Defence
Safety Authority

DSA 03.OME Part 3 (JSP 403)- Defence Code of Practice (DCOP) and Guidance Notes for Ranges (Formerly Volume 3 Part 2)

Defence OME Safety Regulator

DOSR

DSA VISION

Protecting Defence personnel and operational capability through effective and independent HS&EP regulation, assurance, enforcement and investigation.

PREFACE

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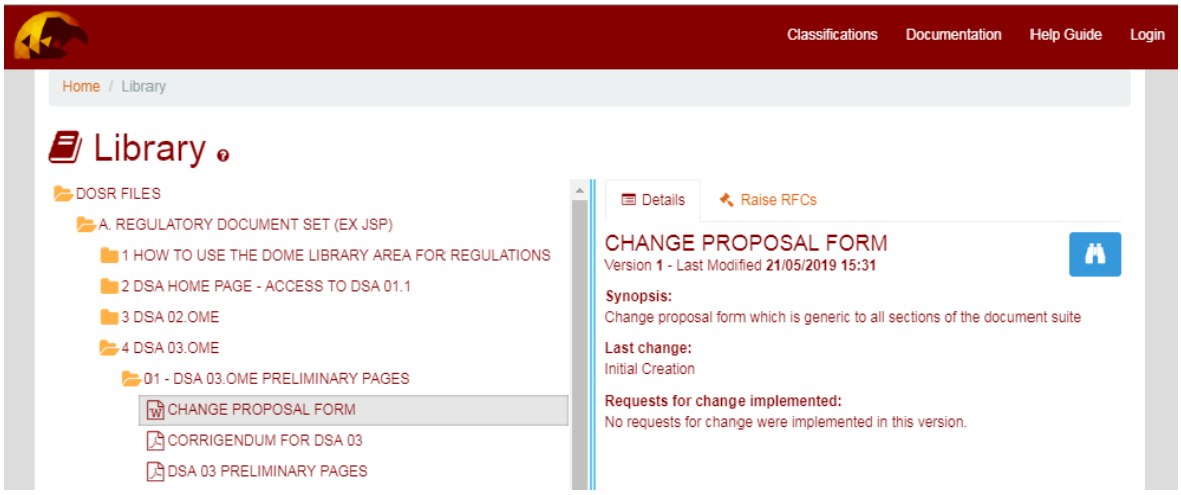

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AMENDMENT RECORD

Version 1.0					
No	**Section**	**Para**	**Amendment Summary**	**Agreed**	**Date**

Contents

Chapter 1

Surface-to-Air Ranges

Surface- to-air ranges are those where the weapon system to be fired is primarily designed to deal with airborne targets (either real or simulated). Some surface to air weapon systems can be used in a ground role, in which case such use is covered in Chapter 6 of this Part of Volume 3.

The aim of DSA03 (JSP403 Volume 3 Part 2) is to detail the policy and principles for the conduct of firing practices by surface-to-air weapon systems against air or surface targets or simulated air targets on or over land or sea

1. **Purpose**. The purpose of surface- to-air weapon systems is to prevent the enemy interfering from the air with the conduct of surface operations. Enemy interference from the air could be in the form of fixed wing aircraft, whether armed or for reconnaissance, armed or attack helicopters, cruise missiles or Unmanned Aircraft Systems (UAS). Surface-to-Air practices allow weapon system operators to carry out live firing training against the potential threats and may be fired on a variety of ranges. Small arms practices will usually take place on Live Firing Tactical Training (LFTTA), larger calibre weapons and missiles will normally require specialised facilities.

Types of Range

2. **General**. Ranges used for surface-to-air firings vary in the facilities that they are able to offer depending on whether they are single or multi-function ranges. For example, Trial, Evaluation, Research and Proof (TERP) ranges can be configured to contain the effects of a greater spread of events than a range established for training with an in-service weapon system. Nevertheless, TERP ranges may well be in a position to provide facilities to fire an in-service weapon system. The sophistication of equipment that can be deployed to support such firings is far superior to that on the training range but this does not mean that the risks involved in such firings will be any less. There are essentially four types of range used for surface to air firings:

a. **TERP Ranges**. These ranges are likely to have sea and air surveillance radars, tracking radars, optical trackers, thermal-imaging and high-speed cameras. These facilities are deployed to monitor the major elements in the firing of a live or inert round. They can therefore monitor independently the launcher system(s), the missile(s), the target(s) and the major parts of any debris after warhead event. TERP activities are prepared and conducted within a safety management system (SMS) which mandates a full risk assessment leading to the risk of harm being reduced to ALARP. Where Service firings for training purposes are carried out on TERP ranges, local conduct and control is exercised by the user unit, but in accordance with the ranges SMS, which will include attention to Range SO and will require a practice or trials specification. In the context of TERP ranges the term ‘practice’ includes trials unless otherwise stated.

b. **UK Surface-to-Air Ranges**. These ranges are operated within the Defence Infrastructure Organisation (DIO) and Defence Equipment & Support (DE&S) in accordance with the provisions of DSA03 (JSP403) and the safe system of training[1]. They provide a sanitised area for the weapon system and target operators to use, and may be supported by sea and air surveillance radars. The operators are monitored, but not necessarily the missile or the target. The use of an approved WDA allows the introduction of generic risk assessment and better use of valuable range time.

c. **Greenfield Sites Used as Surface-to-Air Ranges**. These can be sites for Temporary Exercise Ranges (TER) used, for example, during transition to war or they can be established training areas activated from time to time for surface to air firing. In either case a SMS must be established using the principles and best practice given in Part 2 of this Volume.

d**.** **LFTTA**. LFTTAs do not, as a rule, have the necessary range equipment or permanent infrastructure to reconfigure automatically as a surface-to- air range. Alterations, enhancements and probably some restrictions are likely to be required. A full risk assessment is therefore needed to determine the SMS that must be applied. Provided a risk assessment has been carried out and the risks reduced to ALARP there is no reason why a LFTTA cannot be used for surface to air practices.

