



MINISTRY OF DEFENCE

# JSP 390

## UK MOD Military Laser Safety

### Volume 1 – Policy

Issue 3

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## **PREFACE**

JSP 390 Volume 1 sets out the MOD policy concerning the use of laser equipment. It is the MOD's policy to ensure that all laser use, training, test, research and trials are conducted in a safe manner which complies with or exceeds the requirements of UK Health and Safety legislation. The technical aspects of laser safety assessments are contained in Volume 2, of JSP 390. The policy contained within JSP 390 is to be applied to the use and maintenance of all lasers used in the UK by the MOD. When such lasers are used abroad this policy will apply unless the host nation's processes are more restrictive.

The latest edition (2011) of JSP 390 exists in 2 volumes; Volume 1 contains policy and Volume 2 will contain technical information. Until Volume 2 is issued (expected Q4 2011) any information missing from the 2010 edition of JSP 390 should be taken from the 2005 edition. Where information contained within the 2005 and 2010 editions disagree the information in the 2010 edition will take precedence.

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# 1. INTRODUCTION

## 1.1 Aim

1.1.1 Joint Service Publication 390 (JSP 390) details Ministry of Defence (MOD) laser safety policy and gives direction as to how this policy shall be implemented by Crown Employees and their contractors, as well as persons operating laser equipment on Crown property.

1.1.2 In order for laser safety to be integrated with MOD general health and safety policies, laser-specific policy follows the same generic structure as that of other safety documents published by the MOD. It is MOD policy to comply with all UK health and safety legislation and, where appropriate, laser safety policy in JSP 390.

## 1.2 Overview

1.2.1 The Secretary of State (S of S) for Defence has overall responsibility for Environment, Health and Safety throughout the MOD and has published a top-level statement in JSP 815, Defence Environment and Safety, which defines the Functional Safety Boards (FSB). JSP 390 is sponsored by the Defence Ordnance Environment and Safety Board (DOESB). DOESB is an FSB which exists to provide top-level direction on Ordnance, Munitions and Explosives (OME) safety and environmental management in order to ensure the continual effectiveness of the MOD OME Safety Management System (SMS). Military Laser Safety is included within this responsibility.

1.2.2 The detailed responsibilities of the MOD Chain of Command/line managers under the Health and Safety At Work Etc. (HSAW) Act 1974 and the method of implementation are included in Chapter 3 of JSP 815. The guidance contained within JSP 390 covers the responsibilities and duties required for laser safety.

1.2.3 The Military Laser Safety Committee (MLSC) publishes JSP 390 under the hierarchical structure, as shown in Figure 1; the reporting hierarchy is also shown in Figure 1. The MLSC is comprised of MOD and civilian experts in all aspects of laser safety and reports to the DOESB. The Military Laser Safety Review Panel (MLSRP) has representatives within the MOD and its contractors and reports to the MLSC.

## 1.3 Document structure

1.3.1 JSP 390 comprises two volumes:

a. Volume 1 – Policy. This provides the laser safety policy framework which applies throughout the whole acquisition cycle across the MOD. It mandates a series of requirements, processes, inputs and outputs which collectively support claims of inherent laser safety.

b. Volume 2 – Laser Safety Management System. This provides the procedures and techniques to be employed in order to implement the policy in Volume 1. Compliance with the risk management system detailed in Volume 2 will meet the requirements of Volume 1 and provide robust evidence that the levels of risk presented to personnel and third parties have been assessed and reduced so far as is reasonably practicable.

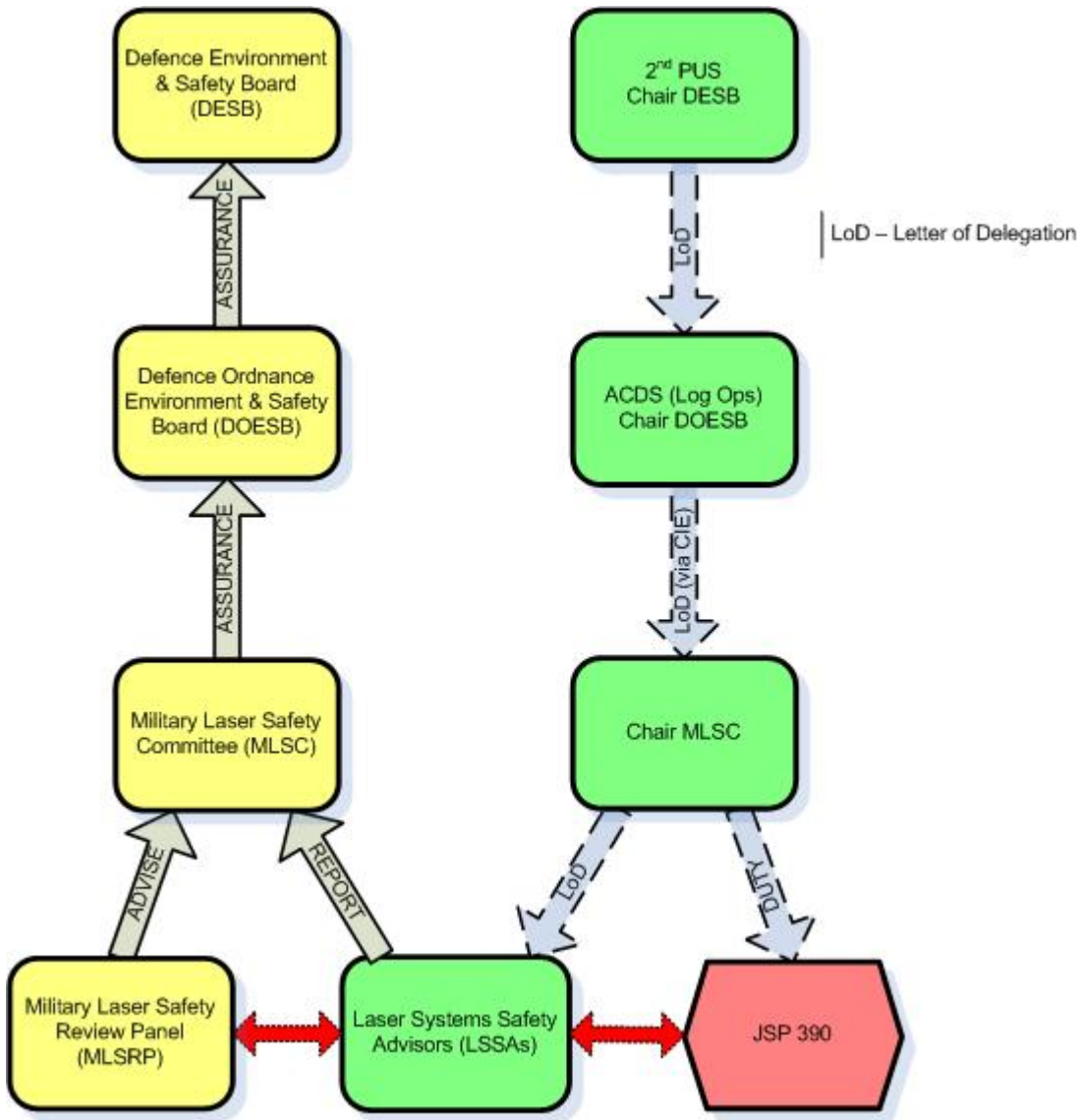


Figure 1: MOD Laser Safety Organisation



## 2. POLICY

### 2.1 General policy

2.1.1 The main hazard when using lasers is the beam of non-ionising radiation which can deliver large amounts of energy over a small area, and over long distances. In order to allow for the safe use of lasers, personnel must be prevented from exposure to levels of laser radiation which could cause injury

2.1.2 The Control of Artificial Optical Radiation at Work Regulations (CAOR) 2010 sets requirements for protection of employees from laser radiation. HSAW requires that employers and employees fulfil their 'duty of care' under Sections 2 and 7 of this Act and that employers comply with Regulation 3 of the Management of HSAW Regulations 1999 by conducting, recording and reporting risk assessments. In the event of an accident, failure to comply with the guidance found in harmonized standards such as IEC 60825-1:2007\* may result in prosecution of the organisation or the individual. The MOD has mandated that the direction given within JSP 390 must be adhered to by all persons operating laser equipment, regardless of where the laser is used (i.e. Operations, Training etc.). This will ensure that MOD fulfils its obligations under the HSAW (1974), Management of HSAW (1992) and CAOR (2010) regulations.

2.1.3 The MOD has a general policy of adopting best practice from industry and meeting or exceeding UK health and safety standards. Laser product safety in the civil sector is subject to several standards, principal amongst which is IEC 60825-1:2007. This has been adopted as the basis for the guidance published in JSP 390. Other standards which are covered by JSP 390 include BS EN 207 and BS EN 208. The purpose of JSP 390 is to ensure that exposure to laser radiation is kept As Low As Reasonably Practicable (ALARP), and is no greater than that required by UK legislation for all Crown employees, visitors and foreign military and civilian personnel operating on Crown Property. When lasers are used abroad, this policy will apply unless the host nation's processes are more restrictive.

### 2.2 Specific policy

2.2.1 In order to protect the public at, or near to, the boundary of MOD facilities or ranges, particularly if they may be using magnifying optics, the MOD has a general policy that the levels of laser radiation which may exit the range or facility boundaries will not cause injury to persons under reasonably foreseeable conditions. In training and maintenance operations, Service personnel and civilians will not be exposed to levels of laser radiation which may have an adverse effect to their health.

