a. Cone of Fire (CofF), accuracy of the firearm & firer.

    b. Ricochet.

    c. Backsplash.

    d. Penetration of range structures. (Hidden Attrition)

    e. Trajectory to target.

3. Other influences on range safety include:

    f. Firearm emissions.

    g. Rate of attrition of range structures.

    h. Effective inspection of ballistic elements.

    i. Range maintenance and management.

    e. Environmental issues.

PART 3 - THE NRA SAFE SHOOTING SYSTEM

1. **Safe Person.** The safe person is competent in the use of firearms and ammunition and demonstrates that capability at all times. The live firing elements of NRA probationary course are conducted under the supervision of a competent person at a ratio of 1:1, which provides training and mentoring that imparts the knowledge and skills that underpin competency. The NRA Certificate of Competence provides an auditable record that the responsible officer of the club, normally the Chairman, has satisfied himself that, at the time of certification, the shooter has the ability to use firearms and ammunition safely.

2. **Safe Equipment.** The individual shooter is responsible for ensuring:

   a. That the chosen firearm is serviceable and properly maintained.

   b. That the ammunition employed in combination with the firearm results in performance within muzzle velocity (MV) and muzzle energy (ME) restrictions for the range.

   c. That the combination of firearm and ammunition is safe and suitable for the circumstances in which it is being used.

The NRA Rules of Shooting clearly define the parameters for firearms that may be used in each Shooting Discipline.

3. **Safe Practice.** NRA RSOs and qualified NRA RCOs are responsible for the safe running of ranges including those belonging to MOD. Additional qualifications are required if pistols, moving targets, CSR events, target shotguns, muzzle loading firearms, firearm/ammunition combinations developing a ME greater than 4500 Joules or event-specific courses of fire are being used. The NRA Rules of Shooting contain regulations detailing the conduct of shooting for each of its Disciplines.

4. **Safe Place.** A safe place is one in which the controls that are necessary to enable shooting to be conducted safely have been identified by a site specific risk assessment and implemented through Range Standing Orders. All MOD and Bisley ranges have site specific Range Orders which must be complied with at all times. It is one of the responsibilities of the NRA RCO to ensure compliance by shooters under his control. NRA Bisley and MOD ranges are maintained regularly and are subject to regular inspection.

PART 4 - RANGE RISK ASSESSMENT

1. The Risk Assessment covered in this CofP relates to the range only and not the areas beyond the ballistic envelope or the common risks such as trip hazards and steep drops. Only those managers with intimate knowledge of their range and the surrounding areas are able to produce an effective assessment of the risks. Clear understanding of how the range and the areas beyond are used is essential to complete an effective Risk Assessment. Risk Assessments should cover range users, range staff, visitors, trespassers and the public around a range. Risk Assessments need to be reviewed at least annually and when there are changes to range use or the use of the areas around the range.

2. The NRA and affiliated clubs have a duty of care to people on the ranges, and those who might be affected by clubs' actions on or around ranges under the law of Occupiers' Liability. The club's duty is to take reasonable care to ensure that the visitor / user will be safe at all times. The duty of care also extends beyond those invited or permitted to be on a range, e.g. trespassers, or a member of the public adjacent to a range, if:

a. The club is aware of the danger or there are reasonable grounds to believe that it exists.

b. The club knows or has reasonable grounds to believe that the other people are in the vicinity of the danger concerned or that they may come into the vicinity of the danger.

c. The risk is one against which the club may reasonably be expected to offer other people some protection.

3. When assessing the risks associated with range activity, the level of protection afforded must take into account both the likelihood of injury and the seriousness of the injury or damage to property. Where such risk exists the club has a duty to provide an appropriate level of protection. In most cases, the duty of care can be discharged by taking all reasonable steps to give warning of the danger concerned and, where necessary, to discourage persons from incurring the risk. Essentially, the duty of care arises if it can be established that it was reasonably foreseeable that injury or damage may be suffered as a result of the club's act or omission to act and that the imposition of the duty of care is just and reasonable. Personnel, civilian or military, should not be given access to a club range until they have received relevant health and safety information. Where access can be controlled, Range Managers are to set up a local procedure to ensure that all relevant safety information is absorbed and understood before access is authorised.

4. The category of user on a range will dictate the level of risk to be assessed. On ranges where only competent marksmen or bench fired weapons are used the risk of a misdirected shot will be low. However on ranges where corporate days are hosted and practical shooting takes place the risk of a shot leaving the range or causing injury on the range will be considerable.

PART 5 - CONTROL OF ACCESS

1. **General.** This section specifies the various measures available to control access on open ranges. The method best suited to a particular site will become apparent during 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 requirements 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 range boundary and a Range Danger area boundary, warning triangles should be used on the outer boundary indicating "Danger Shooting Range" 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.

2. **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.

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

a. Nature of the hazard and the degree of risk.

b. Extent of public access. - Authorised, unauthorised, children.

c. Ground conditions - practicalities of constructing a fence.

d. Possible overreaching the fence from trees or ground.

e. Possibility of ballistic damage – likelihood of the fence being shot away.

f. Whether animals or bird life will be caught in the fence.

4. **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. Three strand fences or marker posts may be used to denote particular areas. 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 club

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.

5. **To Discourage Access**. In areas out of sight to the RCO and in areas where occasional public activity may be expected, a fence to discourage access should 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.

6. **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.

7. **To Provide Security**. Security fences are normally 2m high with canted top section. These are required where weapons or ammunition are to be stored.