3. **Range Requirements**. The basic requirements for any surface- to-air range are:

a. A cleared three dimensional space that will contain the approved Weapon Danger Area (WDA), including any rear danger area, and provide sufficient space for the target to operate within its design parameters.

b. Sufficient safety staff to carry out the safety functions generated by both the weapon system and the target.

c. A Safety Management System (SMS) that provides the confidence to the Range Authorising Officer (RAO) that the range is being operated and used safely.

d. Surveillance and policing of the danger zone when range orders specify.

Boundaries

4. **Boundary Marking**. The boundaries of any permanent range used for surface-to-air practices must be demarcated as described in Chapter 5 of DSA03 (JSP403 Volume 1 Part 2).

5. **NOTAM**. Areas which are covered by a permanent NOTAM are detailed in the UK Air Information Pilot. It is the responsibility of the range authorities to notify the civil aviation authorities of required changes to the NOTAM.

[1] Safe Place, Safe Practice, Safe People, Safe Equipment

6. **Water Space Management**. This system requires authorities programming firings which pose a potential danger to submerged submarines to signal CTF 311 requesting the issue of an Ops Hazardous message. The signal must state who, what, where (Lat and Long of the Range Boundaries) and when (Z time) with a point of contact in the programming authority. This signal must be sent as far in advance of the firing as possible to allow de-confliction and notification to take place. Whilst it is not normally a problem, it shall be noted that clearance is not guaranteed as there may be a higher priority tasking for the waterspace in question. Further guidance is available from CinCFleet Staff.

Range Surveillance

7. **General**. In order to demonstrate that the range operator, whether MOD or a contractor, is carrying out the duty of care a comprehensive system of surveillance of the range is required. Some ranges are sufficiently remote that the surveillance system can be reduced to a minimum but in all cases there is still a requirement to observe the warhead event within the danger area and a responsibility not to endanger the local population. To this end, the active weapon danger area boundaries must be observed or, alternatively, the range area boundaries that enclose the WDA must be controlled. This essentially means that there will be observation of the land, sea and air approaches to the range as well as observation of the likely target area and any impact area.

8. **Surveillance**. At present, radar provides the most efficient system of monitoring an area. However, it is not the only solution and, depending on local circumstances, there may be other means applied or used to support the radars:

a. **Visual Overflight**. Where there is a surrounding low population density, a visual overflight with trained observers may be sufficient to provide assurance that the range area is clear prior to firing.

b. **CCTV**. These systems can be used for specific blind spots as well as part of the general security system.

c. **Manned Vedettes**. Manned Vedettes shall be established at all critical points of access to the range with a suitable communication link to the Range Controller. Vedettes can also be used to observe into radar shadow areas.

9. **Radars**. There are a variety of radars that can be linked into the range surveillance system. However, radars are optimised to specific roles and therefore do not necessarily cover all surveillance requirements:

a. **Air Surveillance Radar**. All permanent surface-to-air ranges in the UK are equipped with an air surveillance radar. The performance of the radar shall be sufficient that it can detect an airborne intruder at such a range that firing can be stopped before a potential intruder reaches the boundary of the Weapon Danger Zone.

b. **Surface Surveillance Radar**. All permanent surface-to-air ranges with a Sea Danger Area (SDA) shall be equipped with a sea surveillance radar. The performance of the radar shall be sufficient that it can detect a waterborne intruder at such a range that firing can be stopped before the intruder reaches the boundary of the Weapon Danger Zone.

c. **Tracking Radar**. This is normally only available on TERP ranges.

10. **Mobile Surveillance Systems**. The more sophisticated Surface-to-Air Missile (SAM) systems have integral air surveillance. It may be possible to use such a system (e.g. FSC) as part of the SMS for a range. However, if this is adopted then the system is to be dedicated to the safety role and come under the direct control of the Range Control Staff.

11. **Air Traffic Control Radars**. In certain circumstances local air traffic control radar may provide an extended area of surveillance. However, the SMS must allow for areas of radar shadow since the ATC radar will be optimised for its own specialised function and area of interest and may not be operating for 24 hours a day.

Range Co-ordination

12**.** **Documentation**.

a. **DIO Ranges**. The Exercising Unit is responsible for writing and distributing the Exercise Instruction, which must reflect the firing practices agreed at the range planning conference. The Range Staff are responsible for producing and publishing the Range Detail and the Range Event Summary.

b. **TERP Ranges**. The Range Staff will co-ordinate the trials documentation. The PT / Customer is responsible for producing the trials specification and supporting data. The Trials Safety Manager has the final responsibility for signing off the trials documentation. The Trials Conducting Officer is the responsible person at the trial site.

13. **Co-ordination between Range Staff and the User**. It is vital that the requirements of the range user are co-ordinated with the services that the Range is able to provide. If co-ordination has not been achieved beforehand on any aspect of the firing the practice must not take place.

14. **Communications**. The key factor in the range communication system is the length of time it takes to pass a safety message and for the safety staff and users to react to that message. Assumptions are made in the construction of a weapon danger area trace that cut down commands are passed immediately and acted upon immediately. Therefore, the safety communication system must be fully tested and shown to be effective. If the communication system fails then the firing is to stop until the link is re-established.

Subject Matter Experts

15. **General**. There are three groups of Subject Matter Experts (SME):

a. **Competent Authority**. The HQ responsible for the corporate knowledge base of a particular weapon system, e.g. HQ DRA for the Ground Based Air Defence (GBAD) assets of the Royal Artillery.

b. **Acquisition and Logistic Staff**. The specialist MOD staff that may be found in DE&S PTs and who are responsible for formulating the weapon system Safety Case.

c. **Training Staff**. Trainers appointed by the Competent Authority to maintain levels of excellence and produce the procedural training pamphlets.

16. **Technical SME**. They are responsible for the maintenance, repair and disposal of the weapon systems. For example, an Ammunition Technician is required on the range during GBAD weapon system firing.

Chapter 2

Surface to Air Ranges Safety

The basic difference between a range used for surface to air weapon firings and a range used for other surface -based firings is that the Air Danger Area (ADA) has increased significance when assessing the total danger area. For GBAD weapon systems the warhead event is planned to be at altitude. This effectively means that the WDA will to a large extent reflect a Total Energy Area / Zone (TEA / Z).