### 2.3 Appointments and duties

2.3.1 Any Project Team (PT) wishing to use or supply lasers, for any purpose, is to provide all necessary technical information required for certification (in the form of a Laser Safety Paper (LSP)) to the Laser Systems Safety Advisor (LSSA) in good time in order to ensure the clearance is provided for the planned in service or trial date.

2.3.2 An LSSA is responsible for implementing the policy of JSP 390 and is a member of both the MLSC and the MLSRP, and resides in the Defence Ordnance Safety Group (DOSG) and has this authority delegated from the Chairman of the MLSC. The duties of an LSSA include:

- a. Making an assessment of a laser system and generating the Military Laser System Safety Assessment Certificate (MLSSAC) from the information supplied by the PT and the sponsor.
- b. Providing advice on the safe use of lasers by reviewing the relevant Laser Safety Paper (LSP).
- c. Issuing policy and advice letters.
- d. Issuing MOD Form 2237 (MLSSAC). Please note MOD Form 2237 replaces the Military Laser Safety Clearance Certificate (MLSCC). All current MLSCCs are still valid and will be replaced by MOD Form 2237 MLSSAC upon their renewal.
- e. Issuing MOD Form 2238A; Military Laser Trial Safety Clearance Certificate (MLTSCC).

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\* IEC 60825-1:2007 – Safety of Laser Products – Part 1: Equipment Classification and Requirements

- f. Issuing MOD Form 2238B; Military Laser Range Safety Clearance Certificate (MLRSCC).

2.3.3 Within a unit/establishment all health and safety responsibility is vested in the Commanding Officer/Head of Establishment (CO/HoE). Where appropriate, the CO/HoE will appoint a Unit Health and Safety Officer (UHSO) and/or a Laser Safety Officer (LSO) who must maintain a register of lasers and ensure their safe use. Where the only laser devices held within an establishment are Class 1 for accessible emissions, an LSO does not need to be appointed.

## 2.4 Laser safety bodies

2.4.1 MOD organisations whose functions are to provide advice on the health and safety of personnel working with lasers are as follows:

- a. **MLSC** – The MLSC is the body which provides laser safety assurance to the Defence Environment and Safety Board (DESB) through the DOESB. Its function is to set laser safety policy, liaise with other MOD and external organisations, direct the MLSRP and associated working groups, and promulgate best practice to all MOD departments. It relies upon laser safety expertise from the LSSAs and the MLSRP.
- b. **MLSRP** – The MLSRP reports to MLSC and is composed of subject matter experts from MOD and industry. Its role is to act upon requirements set by the MLSC and advise MOD departments on technical and practical aspects of safety arising from the direct and indirect non-ionizing hazards from the lasers which are in use, or being developed or considered for use, by MOD.
- c. **Subject Specific Working Groups** – Working Groups are formed at the direction of the Chairman of the MLSC in order to address specific tasks or issues. These could be scientific investigations such as the properties of laser beams, or the assessment of a complex laser safety paper. The membership of each working group will consist of the most appropriate stakeholders. The working group will exist for the duration of the task and report to the MLSC through the MLSRP.
- d. **Defence Science and Technology Laboratory (DSTL) Environmental Sciences Department** – The Dstl Radiation Protection Advisor (RPA) Body, part of the Dstl Environmental Sciences Department, provides advice and services to the MLSC in non-ionizing radiological protection. Their primary functions are detailed in JSP 392 – Radiation Safety Handbook. Contact details can be found in the contact list.
- e. Within the MOD, the central co-ordinating branch for all policy questions arising out of the implementation of the HSAW Act is the Safety Sustainable Development and Continuity division (SSD&C).

## 2.5 MOD and Service laser safety responsibilities

2.5.1 **MOD Cap. [Sponsor]**. The MOD Capability (Cap.) sponsor is responsible for:

- a. Defining the laser requirement, including the specification of any general regulations for laser safety.
- b. Funding aspects of laser safety relevant to each equipment, including trials.
- c. Accepting laser-based equipment for specific Service use.

2.5.2 **PT**. The Project Team, managing the production and procurement of equipment employing a laser, is responsible for:

- a. The concurrent appraisal, within the development contract, of the risks of laser injury to personnel involved in operation, maintenance, inspection and development of the equipment, and to any others, including members of the public.
- b. The parallel development of laser safety precautions and safety equipment.
- c. The incorporation of such laser precautions into equipment manuals and publications.
- d. The preparation of laser training material for operating and maintenance personnel.

e. Ensuring that an LSP is prepared and presented to an LSSA for review in accordance with the requirements of Volume 2.

2.5.3 **The User (as defined by the Acquisition Operating Framework (AOF)<sup>\*</sup>)** is responsible for:

- a. Ensuring that the laser is operated in accordance with the direction given.
- b. Writing laser operational and maintenance orders.
- c. Providing personnel with appropriate information, instructions, training and supervision necessary for the safe operation and maintenance of the relevant laser equipment.
- d. The promulgation of laser safety instructions in equipments' user handbooks and any other instructions which may be issued from time to time.
- e. Seeking advice upon laser safety from the MLSRP if any change of use or technical modification is proposed during the service life of the equipment.
- f. Safe disposal of the laser, in accordance with Chapter 7.
- g. Ensuring that Class 3B and Class 4 lasers are treated as weapons by storing and securing them in accordance with JSP 440; The Defence Manual of Security. Civilian agencies should follow local security procedures and must, as a minimum, meet the requirements outlined in IEC 60825-1.

2.5.4 **Operator.** The operator's duty is to use the equipment in accordance with operating procedures and as commanded by their CO.

2.5.5 **Headquarters and Commands** are responsible for ensuring that LSOs are appointed when required and that laser safety policy and instructions are covered as necessary in ship, unit, station, establishment, range and training area orders. LSOs for this task are to be appointed by the Commander.

2.5.6 **Commanding Officer / Head of Establishment (CO/HoE).** CO/HoEs are responsible for the health and safety of all persons, including the general public, who might be affected as a result of any work carried out at the ship, unit, station or establishment: where this includes laser safety-specific instructions included. They should appoint personnel to assist them in the exercising of these duties. Multiple appointments are permissible provided they do not prejudice safety (e.g. combining the duties of Laser Safety Officer with those of Radiation Safety Officer).

2.5.7 **LSO.** A unit LSO is to be appointed by the CO or HoE in order to co-ordinate laser safety in any ship, unit, station or establishment where Class 3R, 3B or 4 lasers are in use. The duties of an LSO are detailed in Annex A.

2.5.8 **RSO.** The Range Safety Officer (RSO) should be appointed by the HoE owning the range. If the range has a significant laser responsibility, then the RSO must attend the laser safety course at the Defence Academy of the United Kingdom (DAUK). The duties of an RSO are detailed in JSP 403 Volume 1 – Handbook of Defence Land Ranges Safety – Range Management.

## 2.6 MOD agency responsibilities

2.6.1 Responsibilities for all safety, including lasers, in MOD Agencies are covered in the MOD Health & Safety Handbook. Owing to the nature of the work undertaken at these establishments, e.g. research and trials, it is often necessary to consider approval for individual scenarios. Responsibility for the implementation of safety rests with the Heads of Establishments. The Head of Establishment should consult an LSSA for advice at an early stage when considering new laser work or facilities. All personnel whose duties involve the use of lasers must be given training appropriate to their duties. The specific responsibilities for executives whose remit includes laser safety are detailed below.

2.6.2 **UHSO [Safety, Health Environment and Fire (SHEF) advisor/officer, Safety advisor].** The UHSO is responsible to the HoE for the appointment of LSOs. Their duties include the sanction of local laser safety rules and procedures.

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\* [http://www.aof.dii.r.mil.uk/aofcontent/operational/org/user/user\\_purpose.htm](http://www.aof.dii.r.mil.uk/aofcontent/operational/org/user/user_purpose.htm)

2.6.3 **LSO.** The LSO's duties include providing competent technical advice, based upon this and other relevant documentation, on all aspects of laser safety. The LSO should be the first point of contact on all laser safety issues within their establishment. The duties of an LSO are detailed in Annex A.

2.6.4 **Divisional safety advisors.** Divisional safety advisors are to ensure that staff with laser equipment have registered their lasers with the UHSO, and have also notified the UHSO and medical section of the names of authorized users.

2.6.5 **Authorized users.** Only authorized users can operate the laser, taking account of the laser safety advice given by the LSO, having successfully completed suitable training and subject to any local safety rules.

## 2.7 Civilian organizations using lasers on MOD ranges

2.7.1 Private, academic or commercial organizations occasionally seek permission to carry out private venture laser trials on MOD ranges. If the RSO is tasked by the appropriate Service authority to provide facilities or assistance for such work, they should seek the advice of the MLSC. In respect of laser safety liability, the following conditions shall apply:

In general legal terms, primary responsibilities under Sections 2 and 3 of the HSAW Act would lie with the civilian organization, with MOD having secondary responsibility because of its role as the occupier (controlling the premises) under Section 4 of the HSAW Act and under the Occupier's Liability Act (1957). The general duty thus placed on MOD requires that all reasonably practicable precautions are taken in order to protect the health and safety of those who might be affected by activities on the range. The private, academic or commercial organisation will have a similar duty, with additional specific responsibility for their own employees and those MOD personnel involved in their operations. Beyond these general duties, the MLSC have not identified any special legal requirements. The LSO must be given a copy of the trials plan and the MLSSAC issued prior to the trial taking place; they may then elect to be present during the trial but this is not mandatory.