8. **Boundary Signs**. Ranges 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 to prohibit and warn those at risk of the hazards. When it is impracticable to use signs within a range 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.

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 range areas. Current legislation, on which safety signs policy is based, is The Health and Safety (Safety Signs and Signals) Regulations. 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.

9. **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. Boundary signs should be inter-visible normally at 100m 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 club land between the club boundary and any range danger area, warning signs with "Caution Ranges" 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.

10. **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.

11. **Range in Use Flagging**. The range in use flag is hoisted to indicate that the range is in use by the club or MOD. 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.

12. **Butt Flag**. Used to indicate safe access from and into the butts.

13. **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:

a. **Byelaw**. The local byelaw is a detailed explanation of the rights and measures by which a club may legally control access to its property. Byelaws take time to come into force due to the consultative process between the local authority and local interest groups. 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 described below:

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

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

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

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

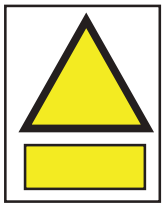
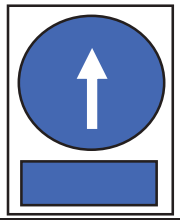
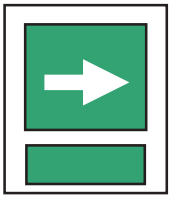
v. Fire. (Symbol at least 50% of the area of the sign).

c. **Demarcation Posts.** When it is not practicable to sign an area where two levels of risk exist within a range, 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 club 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. 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. Notices are not to be used instead of safety signs but may supplement them.

f. **Night Signing**. Although red lights are used when a range 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 range area should be in reflective paint. There is no requirement to provide additional signs that a range area is used at night.

				
Prohibition	Warning	Mandatory	Safe condition	Fire
Range Danger Area	Warning Deep water	Ahead only	ERV	

Safety Signs (Examples)

PART 6 - RANGE SAFETY INSPECTIONS

1. All ranges should be inspected by a competent person at least annually. For those ranges where there is very heavy use inspections will need to be conducted more frequently to ensure they remain safe. A formal inspection report should be used specific to the range type to ensure all key elements of a range are inspected for attrition or for evidence of misuse. A specific to range check list should be prepared for each range. Example inspection reports are provided within JSP 403.

2. Inspections should ensure the ranges are being used in the way intended by focusing on the key elements of administration and structure.

3. Evidence of range administration and documented records are key and should consist of:

    a. Range authorisation document detailing authorised firearms, firing positions and practices.

    b. Risk Assessment - current, reviewed within 12 months.

    c. Range Orders - includes weapons authorised and any restrictions on the range.

    d. Range log being completed correctly with ammunition quantity and type used.

    e. Range Safety Certificate

4. The range structure must be inspected for ballistic damage:

    a. Check for evidence of impacts beyond the expected CofF and investigate cause.

    b. Stop butt or bullet catcher - well maintained to profile and free from a build-up of lead.

    c. Attrition at areas of main impact including hidden attrition behind protective materials.

    d. Ensure there are no backsplash or ricochet inducing surfaces exposed to firing points.

    e. Check any anti back splash measures remain effective.

    f. Indoor Ranges- check air flow has negative down range pressure.

    g. Indoor Ranges- check for any build up of dust in the range (explosive hazard).

5. Access control must be effective and maintained:

    a. Check flags, barriers, fences & signs.

    b. Review public use on and around the range.

PART 7 - MANAGING RANGE USE

1. **Range Records**. Range managers should be aware of all users authorised to use the range and the firearms they intend to use. All shooting activity should be recorded in the Range Log including ammunition type and number of rounds fired. This log is then used following an incident and provides range managers with an estimate of the amount of lead in the stop butt or bullet trap.

2. **MOD Ranges**. The MOD requires all civilian organisations using military ranges to have an auditable system of training based on a specific risk assessment. In response, the NRA has developed a Safe Shooting System (SSS), which has been approved by the MOD. All clubs affiliated to the NRA who use military ranges must adopt the NRA SSS and each civilian shooter, other than those under one-to-one supervision, must have a certificate of competence signed by their Club Chairman.

3. **Other Codes**. Organisations affiliated to other NGBs with existing MoD-approved Codes of Practice (BDS, CPSA, MLAGB, NSRA) are not required to follow the NRA SSS when using MoD ranges. However, other groups will need to adopt the NRA system or have their system approved by the NRA.

4. **Range Maps**. All outdoor ranges with a danger area and controlled range boundary should have accurate maps illustrating the extent of the danger area and the location and type of control measures.

5. **Environmental issues**. Ranges operators must consider the effect of lead, carbon monoxide, un-burnt propellant and noise on the immediate and surrounding environment. An environmental impact assessment should be carried out before any range is first authorised for use. The principal environmental concerns on ranges are those which have a potential impact on the health, safety and well-being of range staff, range users and the general public who access the range or live nearby. The main issues for outdoor ranges are lead contamination and noise. The main concentrations of lead contaminants are the stop butts and bullet catchers, both indoor and outdoor. These issues are covered in part in the Range Managers Guide and more detail can be found in JSP 403. All those exposed to firearm noise on a range should wear suitable hearing protection. Measures for the attenuation and containment of noise on indoor and enclosed ranges are addressed in the Range Managers Guide and Chapter 31 of JSP 403 Vol.2. Firearm generated impulse noise when measured at the boundary of an open range is not to exceed the maximum level of impulse noise permitted under the current Noise at Work Regulations.

6. The management of waste on ranges is to comply with the Environmental Protection Act (EPA) requirements.

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