The aim of this chapter is to set out the responsibilities of the range operator and the range control organisation when involved in the conduct of surface to air practices and to define the interface between the Range Staff and the Range User.

General

17. **Range Authorisation**. MOD ranges may only be used for surface to air firings if authorised for this type of practice. The procedures for authorisation and for the Safety Management System (SMS) are contained in Volume 1. In relation to TERP ranges the term ‘Practice’ is taken to include trials unless otherwise stated.

18. **Range Inspection**. All surface to air ranges must be inspected in accordance with the inspection cycle laid down in Chapter 8 of Volume 1.

19. **Range Incidents and Accidents.** In accordance with DSA03 Volume 1, any incident or accident resulting from a live firing activity, including the use of the target system, must be reported through the Chain of Command in accordance with the appropriate Service or Agency procedures. Both the User and the Range Staff are separately responsible for reporting incidents. The relevant Service Publication should include the reporting of accidents / incidents.

20. **Environmental Concerns.** There will need to be a full environmental impact statement1 concerning the use of the range danger area, where such topics as noise, pollution, effects of troop activity on flora, fauna and archaeology are addressed, which may in turn limit or prevent certain types of military activity. It should also be noted that the land / sea edge is generally considered to be a fragile area in environmental terms and this may well affect its use as a part of the range area.

21. **Byelaws.** Military byelaws are in place on some ranges but are specific to their defined areas. Advice on byelaws should be sought from Defence Estates. It should be noted that they can be enforced only when the range is being used for Defence purposes as set out in the specific byelaws.

22. **Duty Holders.** The MOD as owners and operators of surface to air ranges in the UK and overseas has a responsibility to see that the ranges are operated in accordance with DSA03 (JSP 403). A Duty Holder, as defined in DSA01, is a MOD person with specific responsibilities for the safety management of the system. Therefore, Range Staff who are responsible for the maintenance of the infra-structure of the range, such as emplacements and radars, as well as the control of access are Duty Holders. Users of ranges are also duty holders with the responsibility for the safe conduct of firing practices.

23. **Range Authorising HQ**. The CO / Head of the Range Administering Unit exercises responsibility for the safety of the range on behalf of the Range Authorising Officer (RAO). The RAO HQ is responsible for ensuring that Range SO are produced and maintained and that monthly and annual inspections of the range and its operations are conducted.

24. **Level of Risk**. Guidance on individual risk is given in Volume 1, Chapter 1. The level of risk that is acceptable to the range user will vary as training needs change and experience with the weapon system grows. Against this variable must be weighed the consequences of an accident both to human life and in material terms. The user, in this situation, will be guided both by the Chain of Command and DOSG advice. On TERP ranges the user's risks will also be considered as part of the Trials requirement by the range operator.

Use of the Range

25. **Types of Practice.** Within the UK most of the surface to air ranges are on the coast with the bulk of their danger areas out to sea. This lack of land space has lead over the years to the development of fixed firing points and formalised firing practices. Range users, however, have expressed the need for increased realism in training. This has produced four different types of training practice that are used for training weapon system operators in surface to air engagements:

a. **Technical Firings.** These practices are carried out from fixed firing positions with the Safety, Assessment and Monitoring Equipment (SAME) fitted under the direction of the Unit with the appropriate Subject Matter Expert (SME) staff in support. The aim is to gain the maximum benefit for the firer in terms of assessment of the firer's performance and also to collect the maximum data on the performance of the equipment.

b**.** **Tactical Firings (Static).** Tactical firings exercise the complete firing detachment. These practices are carried out from fixed firing points with the SAME connected but under realistic tactical scenarios. The firing detachment is separated from the mechanics of target presentation, the physical presence of SME and higher Unit Command, the safety net communications and range timings. The SAME is required to be effective but unobtrusive. Safe firing arcs are set by detachment orders and range clear orders translated to the language of unit fire control orders. Individual ranges must have SOP to cover these requirements that take into account the technical level of SAME available. Multiple targets with counter measures, both electronic and by decoy, can be used at unpredictable times under this system.

c. **Tactical Firings (Mobile).** These practices primarily involve the movement of the launcher and firing detachment to a variety of actual or potential firing positions on the range in order to develop into and out of action drills. There are a variety of techniques to maintain the SMS depending on the level of risk that is acceptable to the exercise commander and within the constraints of the range SOP. The purpose is to test the weapon system and firing detachment as fully as possible within the SMS. The intrusion of the SAME system may be reduced in order to increase realism if this is

acceptable within the range SMS. Multiple targets with counter measures, both electronic and by decoy, can be used.

d. **Fire and Manoeuvre Engagements.** These practices are dependent on there being sufficient space to both manoeuvre and fire in the Danger Area. Positive safety[2] may well be applied as connection to a fixed safety system could prove unacceptable in terms of timely support to the Combined Arms Grouping. The intention is to integrate the weapon system with the other Arms and Services within the Combined Arms command structure.

26. **Trials.** Land ranges may be used for surface to air firing trials which are conducted at the direction of or on behalf of the MOD.

27. **Principles.** The core principles governing the use of any range for surface to air firings are:

a. **Range Clearance**. Before any firing is carried out the range is to be cleared by the range authorities and that state maintained as long as the range is in operation. In practical terms this may involve a variety of measures such as sentries, wardens, flags, lights, fences and signposts as well as more complex arrangements such as motion detectors, radars of various types, aircraft with trained observers and safety boats.

b. **Range Surveillance.** During operations on the range it is important that the area surrounding the range is also monitored so that there is time to react to a potential incident or incursion. Achieving this may involve a variety of measures such as sentries, range radars, local Air Traffic Control (ATC) radars and Safety Officers with the firing / flying equipment. Duty of care is also part of the operators remit and applies to civilian contractors as well as to MOD personnel. The control of movement within the range boundary is part of the safety management system.

c. **Communications.** All MOD surface to air ranges, when in operation, are required to have a dedicated 'all informed' range safety communications network. This is so that if anyone, either range staff or from the user unit, sees a potential safety incident, they are able to stop the firing and warn others.

d. **Cut Down Systems.** Both surface to air weapon systems and their targets commonly have some form of cut down or bring down system. However, there is a requirement to evaluate when and where to use these systems as, uniquely with UAS, it may well be the safer option at the time to turn the UAS back into the range centre rather than risk recovering it outside the range boundary.

e. **Air Danger Height.** The air danger height above the range must contain the Total Energy Zone (TEZ) of the weapon and its warhead effect. If the

[2] The term Positive Safety refers to the actions of a supervisor at the firing position where he/she is in a position to terminate by a physical action the firing practice. It is a position that requires judgement and a detailed understanding of the weapon system involved.

warhead uses any form of shaped charge for target attack, the effect must be added to the TEZ.