2.7.2 It is essential that the Commander / HoE ensures that all practical precautions have been taken and are in place before allowing work to commence or continue and all requirements of JSP 390 are met in full.

## 2.8 Self certification

2.8.1 Individual organisations or establishments involved in trials work may be permitted to self-certify laser trials at specific sites, with the LSSAs acting as the laser safety auditors. In order to achieve this independence, the organisation concerned must demonstrate, to the satisfaction of the LSSAs, that it has a strong safety management culture and the appropriate technical skills to produce suitable and sufficient laser safety assessments. The Chairman MLSC and the organisation or establishment concerned will produce an agreement document outlining the self-certification procedures and auditing arrangements. This does not abrogate the Commander's / HoE's responsibility under the Occupier's Liability Act (1957).

## 2.9 Qualifications and training

2.9.1 All Division, Command, unit and establishment LSOs must attend an MLSC-approved laser safety course. The approved LSO courses are held at the DAUK Shrivenham, or alternatively, receive MLSC-approved instruction as part of a career course.

2.9.2 **Laser safety course.** The two-day laser safety course, held at the DAUK Shrivenham, can accommodate up to 100 students per annum of any ranks or MOD civilian status. The courses are held 4 times per year. Applications for a course place should be submitted at least four weeks in advance through the appropriate service training officer. See contact list. An LSO is required to retake this course every five years. However, those who work infrequently with lasers should retake the course every three years.

2.9.3 **Naval Laser Safety Course.** A laser safety course exists for Royal Navy personnel, particularly Weapon Engineering Officers (WEOs), and is taught at HMS Collingwood. Persons who successfully complete this course can hold the position of LSO (RN), which gives them the same duties and responsibilities as an LSO but within the naval environment only.

2.9.4 **Laser operators.** All personnel responsible for the firing of a laser are to receive appropriate laser safety training. The training is to be co-ordinated by the Service sponsoring the introduction of the

equipment. The documentation for the introduction into service of any laser equipment must include the procedures for training the user. Such procedures must be in place before approval will be given by an LSSA.

2.9.5 More advanced training may be obtained from specialist courses; an LSSA can advise upon suitable suppliers of this training. Range procedures must ensure that all relevant staff have received a briefing on any laser hazard which exists and that a qualified LSO/RSO has reviewed the planned laser activity.

## **2.10 Safety management system**

2.10.1 The MLSC has a robust system of safety management (both in this document and in Volume 2) in order to ensure that laser hazards are identified, categorized, risk-assessed, subjected to a mandated certification process. The MLSC is also responsible for the continuing maintenance of the agreed standards and procedures, and will be involved in the lifecycle of each laser system.

2.10.2 The first stage of the process is the production of a LSP. This should be written by the PT in order to provide the LSSAs with sufficient technical data such that they can identify and categorize the hazard(s) posed. It should be noted that certain types of laser do not require an MLSSAC, as is detailed in Annex B and in Volume 2. The LSP should contain details of the intended method of deployment, maintenance and training for use of the laser or system. Following review by an LSSA and any problems are resolved, an MLSSAC is issued. LSSAs will keep copies of all MLSSACs, LSPs and the supporting information and calculations against possible future audit. MLSSACs have a limited validity and will be reviewed before being re-issued. The duration of an MLSSAC is normally related to the hazard posed by the laser or its complexity of operation. Users requiring copies of the MLSSAC should consult the relevant PT. For a full description of the processes involved in producing an LSP Volume 2 should be consulted.

## **2.11 Laser safety certification**

2.11.1 Due to the associated laser hazards, with the exception of systems with no accessible emission (such as CD players, laser printers or ring laser gyroscopes), no laser system, or associated procedures, may be used in training or in service, without the approval of an LSSA. The MOD has a duty of care to ensure the safety of unprotected persons who may be in the vicinity of the laser during firing. All laser systems, therefore, must have an MLSSAC before they can be used in training and/or in service. Systems containing laser devices that are completely enclosed such that there is no accessible emission do not require certification.

2.11.2 When a laser system is used, persons within the hazard zone, known as the Laser Hazard Zone (LHZ), are at risk of exposure and subsequent risk of eye and/or skin damage. The LHZ is considered to be a danger area, within which all persons must be protected either by engineering controls (e.g. within buildings/shelters), administrative procedure or by use of Personal Protection Equipment (PPE).

2.11.3 Laser safety advice is provided by an LSSA to the PT throughout the acquisition process. Prior to the In-Service phase of the process, the certificate will clearly state any constraints placed upon the firing of the laser, highlight the known hazards and residual risks arising from use of the laser system and will define the LHZ of the system.

2.11.4 When laser equipment is being trialled a trials clearance (MLTSCC) is required. This will be provided in the form of a trials certificate. The trials certificate is only valid for a stated location, expected period of the trial, trials procedure and specified laser equipment.

2.11.5 At a minimum, a laser system must have a laser classification and a LHZ, which will define an exclusion zone which will be used during trials and training. Where a laser system is attached to a platform, it is the responsibility of the platform PT to hold and initiate a review of the laser safety procedures, specifically (but not limited to) the associated Nominal Ocular Hazard Distance (NOHD), contained in the LSP. If the LHZ is too large for the range/ Dry Training Area (DTA), advice must be sought from an LSSA and, if appropriate, a MLRSCC may be issued.

2.11.6 Standards used by the LSSAs in preparing MLSSACs, MLTSCCs, MLRSCCs:

- a. BS EN 207:1999 – Specification for Filters and Equipment used for Personal Eye-protection against Laser Radiation.
- b. BS EN 208:1999 – Specification for Personal Eye-protectors used for Adjustment work on Lasers and Laser Equipment.

- c. IEC 60825-1:2007 – Safety of Laser Products Part 1: Equipment classification and requirements.
- d. DEFSTAN 00-55 – Requirements for Safety Related Software in Defence Equipment.
- e. DEFSTAN 00-56 – Hazards Analysis and Safety Classification of Defence Systems.
- f. JSP 336, Volume 2, Part 3 – The Defence Supply Chain Manual.
- g. JSP 336, Volume 12, Part 3, Pamphlet 6, Section 2 – Personal Protective Clothing (PPE) [December 2004].
- h. JSP 375 – MOD Health and Safety Handbook.
- i. JSP 390 – Military Laser Safety, Volume 2 – Laser Safety Management System.
- j. JSP 392 – Radiation Safety Handbook.
- k. JSP 403 – Defence Land Ranges Safety.
- l. JSP 418 – The MOD Sustainable Development and Environmental Manual.
- m. JSP 454 – MOD System Safety and Environmental Assurance for Land Systems.
- n. JSP 520 – Ordnance, Munitions & Explosives Safety Management System.
- o. JSP 602 – Information Coherence Directions – Directions and Guidance.
- p. JSP 815 – Defence Environment and Safety Management.
- q. PD IEC TR 60825-14:2004 – Safety of Laser Products Part 14: A user's guide.
- r. STANAG 2900 – Laser Radiation – Medical Surveillance and Evaluation of Overexposure.
- s. STANAG 3606 – Laser Safety In Outdoor Military Environments.
- t. STANAG 3828 – Aircrew Protection against Laser Designators.
- u. Control of Artificial Optical Radiation Regulations:2010.

## 2.12 Procedures

2.12.1 During the acquisition process an LSSA may be tasked to produce an MLSSAC for the PT. The level of restriction will depend upon the detail provided in the LSP.

2.12.2 Once the LSP has been reviewed and the hazard calculations are complete, LSSA advice is prepared and subjected to internal review. All calculations are subject to independent verification. Upon completion of the review, copies of the MLSSAC are issued to the PT and, in certain cases, the user. Copies of the LSP and review evidence is archived by the LSSAs.

2.12.3 The MLSSAC forms the basis for the laser safety measures included in the Safety Case and is promulgated to the user by the PT. The Safety Case report should demonstrate that, where applicable, an MLSSAC has been obtained, and that appropriate operating procedures are in place to allow safe use of the laser equipment. The MLSSAC will contain any caveats about the use of the laser, or assumptions made about its operation or performance.

## 2.13 Review

2.13.1 Laser Safety Advice is reviewed:

- a. Every 3 years, but may be more frequent under special circumstances, such as devices with very high emissions or where low fidelity information is provided resulting in an overly cautious hazard distance.
- b. Due to changes to the parameters/use of the laser system.
- c. In the event of an incident or accident which may have arisen.

## 2.14 Accidents and incidents

2.14.1 Definition of an **Incident** – An incident is an unplanned event with the potential to cause harm to personnel, the public, equipment or the environment.

2.14.2 Definition of an **Accident** – An accident is an unplanned event which results in injury or suspected injury to personnel or the public, or damage to equipment or the environment.

2.14.3 In the unlikely event of an accident or incident the safety management policy requires the following actions to be undertaken:

- a. The details must be reported according to the process set out by the appropriate Service/Agency/MOD Centre.
- b. Take action as prescribed in Volume 2. It is mandatory for units operating lasers to have a documented accident response procedure.

2.14.4 The role of incident-reporting in policy implementation is to determine the cause of the incident rather than to apportion blame. If the incidents which are reported highlight potential flaws in procedure, equipment or training, these will then be identified and rectified. Accidents and incidents must be reported in accordance to both JSP 375 and, in the land environment, LFSOs 3202 and 3216.

## 2.15 Health monitoring and surveillance

2.15.1 Based upon the advice of the Health Protection Agency (HPA) and the Royal College of Ophthalmologists (regarding the purpose and benefit of laser eye examinations) the **MOD does not mandate eye examination before commencing laser use or at termination of involvement with lasers. An eye examination will be undertaken after an accident where exposure is suspected or known to have occurred; such examinations shall be carried out by a competent person.**

## 2.16 Procurement and disposal of lasers

2.16.1 If the MOD procures lasers from outside the European Union (EU) without using an identifiable importer and supplier, the responsibility for Conformité Européenne (CE) marking, Low Voltage Equipment classification and Laser Hazard/Classification marking are assumed by MOD. For this reason it is not MOD practice to act as an importer or supplier of lasers.

2.16.2 When disposal of lasers is required certain precautions are to be observed:

- a. Lasers which may cause a threat to health or become a viable threat to MOD personnel must not be re-sold. Such lasers should be destroyed by a reputable company, which is on the MOD list of registered disposal agents.
- b. There may be non-beam hazards associated with the laser, such as high voltages, noise, cryogenic systems or substances which are hazardous to health and/or the environment. These issues will require JSP 418 and Project Oriented Environmental Management Systems (POEMS) to be consulted. The Disposal Services Authority (DSA) is responsible for decisions relating to the sale or disposal of surplus equipment and JSP 886 Pamphlet 9 contains the disposals policy guidance material.
- c. The capability of MOD laser equipment is often classified; any disposal must be conducted such that the disposal process does not permit reverse-engineering, does not compromise classified data or equipment capability.
- d. If experimental lasers which require consumables, such as lasing dyes or coolant, are to be purchased, an environmental management plan will be required. The majority of laser dyes are toxic or carcinogenic and many coolants are subject to Control Of Substances Hazardous to Health (COSHH) and environmental regulations.

2.16.3 LSSAs require that PTs disposing of lasers notify them in order that the laser's certificates can be withdrawn and the file closed. Full details of procurement and disposal policy are given in Chapter 7.

## 2.17 Probabilistic Risk Analysis (PRA)

2.17.1 In circumstances where a platform-mounted laser of Class 3B or Class 4 is assessed using deterministic risk analysis results in impractical hazard traces, a probabilistic laser safety assessment

may be used. The general policy concerning probabilistic laser safety assessment provides that there will not be a greater than a 1 in 100 million probability per engagement of a laser causing ocular damage to persons outside MOD property.

2.17.2 Probabilistic safety is a commonly used technique in ballistic range safety, complex industrial processes and many areas of civilian life.

2.17.3 The MLSRP uses a mathematical model written specifically for the purpose, and will only accept results from this model. Probabilistic modelling will incur a cost which will be passed onto the PT wishing to bring the laser into service.

2.17.4 Probabilistic laser safety is described in Volume 2, with the minimum requirements to undertake probabilistic laser modelling.

2.17.5 It is the policy of the MLSC to use probabilistic modelling only where procedures and deterministic risk analysis fail to deliver a practical solution for UK training areas. To determine the requirement for probabilistic laser safety modelling, the PT should present the MLSRP with sufficient technical details at an early stage of procurement.



### 3. LASER SAFETY IN THE NON-RANGE ENVIRONMENT

#### 3.1 Introduction

3.1.1 There are quite different safety requirements for laser activities which are neither part of military training nor trials in range environments. The over-arching concept of military laser safety policy in the UK is that of the 'Warned but unprotected' drill. This is based upon the reasonable assumption that ranges are controlled areas, where personnel are routinely prevented from encountering hazards (such as projectiles or explosions) by the use of procedures and administrative controls, as opposed to physical barriers or protective devices.

3.1.2 The policy is that of preventing, where reasonably practicable, any laser radiation which could pose a hazard from exiting the boundaries of the test or maintenance area, and from preventing laser radiation exiting the boundaries of Crown Property.

3.1.3 The policy contained within JSP 375 and JSP 815 stresses the importance of MOD's compliance with all UK safety regulation. Many non-range laser activities bear a similarity with industrial and research activities carried out in the civilian sector. MOD policy will incorporate best practices in industry into its own safety policy.

3.1.4 All lasers operated by MOD Employees or on MOD Property must be used in accordance with JSP 390. The basis for JSP 390 is the EU standard: IEC 60825-1:2007; hence compliance with JSP 390 will ensure compliance with prevailing UK legislation. This is useful in forming policy and procedures for non-range laser safety, since best practices from industry can be adopted. The HPA is the government body which advises on laser safety in civilian organisations, and should be consulted where MOD has adopted civilian laser equipment or practices. The users of laser equipment off-range must note that an LSP is still required by an LSSA, additionally MLSSACs are required for all laser equipment.

#### 3.2 Types of non-range laser facilities covered by this chapter

3.2.1 Mobile repair facilities, such as those operated by the Royal Electrical and Mechanical Engineers (REME), the Royal Air Force (RAF) and civilian contractors for the purposes of maintenance, repair and servicing of equipments (such as laser rangefinders in armoured vehicles and aircraft).

3.2.2 Laser activity which is carried out in order to adjust or test the laser in hangars or in open air.

3.2.3 Test procedures for systems fitted to platforms such as aircraft and ships which need to be performed before a sortie or deployment in order to confirm operation within operational parameters.

3.2.4 The testing of aircraft fitted with laser-based Defensive Aids Suites (DAS).

3.2.5 Interior bore-sight alignment of target acquisition systems.

3.2.6 The functional testing of some Intelligence Surveillance Target Acquisition Reconnaissance (ISTAR) pods fitted to aircraft and helicopters which have integral lasers.

3.2.7 Fixed test and repair facilities for lasers with large output power.

3.2.8 Mobile Non Destructive Test (NDT) and paint-removal systems.

3.2.9 Fixed experimental laser facilities.

3.2.10 Portable lasers used for environmental monitoring, law enforcement and asset tracking.

#### 3.3 Non-range laser safety policy hierarchy

3.3.1 The hierarchy of laser safety policy in non-range environments is as follows:

a. **Remove The Hazard.** Carry out the activity using enclosures, interlocks and remote operation of equipment so there is no possibility of any person being exposed to laser radiation, effectively making the process a Class 1 system.

b. **Remove Personnel From Hazard Areas.** If the above procedure cannot reasonably be applied ensure only those persons vital to the effective operation of the laser equipment are permitted to operate the system.

c. **Protect Personnel Who May Be Exposed to The Hazard.** Where personnel may be exposed to laser radiation, the exposure must not exceed the Maximum Permissible Exposure (MPE), for both eye and skin exposures. The exposure should be kept to ALARP in

accordance with JSP 375. The protective devices and personal protective equipment must comply with all legislation (e.g. BS EN 208) and should ensure the minimum practical exposure.

3.3.2 **Note:** The methodology of ALARP exposure should be reviewed periodically to ensure that recent technical developments do not allow for improved reduction of risk.

### **3.4 Laser safety certification for non-range laser safety**

3.4.1 When using lasers indoors, such as in a laboratory, medical facility or within an industrial process, IEC 60825-1 must be adhered to, as well as any local safety procedures. A MLSSAC will not be required. For other non-range laser activities a MLSSAC is required, unless explicitly exempted in writing by an LSSA.

3.4.2 Laser activity will require a risk assessment to be carried out to a 'Suitable and Sufficient' standard, such as those defined in CAOR 2010, JSP 375 and JSP 815 before physical and procedural safety requirements can be agreed with the LSSA. An LSP is required for each laser system. Upon satisfactory risk assessment and control procedures being agreed and documented, the LSSA will issue laser safety clearance certificates on the following basis:

- a. Every maintenance, test and research facility requires approval from an LSSA resulting from a satisfactory risk assessment, which defines the physical and procedural safety measures employed and the exact methodology of the operations to be performed.
- b. The risk assessment will identify the hazards and vulnerable personnel, describe the control measures and describe the residual risk associated with the operation.
- c. The risk assessment will define all lasing procedures.
- d. Where procedures for mobile test or maintenance of equipment are required, the LSP must contain the following: an agreed laser hazard zone resulting from the activity, and proof that this will be contained by physical beamstops, or be within a marked and picketed cordon which is wholly inside the boundaries of Crown Property.
- e. When lasing is required for mobile maintenance, workshop or medical facilities the LSP must define how administrative controls (e.g. working practices) and/or engineering controls (e.g. physical barriers) will reduce the risk such that if any person not directly connected with the maintenance, workshop activity or medical procedure shall not be irradiated.

### **3.5 Responsibilities for non-range laser safety**

3.5.1 The responsibilities outlined in this chapter also apply to range use. Within a unit or establishment, safety is the responsibility of the CO/HoE. An LSO is to be appointed in any unit or establishment having laser test, maintenance or research facilities. The LSO is to have a copy of all MLSSACs and procedures issued to the unit. It is the duty of the LSO to advise on safe operating procedures, and on the suitability of safety equipment such as interlocks and PPE. The designated operators of the laser equipment are responsible for ensuring that they observe the agreed operating procedures and that safety equipment is being used correctly and in serviceable condition. All control measures described in the risk assessment must be in place and functional. All parties must ensure that visitors to the unit are briefed on the hazards and have been trained in the use of PPE where appropriate.