Firing Point Procedures

28. **General.** Dedicated surface to air firing ranges have specific Range SO to control the conduct of firing practices. However, other types of ranges may also accommodate surface to air firings and when the user is firing on these he must be sure that he is using the appropriate section of the Range SO. The 'best practice' procedures that have been established on dedicated surface to air ranges are to be carried forward to firings on other types of range. SME located within the individual Services are to be used to provide the depth of experience and advice to ensure this happens. They must be fully consulted at an early stage within the planning process.

29. **Weapon Crews.** All weapon crews are to be qualified, current and competent for the type of firing practice in which they are involved. In the case of progressive training firing practices this means that the firer has completed the necessary dry training before attempting to qualify for the next level of training competence. The Range Officer will require confirmation from the user (CO / OC of the unit or equivalent for a civil contractor) that the crews are so qualified. The user is responsible for ensuring that all firers have met the required standards.

30. **Safety Staff Certification.** The appropriate single Service training pamphlet will provide the required pre-firing standards that must be achieved by Safety Supervisors. The CO of the user unit is responsible for ensuring that all Safety Supervisors have met these standards and is responsible for certifying that this is so.

31. **Misfire Bearing.** Whenever there is a misfire, the gun/weapon system is to be immediately laid in the pre-planned misfire bearing and elevation. This should be the centre of the firing arc with an elevation that will cause any round subsequently fired to land in the middle of the WDA. The misfire procedure and settings are to be known and understood by both the FPSO and the firer.

32. **Restriction of Firing Arcs.** The mechanical / electrical 'taboos' and arc restrictions must be correctly set prior to firing. The RCO will require confirmation from the FPSO that the firing arcs are set and have been checked.

UK Airspace

33. **General.** In the UK, the airspace above the range is not owned by the MOD but is part of the overall UK airspace controlled and regulated by the Civil Aviation Authority (CAA). The CAA is advised by the Directorate of Airspace Policy (DAP) on all military requirements within UK airspace. In practice, the MOD is responsible for safety within a defined and activated Air Danger Area (ADA) during the time that surface to air firing is taking place. The MOD, as the owner of the range, has a duty of care in respect of all activities within the boundary of the range danger zone. Therefore, any hazardous activity must have a Safety Management System (SMS) in place to control the risks involved and to show that those risks have been driven down to a level that is ALARP and tolerable.

34. **SMS.** On a MOD surface to air range there should be a layered approach to the range SMS, based on four principles:

a. Notification - where the wider public is kept informed of range activities, including specialist groups such as pilots of aircraft.

b. Surveillance – of the air, land and sea approaches to the range boundary and the enclosed danger areas.

c. Positional awareness - in that all users of the range are kept informed of what others are doing.

d. Duty of care - proactive response to any potential incident with the necessary communications to facilitate this.

35. **Memorandum of Understanding (MOU).** Firing practices are largely conducted on surface to air ranges where there is a MOU between the RAU and National Air Traffic Services. The MOU defines the extent of the danger area, the activation times, activation altitude limits, notification procedures and conditions of use. Each Service has a representative on the UK Danger Area Users Group (UKDAUG) which deals through DAP with the CAA.

36. **Notification.** In practice, the following apply:

a. **Notice To Airmen (NOTAM)**. The Air Danger Area (ADA)5 applicable to the range must have a NOTAM that is current and which specifies the grid references or latitude/longitude of the ADA, as well as the height and the times that it is effective. It is normally the responsibility of the RAU to arrange or activate the NOTAM in accordance with the MOU.

b. **Airspace Co-ordination Notice (ACN).** It is possible to conduct firing practices in airspace which is not covered by an MOU, or where an existing MOU will not accommodate the WDA for a particular weapon system. A firing practice carried out in these circumstances is defined as Unusual Aerial Activity (UAA)6. The RAU wishing to obtain approval for UAA is to apply at least 6 weeks in advance of the start of the UAA, to the Airspace Utilisation Section (AUS) in the Directorate of Airspace Policy. AUS will pass the UAA request to the civilian and military Air Traffic Control (ATC) authorities. ATC may impose conditions and restrictions on the UAA. Once AUS has obtained ATC agreement for the UAA, AUS will produce an ACN. The ACN will include:

(1) Description of UAA.

(2) Dates and Times.

(3) Operating Area.

(4) Vertical Limits.

(5) Sponsor / Operating Authority.

(6) Co-ordination Arrangements.

(7) Aeronautical Publications. Note that AUS will issue the Notice to Airmen (NOTAM) for UAA.

Weapon Danger Area Templates

37. **Derivation**. The WDA for both the weapon system and the target are derived from data provided by the Design Authority (DA) in the first instance and as a result of further work done by DOSG. Initially a 60 of freedom model is developed from the analysis of the hazard log, the Fault Tree (FT) and the Failure Modes Effects and Criticality Analysis (FMECA) that is tested against the prototype firings and refined. From this model probability contours are derived which allows recommendations to be made as to the levels of risk. Advice is consolidated into the Safety Case suite of documents and passed to the Service SME concerned. The Service SME are responsible for producing the appropriate training publication.

38. **Calculation of Risk**. Weapon Danger Area (WDA) templates are constructed on the basis that the following factors are valid:

a. The firer is competent, current and qualified up to the level of training that is being carried out.

b. The weapon will be fired within the safe firing arc.

c. The firing practice has been approved by the competent authority.

d. The range is fully prepared for firing.

e. The firing will be conducted and supervised at the appropriate level.