### **3.6 Contractors and other agencies using lasers for test and maintenance procedures on Crown Property**

3.6.1 Private, academic, commercial and GoCo staff often carry out laser test, research and maintenance operations on MOD Property. Any such person must comply with the requirements of JSP 390 and all other relevant health and safety legislation whilst on MOD Property. Such persons will be subject to the full MLSC approval process. The contractor must inform the unit or establishment LSO before commencing any laser-emission activity, and be in possession of the MLSSAC and any other relevant operating procedures. MOD will require the contractor to provide proof of adequate liability insurance.

### **3.7 Instructional laser pointers**

3.7.1 MOD policy for instructional laser pointers is that they must be only Class 1 or Class 2. Pointers procured from a reputable source, and bear IEC 60825-1:2007 hazard markings are exempt from LSP

and MLSSAC approval systems. If the LSO is not satisfied that any pointer is within this definition he should withdraw it from use until an LSSA has been consulted. Many pointing devices from sources outside the EU have counterfeit or incorrect hazard markings. A device sold within the EU must be subject to IEC 60825-1:2007 standards and will thus be correctly marked and assessed by the manufacturer or distributor. Lasers with outputs in excess of the Class 2 Accessible Energy Limit (AEL) are never to be used for instructional purposes.

## 4. RANGE AND TRAINING AREA LASER SAFETY – LAND, SEA AND AIR

### 4.1 Introduction

4.1.1 The MOD policy on range laser safety is dominated by two principal requirements: The first is to ensure that all service personnel and civilians on or around training areas are protected from exposure to hazardous levels of laser radiation. The second is for realistic training to be possible whilst all guidelines and legal requirements (both civilian and military) are adhered to. This is a challenging requirement given the following two factors need to be taken into account: The UK ranges are often close to areas of significant population and are often in areas used for tourism and leisure pursuits. The second is the increasing use of lasers for many aspects of military operations and the considerable hazard distances posed by some systems, e.g. target illuminators/designators. The MLSC's mission is to promote the safe use of laser technology used in military equipment, whilst ensuring that all laser firing is performed in a safe manner, compliant with all UK health and safety regulations, in particular, JSP 403 – The Handbook of Defence Land Ranges Safety.

4.1.2 For the purpose of this document the term MoD Range should be understood to include Dry Training Areas (DTAs).

### 4.2 General policy

4.2.1 All laser activity on a range must be approved by the Range Administering Unit (RAU). An RSO will normally be trained as an LSO; if this is not the case, an LSO should be consulted by the RSO. The duties of RSO with respect to laser use are described in Annex A. Generally laser beams and reflections which exceed Class 1 energy levels should not be allowed to exit range boundaries nor enter non-hazard areas of the range.

4.2.2 Any laser being used on a range must have an MLSSAC issued by an LSSA. It is the duty of the RSO and the user to ensure that the details in the MLSSAC are understood and that it is extant.

4.2.3 Laser firing can only be performed inside the range or training area boundary and from locations agreed with the RSO. All of the provisions detailed in Volume 2 should be taken into account in order to ensure that this is achieved.

4.2.4 Lasers fall into hazard classifications as described in Volume 2. If the laser hazard class is:

- a. Class 1 and Class 2 – these lasers may be used outside of the approved areas.
- b. Class 1M and Class 2M – these lasers can be treated as Class 1 and Class 2 lasers respectively, however, they may pose a risk to observers using magnifying optics. If these lasers are used such that their Extended Nominal Ocular Hazard Distance (ENOHD) does not exceed range or hazard area boundaries they may be fired from any point within the range or training area, otherwise they must be treated as Class 3R lasers.
- c. Class 3R, Class 3B and Class 4 – can only be used under the following conditions:
  - (1) On MOD ranges, GoCo operated MOD ranges and Dry Training Areas (DTAs), provided the hazard distance template stated in the user handbook or in the MLSSAC fits within the range or training area boundary and control measures are put in place in order to ensure non-authorized personnel cannot enter the LHZ. Should the exclusion template be too large for the range or training area, advice must be sought from an LSSA and, if appropriate, an MLRSCC (MOD Form 2238B) may be issued.
  - (2) On non-MOD ranges, after any MOD Employees involved have obtained approval from an LSSA. MOD personnel must comply with JSP 390 when using lasers in the UK.
  - (3) At other test or trials sites when an LSSA has been consulted and has granted written permission.
  - (4) In the case of all trials on MOD ranges and DTAs, an MLTSCC MOD Form 2238A will be required to be issued by an LSSA before trials can commence. This policy is applicable to sea and air trials and training.

4.2.5 Where magnifying optics, such as binoculars, are being used, special conditions are imposed. If there is no suitable protective filter fitted, commensurate with the laser being used, the following two policy statements apply.

- a. No magnifying optics must be used within the ENOHD of the laser.
- b. The hazard area is now determined by the ENOHD (not the NOHD).

4.2.6 It should be noted that, in the case of visible lasers, outside the NOHD (including for Class 1 and Class 2 devices) dazzle can still occur, and although this will not cause any permanent ocular damage, there may be safety implications due to temporary visual impairment.

4.2.7 Service personnel working or training on ranges are frequently engaged in very hazardous activities such as live weapons'-firing. The safety of individuals is normally achieved solely by the use of administrative and engineering controls (e.g. procedures and physical separation of the individual from the hazard); an example being the absolute ban on personnel from the hazard zone during firing and the physical separation of the individual from the hazard zone using signs, fences, patrols and warning flags.

4.2.8 It is not good practice solely to rely upon protective equipment to protect personnel from the effects of live firing during training activities, since faulty, damaged, incorrectly specified or employed protective equipment may fail to protect the user. Protective equipment, therefore, is not normally a primary safety methodology. Additionally, it is difficult to ensure that every person involved in the training has been issued with protective equipment, has been trained in its use, will be wearing it at the appropriate moment and has protective equipment which is pertinent to the particular hazard involved. Furthermore there is a requirement to ensure that any Personal Protective Equipment (PPE) issued is in serviceable condition. There are considerable cost and logistical issues relating to the mass use of PPE. Many forms of PPE reduce user's situational awareness and hence can constitute a hazard in their own right.

4.2.9 All persons present, therefore, are warned of the hazards posed by lasers and protected by the implementation of procedures which should ensure no person is ever exposed to hazardous levels of laser radiation.

### **4.3 Targets and target areas**

4.3.1 Considerable hazards may arise from reflected laser beams as a result of using targets which are specular (i.e. reflective, as in the manner of a mirror) or become so when wet. MOD policy forbids the engagement of targets not previously authorized by the range control staff. Ultimate responsibility for decisions about which targets are engaged resides with the RSO.

### **4.4 The hierarchy of responsibility**

4.4.1 When lasers are used on a range the RAU's LSO is responsible for laying down any additional control measures pertinent to the range that must be adhered to by laser users. The Range Conducting Officer (RCO) has a responsibility to ensure that the range's orders are adhered to and that the laser is operated in accordance with the MLSSAC and the Range Administering Unit (RAU) procedures. The operator is also responsible for ensuring only the correct target is engaged, and that a warning is issued before laser firing commences and this warning is cancelled only after firing is complete. It is also the operator's duty to ensure laser firing is terminated if any person is seen in, or entering, the laser hazard area. If there is any accident or incident (actual or suspected) involving a laser, it is the operator's responsibility to inform the RAU immediately.

### **4.5 Land ranges**

4.5.1 Land ranges are usually bounded by public or private property. Many ranges are bounded by Schedule 1 land which, although MOD property, is subject to use by tenants (often agricultural) and the general public exercising their right to use public rights-of-way (footpaths, bridleways and off-road tracks subject to public rights of use). The prevalence of civilian activity on range boundaries and rights-of-way which cross MOD Property dictates that laser safety policy addresses the possibility of persons viewing activity on the range using magnifying optics from these off-range positions.

4.5.2 Except where Probabilistic Risk Analysis (PRA) is employed, the policy of prohibiting laser beams exiting the range with intensities which exceed the AEL of a Class 1 laser is used, in order to ensure that persons on the range boundary cannot be subject to hazardous exposures from laser

activities on the range, even when using magnifying optics. This may often prove impossible unless the measures described in Volume 2 are adopted. Engagements involving moving lasers require special planning to be carried out in order to ensure policy is adhered to; an LSSA should be consulted in these circumstances.

## **4.6 Air to ground ranges**

4.6.1 Many airborne laser devices pose a hazard to personnel on the ground, in-flight or to the public. The aircrew must operate in accordance with Air Command Air Weapon and Electronic Warfare Range Orders (ACAWEWROs).

4.6.2 In order to use a laser device in a scenario not explicitly permitted by the ACAWEWROs, a MOD Form 2238B (MLRSCC) must be sought from an LSSA providing clearance for the requested scenario.

4.6.3 A MOD Form 2238B can only be issued for systems with an extant MOD Form 2237 (MLSSAC). Assessing the scenario in order to provide a MOD Form 2238B may require PRA and provision of resources.

4.6.4 Once a MOD Form 2238B has been issued, the aircrew can apply it immediately and it will be incorporated into the next edition of the ACAWEWROs.