Safety Assessment and Monitoring

39. **General.** For surface to air weapon systems, it is important to control the firing effects and to gain the maximum benefit from each firing. For gun systems with a predictable trajectory the safety problem may be easier to define, whereas a missile can go rogue at any time in its flight and the outcome is more difficult to predict. Safety of the surface to air range, therefore, is a matter of identifying what can go wrong, assessing the probability and taking precautions to mitigate the identified hazards.

40**.** **SAME.** Due to the high cost of modern munitions it is incumbent on all parties to obtain the maximum benefit from each firing. To achieve this most dedicated surface to air ranges in UK have a built-in SAME. This may be linked to on-board target equipment such as the Miss Distance Indicator (MDI) that helps to provide a complete performance record of both the individual firer and the missile.

Overseas Ranges

41. **General.** The UK has a variety of agreements with other nations so that UK units may use their ranges. As a general principle UK units will operate to normal UK regulations and procedures, but will apply Host Nation requirements wherever they are the more stringent. UK units will not modify their normal UK practices without obtaining waiver or exemption to do so.

42. **Air Space.** Unlike the UK, where all the national airspace is controlled by the CAA, there are many countries that have large volumes of national airspace controlled by the military. When operating overseas units must ascertain exactly who controls the airspace above the range and comply accordingly with Host Nation requirements.

43. **Air Surveillance.** Depending on which type of range is being used, there may be a facility that provides air surveillance coverage of the range danger area and the associated ADA. It should be noted that on some overseas ranges, the ADA is owned by the military and they may use a simple NOTAM or ACN procedure. It may be possible to use a LFTTA without radar coverage provided a risk assessment has been carried out and measures are in place to mitigate against the risk of hitting an intruder. The duty of care may be met with adequate air sentries, communications and restricted target heights. In all cases the requirement is to show that the risk to an intruder is ALARP.

Chapter 3

Ground Based Air Defence Missile Firings

Ground Based Air Defence (GBAD) missiles are used by the RN and Army. However, there are other groups of users who may also use Service surface to air ranges for missile firings. These can include contractors at the direction of the MOD and commercial enterprises carrying out private venture work. Additionally, some TERP ranges provide facilities to Service units for in-service equipment firings. This variety highlights the need for a flexible, and often individually tailored, approach to the provision of the SMS for GBAD missile systems and their targets.

The aim of this Chapter is to provide guidance on the operation of a range being used for GBAD missile firings.

44. **GBAD Missile Environment**. From a doctrinal point of view GBAD is considered both as a joint and combined responsibility. The UK contribution as part of the combined GBAD environment is focused on Low Level AD (LLAD) up to 16,000ft (4876m) and is divided into Close GBAD and Area GBAD. Historically, this division has required different training needs and standards and has resulted over the years in different approaches to the requirements of the user from the UK surface to air range providers.

Principles

45. **General.** The User may not fire on the range unless the practice has been authorised and the range is declared to be open for firing. The Range Officer has the delegated authority from the Range Authorising Officer (RAO) to stop all firing on the range at any time if he feels it is necessary so to do. Anyone may call for the firing to be stopped if he or she sees or detects a dangerous or potentially dangerous situation.

46**.** **Planning.** Prior to the User arriving on the range a planning conference will have taken place to settle the details of the firing practice. Targetry and administrative details will also be discussed. It is upon this planning that the Daily Range Summary / Training Safety Authority / Range Detail / Trial Plan is based. Minor changes to the planned activity may be accepted by the range operator provided no new risks are introduced. Major changes will require the submission of a new plan of the firing practice to the range operator, and may require formal approval.

47. **The WDA.** The Range Staff are responsible for applying the WDA template that has been promulgated by the holder of the Safety Case. If there is any discrepancy or doubt about the WDA or its application then advice must be sought through the SME HQ and DOSG.

48. **Mitigation of Hazard**. There are methods to mitigate hazards of GBAD missile weapon systems, such as independent cut-down and self-destruct systems. These are assessed by DOSG who will provide Range Safety Advice to the platform Project Team (PT) that holds the weapon system Safety Case. This Advice will contain

the recommended WDA and the restrictions on its use. Only the PT and Service approved WDA is to be used for GBAD missile firings. The range operator will require prior and timely information on the WDA, it's construction and restrictions, in order to consider approval for the firing to take place.

Range Procedures

49. **Firing Practices.** The appropriate Service training/procedural publication provides the detail for the conduct of practice to be used with the weapon system.

a. RN / RM.

b. RM.

c. Army.

50. **Service Technical Publications.** These publications provide the User and Technicians with operating procedures, equipment function explanations and repair / maintenance information and should be available on the range.

51. **Training Safety Authority / Range Summary / Range Detail.** Only those practices that appear on the Training Safety Authority / daily range summary / range detail may be fired, using the equipment and ammunition specified in the areas designated and within the times stated.

52. **Range Clear for Firing.** The Range Staff will inform all User Units when the range is open and clear for firing and also when it is closed. Temporary suspensions of the authority to fire will occur and it is the duty of the Range Staff to ensure that all users are aware of where and when these suspensions apply and what range activities are affected.

53. **Target Provision.** The target provider, whether civilian or military, will be treated as any other range user and is responsible for ensuring the safe operation of the target equipment.

54. **Ammunition Technical Support.** An Ammunition Technician (AT) is normally required to be present at all missile firings to deal with misfires, performance failures and other ammunition incidents. The AT will make a report about any ammunition incident that occurs and forward it through the chain of command.

55. **Ammunition Incidents.** Both the Practising Unit and the Range Staff should make reports on ammunition incidents in accordance with Service / Agency procedures. In the event of death, serious injury or damage the Civil Police are to be informed and the site cordoned off, initially by the Unit.

60. **Misfires**. A safe bearing and elevation is to be calculated and applied for each firing point that will allow any subsequent launch to be contained within the centre of the WDA.

56. **Observation**. All missiles fired are to be observed and the results of the firing recorded. If the target is flown beyond visual range the target operating team is to record its track. These records and observations are important should an investigation become necessary.