4.6.5 An exception to the above procedure is granted when an airborne laser is used when its Extended Ocular Hazard Distance (EOHD) is smaller than the minimum height Above Ground Level (AGL) at which it can be fired. There must be sufficient engineering or procedural controls which will limit laser firing to times when the platform is above the EOHD and at least the EOHD from another aircraft or occupied building. This also applies off-range within the UK, provided local procedures are met.

## **4.7 Air to air ranges**

4.7.1 There are relatively few air-to-air engagements using lasers. The MLSC will develop policy as and when the need to operate such systems arises. Generally, those at risk from exposure will be aircrew and, if procedural laser safety is not possible, PPE or platform-protective equipment will be employed.

## **4.8 Naval laser range safety**

4.8.1 The naval environment is at variance with land range laser safety, as there are no identifiable range boundaries for most ranges or training scenarios. It is also likely that the engaged target will be a ship, submarine or aircraft, which has the added problem of manned targets. The naval environment also involves wet targets and seawater-reflected laser beams, and hence increases the probability of unpredictable specular reflections. The rules contained in BR 1043B Gunnery and Guided Weapon User Instructions apply to all Class 3R, Class 3B and Class 4 lasers. Naval laser safety policy is as follows:

- a. No person aboard the laser-firing platform, the target, or any vessel in the range or near its periphery should ever be exposed to hazardous levels of laser radiation.
- b. Engagement of targets which are manned will be necessary, but must be carried out only after a warning is issued to the target that it is to be illuminated. The target vessel must acknowledge the warning and laser firing may commence only after this acknowledgement is received. The target vessel must issue a warning to its crew that the ship firing its laser is not to be observed with magnifying optics. If possible, observation of the ship firing its laser should be made using remote systems such as cameras.
- c. The platform firing its laser must issue a cancellation of the warning when firing is complete. The platform firing its laser is to exercise special caution where submarines using periscopes may be present, as communication with them may not be possible and powerful magnifying optics are employed within periscopes.
- d. A lookout for vessels entering the laser hazard area is to be maintained using optics which are protected from laser reflections or are remote systems. Upon any unauthorised vessel entering the hazard area, all laser firing must cease.

4.8.2 The responsibility for laser safety lies with the Captain of the vessel firing its laser. The Captain may delegate other matters of laser safety to the appointed LSO.

## 5. PERSONAL PROTECTIVE EQUIPMENT

### 5.1 Policy

5.1.1 The MOD operates a policy of 'warned but unprotected drill' (Chapter 3) in many cases where service personnel are training with lasers. There are, however, many maintenance, trials and test scenarios where PPE is an appropriate safety measure, and where its use falls within MLSC policies. The MLSC have incorporated all of the requirements of IEC 60825-1:2007 within this JSP. Additionally, the MLSC has adopted the practices contained within BS EN 207 and BS EN 208 in order to formulate its policy on PPE. The regulations which govern personal protective clothing are the Personal Protective Equipment at Work Regulations 1992 (as amended).

5.1.2 There are some laser systems in service which will require PPE not covered by BS EN 207 or BS EN 208. This is due to the requirement for some test and trials operators to be protected against skin burns from powerful laser systems currently entering service, or from a variety of experimental laser systems. Those persons requiring PPE for skin protection should consult an LSSA directly.

5.1.3 Any PPE issued is to be used only for the specific laser system or systems for which it was obtained. The MLSSAC for any laser requiring PPE will state the Optical Density (OD) of the PPE required and the wavelength(s) for which it must be effective. The PT procuring PPE for a laser system must consult with an LSSA before purchasing any equipment.

5.1.4 Hoods and gauntlets used as laser PPE should be issued on a personal equipment basis in order to avoid health and safety issues relating to cross-infection. Goggles may be issued to a unit as non-personal equipment. Where goggles are used they must be suitable for use by spectacle wearers. Goggles must be issued with suitable containers in order to protect them when not in use. The cleaning of goggles using 'non-approved' methods or materials will often render them unserviceable; PTs procuring goggles must procure suitable cleaning materials or issue procedures which will allow safe and effective cleanings.

5.1.5 There are two types of goggle specification; BS EN 208, which relates to protection during alignment of visible lasers, and BS EN 207 for protection from any type of accidental exposure to harmful levels of laser radiation. Goggles specified for BS EN 208 purposes (alignment) must never be used for BS EN 207 purposes.

5.1.6 PPE must be CE marked in compliance with the Personal Protective Equipment Regulations 2002 except where exempt under HSE L25 – Personal Protective Equipment at Work. This further states that:

- a. PPE is provided where necessary.
- b. It provides adequate protection for its intended use.
- c. Those using it are adequately trained in its safe use.
- d. It is properly maintained and any defects are reported.
- e. It is returned to its proper storage after use.

5.1.7 When trials or training make the use of lasers against manned platforms necessary (moving targets on land ranges, some air-to-air engagements and most vessels on sea ranges), persons not protected by the structure of the platform or by the use of remote viewing systems, must be issued with suitable PPE.

## **6. MEDICAL**

### **6.1 General policy**

6.1.1 It is MOD policy that workers using laser equipment are not given regular eye examinations for the purposes of health surveillance. The advice from the Royal College of Ophthalmologists and the HPA is that the risks posed by regular laser eye examinations outweigh any possible benefits in terms of the detection of pathology. Additionally, it does not control the risk of laser exposure.

6.1.2 Eye examinations are only performed if a suspected or actual laser incident or accident occurs, during which persons may have been exposed to laser radiation which had the potential to cause them harm.

6.1.3 It should be noted that some lasers can cause skin burns.

### **6.2 Laser accident and incident reporting**

6.2.1 Any incident or accident resulting from the use of lasers is to be reported in accordance with Service/Agency procedures. Each Service and MOD Agency is to pass on the details of such incidents/accidents to an LSSA as soon as practicable. The appropriate authority within the Service/Agency/MOD Centre will convene a formal inquiry into any accident resulting in damage, injury or death. Significant incidents must be subject to a similar inquiry process. The inquiry into any accident or incident is to be conducted in accordance with the appropriate Service/MOD Agency regulations and procedures. The incident or accident will be reported on the Incident Recording Information System (IRIS) under non-ionising radiation section.

### **6.3 Planning medical support in case of an accident**

6.3.1 Many establishments in which lasers are fired have some form of medical facility. Whilst the rapid intervention of trained medical staff is desirable in the event of a laser accident, the treatment required will often be outside the unit medical facility's capability. It is desirable, therefore, that all laser ranges, workshops and establishments in which laser firing takes place have a medical evacuation plan. This should be written and agreed before laser firing operations commence. Normally, the casualty will be taken to the nearest accident and emergency unit. The plan for a laser incident should contain contact details for this facility and the method of transport which will be employed. In some range environments an ambulance with off-road capability or a helicopter would be required. If possible, the nearest local hospital's ophthalmology department should be consulted when the evacuation plan is being made in order to ensure that relevant staff and facilities are available.



## 7. PROCUREMENT AND DISPOSAL OF MOD LASER EQUIPMENT

### 7.1 Introduction

7.1.1 The processes by which lasers are procured and disposed of are fully described in Volume 2. This chapter outlines MOD, and hence MLSC, policy and guidelines.

7.1.2 Lasers, or associated laser safety orders, may be not introduced into service (including all trials and development) without the approval from an LSSA. Each project manager (or procurement authority where there is no official project manager) should approach an LSSA at the earliest opportunity in the procurement process; in particular, to establish the level of detail in any required documentation and the level of funding which the project must provide.

7.1.3 The LSSA cannot provide laser safety clearance without adequate notice, technical detail and financial resources. There are very few security-cleared and technically-competent laser safety experts which can be called upon – even if funding were not an issue. This makes it imperative that the project manager or procurement authorities contact an LSSA as soon as any laser procurement cycle begins.

7.1.4 Because the impact of laser safety upon training and maintenance is not usually well-understood by those procuring laser-based equipment, early involvement by an LSSA can often provide valuable advice about the suitability of such equipment for use in UK peacetime training, this may save considerable unplanned expenditure at later stages in the procurement.

7.1.5 The AOF requires procurement authorities to follow the Project Oriented Safety Management System procedures (POSMS) and POEMS. AOF resources can be found at [aof.mod.uk/](http://aof.mod.uk/). Guidance on safety management and POSMS is contained in Def Stan 00-56. Land equipment safety management is dealt with in JSP 454. The environmental management of a project or system is detailed in JSP 418.

### 7.2 Lasers requiring the clearance process

7.2.1 The policy for the full clearance process is explained in this chapter. The technical details of laser safety clearance are explained in Volume 2. Some types of laser do not require a full clearance process; MLSC are the only body able to make a decision as to which lasers fall into this category and they must be consulted by any PT or procurement manager seeking to procure lasers for MOD.

7.2.2 Lasers which can be proven to an LSSA to be Class 1 or Class 2 products often do not require the full clearance process. This is usually dependent upon the laser being of a type that is inherently Class 1, rather than a laser which is only Class 1 by virtue of the software which controls it. The project manager is responsible for producing and publishing the safety instructions. The proof of classification should be given to the LSSA in an abbreviated LSP; the format for this is given in Volume 2. Should there be any doubt about the laser's classification, an LSSA should be contacted. Further details of laser types not requiring the full clearance process are given in Annex B.