57. **Target Operation**. The target may be operated by either MOD or Contractor staff. A log of all significant events (launch and recovery times, number of engagements, hits, target track and flying conditions) is to be opened and maintained whilst operating on the range. This log is to be made available to the Range Staff. The records are to be kept for one year.

58. **Overflight**. The question of whether a target may overfly an unprotected position or any other range user or critical store will be addressed in the Aircraft Release and the Safety Case. Limitations will also be addressed in the same documents. For GBAD missiles firings it is entirely possible that the command link or control of the target UAS may be damaged during an engagement. Thus, during presentations for the engagement, a limitation may allow the target to be flown directly towards the firing point provided it is kept at low enough height and far enough away for the cut down mechanism to operate before the engagement of the UAS presents a potential hazard to those on the firing point.

59. **End of firing**. At the end of firing the user unit RCO is to report all suspected blinds and the position of fallen debris. Confirmation must also be provided to the Range Staff that all weapon systems are clear and set to safe, and have been inspected as such by a competent Officer.

Chapter 4

Ground Based Air Defence Gun Firings

Both the RN and the Army operate dedicated GBAD guns, primarily based upon the PHALANX and GOALKEEPER systems. The RN also has a variety of 20/30mm cannon that could be used in the GBAD role. All the RN systems are ship mounted and therefore the firings all take place at sea.

The aim of this Chapter is to provide guidance on the operation of a range being used for GBAD guns firings. This is additional to the general requirements applicable to all Surface to Air firings given in Chapter 1.

Foreign Forces using UK Ranges. Several NATO and PfP countries have GBAD gun systems and may from time to time use UK ranges. DOSG Advice should be sought in order to develop/issue/allocate a suitable WDA template for the gun system to be fired on a UK range. Early contact with DOSG is essential in order that the necessary ballistic and technical data can be gathered and analysed.

GBAD Gun Range and Firing Point Procedures

60. **Template.** Because it is probable that high QE will be involved, the WDA template for a GBAD gun system is likely to reflect the total energy area for the weapon system. It should also subsume the danger area from debris falling from the target although the normal target flight danger area will probably require greater space. It should also be noted that high angle fire will require greater consideration of meteorological effects.

61. **General.** A GBAD gun system usually relies on firing a large number of projectiles into the path of the target in a short space of time. In addition, it is likely that multiple weapons will engage the target in order to maximise the chances a hit. This type of firing will generate noise, smoke, discharge debris, dust and toxicity, all of which present hazards and need to be mitigated. The firing point safety management system should therefore include special attention to:

a. Control by flags and lights.

b. Taping restricted / prohibited areas.

c. Arc markers.

d. Multiple Safety Supervisors.

62. **Safety Supervisors.** The firing point / gun line will be supervised by the Firing Point Safety Officer (FPSO) who reports to the RCO. Individual weapons on the firing point should have dedicated Safety Supervisors.

63 **Flags.** During a GBAD gun practice each weapon system is to display a red flag when engaged in live firing. When the gun has been made safe a green flag is to be displayed. Where there is no flag displayed, the gun is to be fully unloaded.

64. **Firing Arcs.** It is the responsibility of the user unit to mark the firing arcs in such a way that they accurately correspond to the arcs shown in the range detail provided by the RAU. It is the responsibility of the FPSO to check the arc markers and to confirm to the RCO that they correspond to the range detail. Individual weapons will need to have their own dedicated arc markers. Care must be taken in positioning the markers so that they do not become obscured by firing debris or smoke.

65. **Radar Controlled Firings.** Where the GBAD gun is part of a fully automated system that is radar directed, care must be taken to ensure that 'taboos' and arc restrictions are correctly set. The reliability assessment of the Taboo system will be part of the Safety Case and any additional precautions or procedures will be in the relevant Service publication. The RCO will need confirmation from the FPSO that the gun is correctly set prior to firing.

66. **Control.** All firings and range practices, including those by Foreign Forces, must be conducted by a properly qualified, competent and current RCO. The RCO, the FPSO and the Safety Supervisors must be familiar with the firing cut out controls for all automated gun systems under their control

Target Operations

67**.** **Presentation.** Due to the high attrition rate of targets against multi-barrel, radar controlled, high volume automatic GBAD guns, it is common practise to use towed targets, either by UAS or by manned aircraft. Towed targets, however, require a large amount of turning room. There should be a dry (non-firing) run across the firing point by the target before the actual live firing pass. This is to confirm the target track is within the firing arcs and to prevent the gun being seduced out of arc. An exception might be made for tactical firings, in which case a dry run should be made during the setting up of the range.

68. **Overflight.** The question of whether a target may overfly an unprotected position or any other range user or critical store will be addressed in the Aircraft Release and the Safety Case. Limitations will also be addressed in the same documents. The hazard generated by loss of control of a UAS or towed target dictates that the presentation must not be on a direct line over the firing point. Towed targets should not be flown directly at the FP and UAS must turn away before the in-flight danger area reaches the firing point.

Chapter 5

All Arms Air Defence

All Arms Air Defence (AAAD) is not part of standard training but can become part of the surge training prior to operational deployment and is taught on some courses in the UK.

The aim of this chapter is to provide guidance on the operation of a range to be used for AAAD training.

69. It is important to take into account the threat categories contained within Joint Warfare publications as these should dictate the type of live firing training that is planned and conducted.

a. **The Fighter Ground Attack (FGA) Threat.** It should be noted that the likelihood of hitting a FGA aircraft with small arms fire is remote. The speed of the target, the engagement distances and the stand-off ranges of modern ground attack weapons all mitigate against hitting the aircraft. However, AAAD fire may be able to prevent the attacker from achieving his aim by breaking up the attack profile.

b. **The UAS Threat**. Sensor carrying UAS are a real-time threat to ground forces and may need to be countered as soon as possible where small arms fire is known to be effective. It should also be noted that some larger UASs have the capability to carry and launch munitions. A UAS flying a fixed pattern between way-points is a reasonable target for small arms engagement.

c. **Helicopter Threat**. Troop and attack helicopters present differing threats to ground forces and highlight the need for a comprehensive Air Defence plan and the importance of fire control. Both types of helicopter are vulnerable to small arms fire.

General

70. **Control**. The key safety requirements for an AAAD live firing practice are control of the target and control of the firer. For small arms to be effective against aircraft and UAS, it is necessary to engage the target with the maximum number of weapons. Control, therefore, is crucially dependent on positioning the target within a safe engagement arc and ensuring that the safe arc limits are clear to the firers. Arc markers must be placed in a prominent position so that they are visible at all times, bearing in mind that firers and supervisors will be looking upwards at targets.

71. **Weapon Types.** A wide variety of weapons could be used for AAAD firings but realistically there are three broad groups that should be permitted on ranges:

a. **Shoulder Fired Small Arms**. Examples are 5.56mm and 7.62mm rifles and machine guns (MG). These require the greatest level of supervision

to ensure that each firer in a tactical group/unit remains within arcs and safe engagement limits.

b. **Pintle Mounted Weapons**. Examples are 7.62mm and .05in MG bolted on to vehicle mounted bars or rings. Consideration may be given to the use of physical ‘stops’ to limit azimuth and elevation. Supervision of each weapon system will be required.

c. **Turret Mounted Weapons**. Examples are 7.62mm chain gun and 40mm Rarden cannon. Where possible stops should be employed to limit traverse and elevation.

The Range

72. **The Range.** All Arms Air Defence (AAAD) firings may take place on any range that can contain the weapon and target WDA templates. It should be noted that in the case of a UAS target there may be additional requirements in order to meet the MOD duty of care but these will be contained within the UAS flight operating instructions.

73. **Establishing the Danger Area.** For a detailed explanation of how to apply the WDA template to the allowable danger area see Reference B.

74. **Firing Over the Heads of Troops.** In theory, with sufficient protection, this is possible, however in practice it is difficult to organise and control. It would normally only be considered when realistic training in a combined arms setting is a priority. Advice should always be sought, through the Chain of Command, from the relevant Competent Authority. Troops in front of other weapon systems may have to contend with noise, blast, flash, debris and toxicity in addition to other more direct hazards.

75. **Firing From Ships.** The Royal Marines and embarked Service personnel from Army and RAF Units may require to test weapons or procedures in the AAAD role from ships. Despite the absence of a defined range area and the ad hoc nature of such firings the SMS and practice should be as for a land to air range.

76. **Night Firing.** This should not be undertaken without the right level and quality of night observation equipment. Control of the firers both in terms of position and orientation is essential as is the clear marking of firing arcs

77. **Target Types**. Aerial targets can be mobile or static. For most AAAD training a mobile target will be required but there are occasions when a static target can give a better representation of the attack profile, e.g. for helicopters. The following can be considered for use as targets for AAAD firing:

a. UAS.

b. Towed Targets.

c. Helicopter pop-up targets.

d. Illuminating rounds from Mortars/Artillery.

78. **UAS Safety Constraints**. If hit when making an engagement run directly towards the firers a target UAS can become a ballistic projectile. If the command system is damaged in such circumstances then it becomes possible for the UAS to crash into the firing point. The WDA applied for the target must take this into account but as a consequence the UAS may only be able to operate at ranges beyond the effective engagement range for shorter range small arms. Therefore, a UAS engagement run for such weapons is likely to be parallel to the firers and a sufficient distance away that if damaged it cannot turn into the firing line. However, if it is necessary for the firer(s) to practice against head-on targets overhead protection measures may be necessary or an increased risk may have to be accepted.

79. **Target Profiles**. There are essentially two types of UAS and towed target profiles:

a. **Crossers**. Most targets will be engaged as crossers. This requires careful placement of and strict adherence to fixed firing arcs. Where there is a mix of weapons available in a firing unit it may be possible to match the target profile to the respective optimum ranges for the engagement. Thus, initial engagement could be by 30 / 40mm cannon, gradually decreasing down to shorter range weapons such as MG and rifle.

b. **Head-on**. Control of fire within arcs is easier with a head-on profile but the engagement height cannot be kept as a constant and the risk of the target impacting with the firing point is increased. For the heavier calibre weapons this should not be a problem as turret mounted weapons are usually on armoured vehicles which can provide a measure of protection if a target comes down over the firing point.

80. **Other Targets.** Further detail is contained in Chapter 7.

Chapter 6

GBAD Weapon Systems used in the Ground to Ground Role

Many GBAD weapon systems have a secondary, ground to ground, self defence capability, although it is not current UK policy to use such systems in this role. Some foreign forces that use UK ranges for training do, however, practise this capability and may wish to use UK ranges for that purpose.

The aim of this chapter is to give guidance on the operation of ranges for the use of GBAD weapon systems in the ground to ground role.

Missiles

81. **Weapon Danger Area.** The WDA for a ground target is likely to be similar to the full WDA for an air target since most of the hazards identified in the Safety Case will be unchanged. With guided missiles the maximum range of the WDA will remain the Total Energy (Range) (TER) as the flight is non-ballistic. The key difference will be the increased likelihood of the missile grounding during flight and in particular during the gather phase at launch. An increase in launch elevations may be required to prevent ground strike. This is sometimes known as super-elevation and is applied by the user.

82. **Ranges.** There are only a few MOD ranges that are large enough to absorb the WDA of a GBAD missile. There are two additional firing criteria that should be considered:

a. **The minimum engagement range**. This is usually to allow the missile to arm and to achieve stable flight.

b. **The warhead effects danger area**. This is to avoid the firer being endangered by the warhead event. It should also include debris from the target.

83. **Rear Danger Areas.** For most missiles there will be no change.

84. **Moving Targets.** See Chapter 7.

Guns

85**.** **Weapon Danger Area**. There is considerable scope to re-draw the WDA for a GBAD gun being used in the ground role. The QE of the gun is reduced to the lower elevations with a considerable reduction in maximum range. However, there will be the addition of ricochet and thus the WDA must be re-modelled. DOSG advice should be sought through the Chain of Command well in advance of the proposed firing.