7.2.3 No formal action is required by the LSSA if a laser is to be used only within enclosed facilities which have already been approved (by an appropriate authority) for use with lasers of the assigned (and proven) Class, in accordance with IEC 60825-1:2007. Such approval of a facility by an authority implies compliance with the HSAW Act, and this approval should be presented to an LSSA. Typical facilities are; enclosed test and maintenance bays and enclosed laser laboratories. In these cases, specific local laser rules may need to be generated.

7.2.4 Lasers falling under the classifications Class 1M, Class 2M, Class 3R, Class 3B and Class 4 according to IEC 60825-1:2007 will require a full clearance process. The format of the LSP is shown in Volume 2, where guidance on writing an LSP is also given.

### 7.3 The laser safety clearance process

7.3.1 An LSSA's primary objective is to ensure that all pertinent safety aspects associated with a laser system under their jurisdiction have been considered and, as a result, personnel, the general public, the environment and materiel are not put at risk by use of that device.

7.3.2 In order to achieve this, an LSSA must be satisfied that each laser:

- a. is proven to be safe under all conditions, or
- b. is shown to be safe under all reasonable conditions, or
- c. is used in an acceptably-safe manner.

7.3.3 To ensure that this objective is met, the process shown in Figure 3 must be adhered to. The process is often iterative due to the complex nature of some systems, and the interface between systems'-safety and laser-safety. Trials require an LSP to be raised and will result in the issue of an MLSSAC. If the trials are part of a series, the LSP can be amended, or have annexes added, in order to facilitate the process of producing an updated MLSSAC which supersedes previous issues.

7.3.4 The process is initiated by the project manager, who notifies an LSSA that a laser is being procured. An auditable method of communication such as a hard copy or e-mail must be used. The details of the laser will be considered and, if the laser is of a type requiring a full review process, the LSSA will notify the project manager that an LSP is required. At this time the LSSA will normally be able to give an indication of the potential complexity of the safety study. Once a draft LSP is received by the LSSA it will be possible to give a more accurate timescale for the completion of the laser safety clearance process. When a fully compliant LSP has been produced the LSSA will complete the MLSSAC and issue it to the PT or procurement authority. Trials are often required before a full clearance can be made: In these cases an MLSSAC (with restrictions) will be issued if sufficient evidence is contained in the draft LSP to support this.

7.3.5 There are many non-laser related factors inherent to the laser safety clearance process. These include system-integration and software issues which affect the safe use of the laser. When the laser is part of a complex system, it is helpful to the LSSA if a fault-tree and fault-probabilities are available as soon as possible. The fault-tree should show a diagrammatic view of safety-related systems or actions, and their linkage to the possible un-commanded firing of a laser. These should be accompanied by a functional description of the laser system. The details of these requirements are given Volume 2.

7.3.6 In many laser systems mounted upon fast-moving platforms (air-to-ground systems in particular) there is often no practical way to employ the laser such that the laser safety clearance process can be completed using the standard deterministic calculations and procedural safety methods. If this is the case, a modified clearance process will be used requiring a PRA. This process requires the LSSA to have considerable access to the system-engineering and fault/error history. The calculations are performed using an MOD-owned, contractor-operated computer algorithm. This probabilistic process will require funding. Due to the complexity of probabilistically-assessed, laser safety clearances, a substantially longer lead-time and early notification to an LSSA is essential if delays to the project are to be avoided.

7.3.7 Although the clearance process results in an MLSSAC from the LSSA, it is the duty of the PT project manager or the procurement authority to issue copies to those who require them. A MLSSAC is subject to review every three years, or more frequently dependent upon the system's hazard classification and complexity. It is the duty of the PT or procurement authority to notify the MLSC if any contractor causes the system to be modified or maintained in such a way that the laser hazard is likely to have been changed. The LSSA will then re-evaluate the system and assess whether a new MLSSAC is required.

7.3.8 Although any laser cleared by the process and policies described in this chapter will be deemed to be safe if the conditions on the MLSSAC are adhered to, the responsibility for laser safety remains with the users and the PT or procurement authority.

7.3.9 If a project has Urgent Operational Requirement (UOR) status, an LSSA will ensure that it is given priority and will suggest which data are most vital to the process of advancing the clearance. Operational use of lasers does not fall under the clearance process but the advice given by an LSSA can be incorporated into operational procedures. It is not possible to conduct trials or training for a UOR in the UK without an MLSSAC.

7.3.10 MLSSACs are copied to the following when they have reached their final edition:

- a. The project manager of the PT.
- b. The user, for use by the Laser Safety Officer, or to be incorporated in the Army Equipment Support Publication (AESP) or similar Service document.
- c. The ranges where the laser is to be used, for use by the RSO.

7.3.11 An MLSSAC has a unique reference number in order that it is auditable.

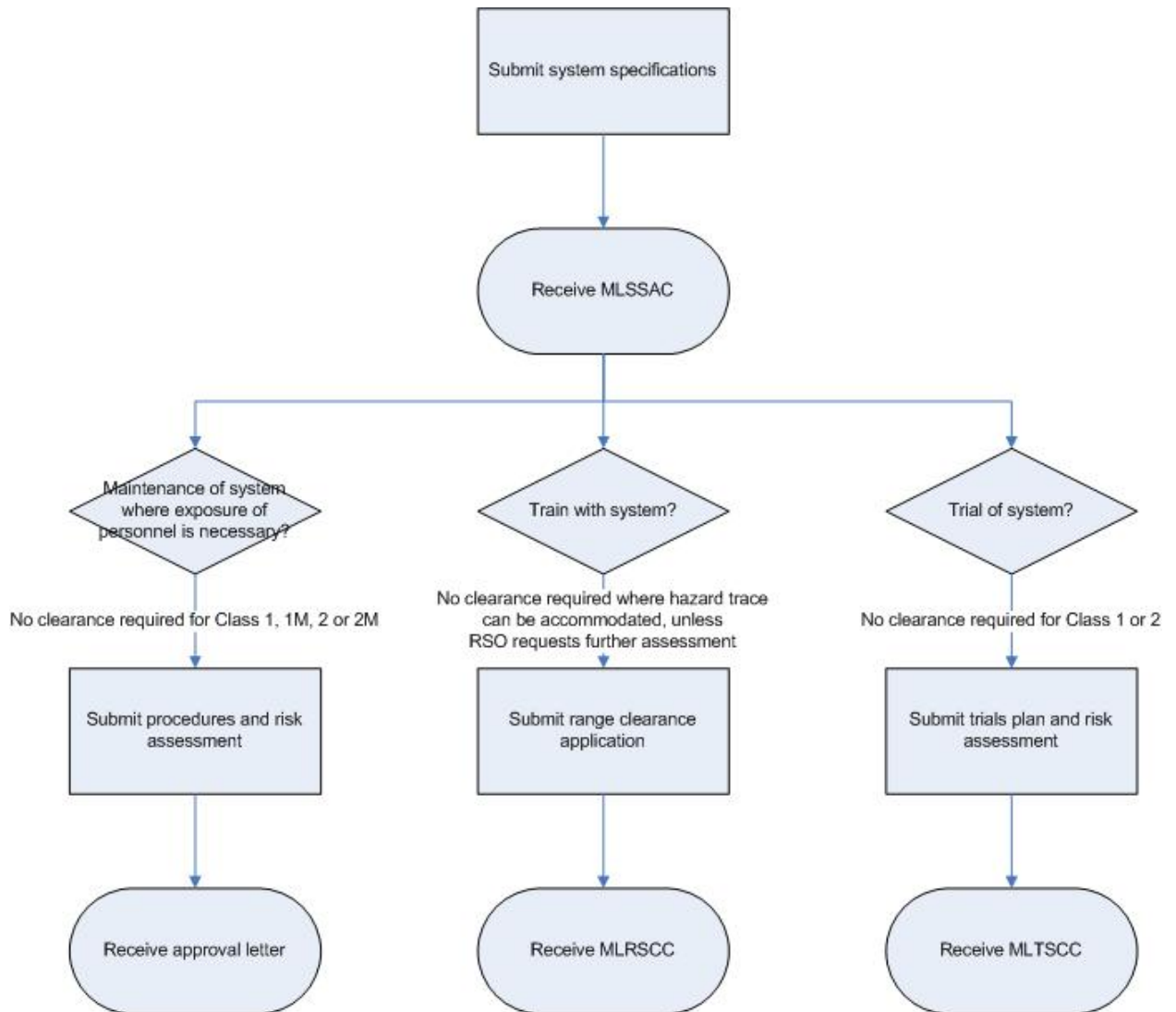


Figure 2: The Laser Safety Clearance Process

## **7.4 MLSC administrative processes**

7.4.1 The MLSC has a policy of administering the laser safety process such that, when subject to audit, any laser safety clearance process can be tracked and the relevant documents produced. A database of all cleared laser systems is maintained and a complementary database of all military laser safety clearance certificates which have been issued. Laser safety papers are stored by the LSSAs until the laser is disposed of but may be kept by the procuring PT for longer. An LSSA must be informed if a laser is to be, or has been, disposed of so that these databases can be kept current.

7.4.2 It is the responsibility of an LSO to produce a list of lasers held in his annual report to the Dstl Environmental Sciences Department. The Dstl Environmental Sciences Department currently maintains the database of laser holdings in the UK MOD. The contact address for the Dstl Environmental Sciences Department can be found in the contacts list.