86. **Firing Platform**. GBAD guns, because of their design, put most of the recoil energy produced by firing into the ground. If the elevation is bought close to the

horizontal then these forces must be absorbed by the recoil mechanism. This may well require additional anchorage to the firing platforms to provide a stable base for firing.

87. **Effects**. The effects of blast, debris, flash, toxicity and noise from a GBAD gun system may well be changed by the muzzle being in close proximity to the ground than when firing in the primary surface to air role. All of these factors and their possible effects on structures and people in the area will need to be assessed before firing takes place.

88. **Moving Targets**. See Chapter 7.

Chapter 7

Targetry

The aim of this chapter is to give guidance on the use of the different types of target that may be deployed on ranges for GBAD firings.

Targets

89. **Types**. The main divisions for targets are shown below:

a. UAS.

b. Small UAS operating under CAA model aircraft rules.

c. Towed Drogues and Sleeves.

d. Ballistic Targets (shells and rockets).

e. Flares and Parachute Illuminating rounds.

f. Ground based pop-up Targets (normally for Helicopter profiles).

g. Synthetic Targets.

h. Static hard targets (for GBAD ground to ground firings)

UAS

90. **Definition**. A UAS is defined in Part 1 Chapter 6. In general terms it:

a. Is capable of sustained flight by aerodynamic means.

b. Is remotely piloted or automatically flies a pre-programmed flight profile.

c. Is reusable.

d. Is not classified as a guided weapon or similar one- shot device designed for the delivery of munitions.

91. **UAS Airworthiness**. Reference T describes the principles and the policy for the regulation of the airworthiness of UK Military aircraft. It is MOD policy that the operation of a UAS should be no more likely to cause injury or fatality to personnel or the general public than the operation of a manned aircraft. The design criteria for a particular UAS is to take into account its intrinsic safety, its mode of operation and the environment in which it operates. The criteria applies to all UAS whether operated by the Services or appointed contractors.

92**.** **Military Aviation Policy.** The regulations and directives are outlined in Military Aviation Policy Regulation and Directive , the preface outlines the flying regulation and aircraft operating authority.

93. **The SMS for the UAS**. The SMS must conform to the requirements of Part I, Chapter 6 of this DSA03. There is no size limit to the target and therefore even small UAS must have a Military Aircraft Release (MAR) and the generic type must have a tail number. This allows for cannibalisation of parts but ensures that configuration control and hence airworthiness is maintained.

94. **Release To Service Authority (RTSA).** RTSA is the delegated HQ that holds the Safety Case and is responsible for the UAS SMS. Operational control of the system may be held by another HQ, (the Aircraft Operating Authority (AOA)) but the RTSA is responsible for the airworthiness of the UAS in training.

95. **The SMS for the ADA**. There is the same four -tiered approach to the SMS as outlined in Chapter 2.

96. **Operating Advice**. DOSG will provide advice on:

a. Range Safety and Safety and Suitability for Service for the UAS – which will take into account the MAR.

b. The interface between the contractor and Range Control.

c. The inspection regime.

d. The WDA for the operation of the UAS.

97. **Small UAS Operating under CAA Model Aircraft rules.** There are currently no small targets operated by the Services, however, there are small sensor UASs that can be operated under CAA CAP 69 rules for model aircraft. It may be possible to use these regulations for a small target should one be procured at any stage.

98. **Chase aircraft**. In the unlikely event of UAS being permitted to cross into general airspace they are required to observe the ‘Sense and Avoid’ rule of the air. One solution is to use a chase aircraft that reports to the UAS operator what the UAS.

Towed Drogues and Sleeves

99. **Towed Targets.** The modern towed target has a height keeping mode so that the target can be programmed to maintain height from sea skimming to high level as required. The target may be towed by manned aircraft or by a larger UAS.

100. The RN and RAF also use targets towed by manned aircraft under a Service contract with a civilian contractor (Flight Refuelling Aviation). This contract is administrated by HQSTC SO1EWTD. Day to day operations are controlled by OC JSATO at RNAS Yeovilton. Other than sleeve targets, there is no overland capability under this contract

Ballistic Targets

101. **Use.** The RN is the only Service that uses ballistic targets for surface to air missile firings.

102. **Radar Controlled Engagements.** A shell is a very small radar target and is moving at considerable speed. It is entirely predictable in its trajectory and therefore a simple target provided the weapon radar can pick out the moving shell. The trajectory of the shell must not cross directly overhead of the firing point. It should be noted that the shell is travelling above the speed of sound for most of its flight and therefore is likely to be well beyond the designed acquisition and engagement limits of most VSHORAD Systems. In addition, the radar reflective cross section of a shell is very small for head-on / tail shoots.

Flares and Illuminating Rounds

103. **Hand held flares.** Historically, these flares have been used as targets but they are essentially static, apart from wind drift, and serve mainly as an aiming point.

104. **Mortar and Artillery Illuminating Shells**. The flares on parachutes are also essentially static, apart from wind drift, but as targets they do have the advantage of being able to be placed at variable engagement ranges.

Ground Based Pop-Up Targets

105. **Helicopter Targets.** Some surface to air ranges, e.g. in Poland and Canada, operate simple pop-up targets based on a vertically swinging gantry. They are used to represent the fleeting helicopter threat. They are not suitable for larger GBAD missiles because of the damage that can be caused to the target armature. The potential for ricochet must also be considered.

106. **Ground Targets.** Moving and static tank targets can be adapted to simulate a variety of GBAD ground to ground or low-level scenarios. However, it should be noted that the electronics involved with such targets are both expensive and vulnerable to proximity warheads.

Static Hard Targets

107. These targets are normally used for AFV firings but can be used in the GBAD ground to ground role and for proof firings on appropriate TERP ranges. There are two additional risk factors to be considered when using these targets for GBAD weapon systems:

a. **Ricochet**. Hard targets usually consist of heavily armoured vehicles that were designed to deflect anti-tank rounds. There is a significant risk of ricochet.

b. **Debris**. Hard targets are shot at until complete destruction and as they deteriorate there is a risk of significant debris being thrown up on impact.