## **7.5 Disposal of lasers**

7.5.1 The MLSC has a role in the disposal of lasers in order to ensure that no MOD laser becomes a hazard to the public or Crown Employees, either by virtue of it being re-sold and used inappropriately or due to other safety hazards it may contain. Disposal of lasers requires compliance with the POSMS. Any sales of surplus lasers should be directed through the DSA. The environmental impact of laser procurement and disposal is subject to the POEMS process. Guidance on these issues can be found on the following website; [www.asems.mod.uk](http://www.asems.mod.uk). Guidance on safety management and POSMS are contained in Def Stan 00-56 and JSP 602. Land equipment safety management is described within JSP 454. The environmental management of a project or system is detailed in JSP 418. The AOF resources can be found at [www.aof.mod.uk](http://www.aof.mod.uk).

## **ANNEX A**

### **DUTIES OF A LASER SAFETY OFFICER**

The duties of a unit/establishment LSO will be laid down by the CO or head of establishment and may include the following:

#### **General duties**

- a. Providing the CO/HoE with advice on laser safety matters.
- b. The preparation and publication of laser safety standing orders and operating procedures.
- c. Ensuring that relevant laser safety standing orders and operating procedures applicable to all items of laser equipment are correctly applied when the equipment is in store, undergoing maintenance/repair or in use.
- d. Ensuring that frequent inspections of laser protective enclosures, adherence to laser equipment operating procedures, and laser protective eyewear and clothing are carried out and recorded.
- e. Ensuring that the name of the LSO and a list of authorized laser users are prominently displayed within each laser work area (not applicable to in-service laser devices).
- f. The immediate reporting and investigation of any possible/suspected overexposure to laser radiation in accordance with Volume 2.
- g. Ensuring that any individual suspected of having received a hazardous exposure is promptly referred to a qualified ophthalmologist.

#### **Laser laboratories and maintenance units**

In laboratories and maintenance units, the LSO would also have duties of:

- a. Ensuring that, for every Class 3B and Class 4 laser, strict laser key control is observed and system safety equipment integrity for each system is maintained.
- b. Ensuring that protective enclosures are provided for each laser product installation such that the laser beam is fully enclosed. Where this is not possible, ensuring that beam attenuators or beam stops are used and are properly maintained.
- c. Advising on the prevention of unintentional specular reflections within the laboratory/maintenance area.
- d. Ensuring that the approved type of protective eyewear is available in compliance with the current MLSSAC or locally produced operating procedures and is in serviceable condition.
- e. Ensuring that suitable protective clothing is provided where it is required by laboratory or maintenance personnel.
- f. Ensuring that correct laser warning signs, as detailed in IEC 60825-1:2007, are used with every laser system.

#### **Duties of Range and Training Area LSOs**

For a list of duties see Chapter 9 of JSP 403 Volume 1.

## ANNEX B

### HAZARD CLASSIFICATIONS OF LASERS AND MOD POLICY

Laser products are categorised in a hierarchy of increasing AEL, and hence hazard, from Class 1 to Class 4 under IEC 60825-1:2007. The MLSC has adopted an approach to laser safety hazard assessment such that:

1. If a laser product (such as a laser printer or CD/DVD player) is marked as being Class 1 and is entirely enclosed, such that no laser energy can be emitted outside of the product, then an MLSSAC is not required.
2. Instructional pointers should ideally be Class 1 products. If this is not practicable because of ambient lighting conditions, then Class 2 laser pointers may be used, providing they are from a reputable source and have a hazard classification of Class 2 and marking compliant with IEC 60825-1:2007.
3. Any laser which is not covered by the policy stated in points 1 and 2 above will require an MLSSAC or trials certificate.
4. Should there be any doubt about the requirement for an MLSSAC then advice from an LSSA must be sought.
5. The ascending order of laser hazard classes defined under IEC 60825-1:2007 are:

Class 1 – Safe under all reasonably foreseeable conditions because the AEL is believed to always be less than that which can cause eye damage, or to contain a laser that could be hazardous but is prevented from doing so by engineering and interlocks.

Class 1M – Safe under all reasonably foreseeable conditions except when any kind of focussing or collimating optics are used.

Class 2 – Are limited in AEL to 1mW of output power in the waveband 400-700 nm and will be safe for accidental exposure due to the natural aversion response.

Class 2M – Are also limited to an AEL of 1mW and a wavelength of 400-700 nm, these lasers are safe for accidental viewing as per Class 2 lasers but are not safe if magnifying or collimating optics are used.

Class 3R – These lasers have an AEL limit of 5mW (5 times that of Class 2) and may be hazardous if viewed by the human eye.

Class 3B – These lasers have an AEL limit of 500mW and can cause eye damage from both direct and reflected beams, in addition they may cause skin burns.

Class 4 – This class of laser has no upper limit for AEL. Class 4 lasers can cause eye and skin injuries from reflected beams even if the reflector is not particularly specular (mirror like) and may start fires or cause explosives to deflagrate or detonate.

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**LIST OF ACRONYMS**

<b>ACAWEWRO</b>	Air Command Air Weapon and Electronic Warfare Range Orders
<b>AEL</b>	Accessible Energy Limit
<b>AESP</b>	Army Equipment Support Publication
<b>AGL</b>	Above Ground Level
<b>ALARP</b>	As Low As Reasonably Practicable
<b>AOF</b>	Acquisition Operating Framework
<b>BR</b>	Book of Reference
<b>BS</b>	British Standard
<b>CAOR</b>	Control of Artificial Optical Radiation at Work Regulations
<b>CD</b>	Compact Disc
<b>CE</b>	Communauté Européenne or Conformité Européenne
<b>CO</b>	Commanding Officer
<b>COSHH</b>	Control Of Substances Hazardous to Health
<b>DAS</b>	Defensive Aids Suite
<b>DAUK</b>	Defence Academy of the United Kingdom
<b>DEFSTAN</b>	Defence Standard
<b>DESB</b>	Defence Environment and Safety Board
<b>DOESB</b>	Defence Ordnance Environment and Safety Board
<b>DOSG</b>	Defence Ordnance Safety Group
<b>DSA</b>	Disposal Services Authority
<b>DSTL</b>	Defence Science and Technology Laboratory
<b>DTA</b>	Dry Training Area
<b>DVD</b>	Digital Versatile Disc
<b>EN</b>	Euronorm
<b>ENOHD</b>	Extended Nominal Ocular Hazard Distance
<b>EOHD</b>	Extended Ocular Hazard Distance
<b>EU</b>	European Union



<b>FSB</b>	Functional Safety Board
<b>GoCo</b>	Government Owned Contractor Operated
<b>HMS</b>	Her Majesty's Ship
<b>HoE</b>	Head of Establishment
<b>HPA</b>	Health Protection Agency
<b>HSAW</b>	Health and Safety at Work
<b>HSE</b>	Health and Safety Executive
<b>IEC</b>	International Electrotechnical Commission
<b>IRIS</b>	Incident Reporting Information System
<b>ISTAR</b>	Intelligence, Surveillance, Target Acquisition and Reconnaissance
<b>JSP</b>	Joint Service Publication
<b>LFSO</b>	Land Forces Standing Order
<b>LHZ</b>	Laser Hazard Zone
<b>LSO</b>	Laser Safety Officer
<b>LSP</b>	Laser Safety Paper
<b>LSSA</b>	Laser Systems Safety Advisor
<b>MLRSCC</b>	Military Laser Range Safety Clearance Certificate [MOD Form 2238B]
<b>MLSC</b>	Military Laser Safety Committee
<b>MLSCC</b>	Military Laser Safety Clearance Certificate
<b>MLSRP</b>	Military Laser Safety Review Panel
<b>MLSSAC</b>	Military Laser System Safety Assessment Certificate [MOD Form 2237]
<b>MLTSCC</b>	Military Laser Trial Safety Clearance Certificate [MOD Form 2238A]
<b>MOD</b>	Ministry of Defence
<b>MPE</b>	Maximum Permissible Exposure
<b>NDT</b>	Non-Destructive Test
<b>NOHD</b>	Nominal Ocular Hazard Distance
<b>OD</b>	Optical Density
<b>OME</b>	Ordnance, Munitions & Explosives

<b>PD</b>	
<b>POEMS</b>	Project Orientated Environmental Management Systems
<b>POSMS</b>	Project Oriented Safety Management Procedures
<b>PPE</b>	Personal Protection Equipment
<b>PRA</b>	Probabilistic Risk Analysis
<b>PT</b>	Project Team
<b>RAF</b>	Royal Air Force
<b>RAU</b>	Range Administering Unit
<b>RCO</b>	Range Conducting Officer
<b>REME</b>	Royal Electrical and Mechanical Engineers
<b>RN</b>	Royal Navy
<b>RPA</b>	Radiation Protection Advisor
<b>RSO</b>	Range Safety Officer
<b>S of S</b>	Secretary of State (for Defence)
<b>SHEF</b>	Safety, Health, Environment and Fire
<b>SMS</b>	Safety Management System
<b>SSDC</b>	Safety, Sustainable Development and Continuity
<b>STANAG</b>	(NATO) Standardisation Agreement
<b>TR</b>	Technical Requirements
<b>UHSO</b>	Unit Health and Safety Officer
<b>UK</b>	United Kingdom of Great Britain and Northern Ireland
<b>UOR</b>	Urgent Operational Requirement
<b>WEO</b>	Weapon Engineering Officer

## CONTACTS LIST

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