



MINISTRY OF DEFENCE

JSP 390

UK MOD

Military Laser Safety

Volume 2 – Laser Safety Management System

Sponsored by the Military Laser Safety Committee
MOD Abbey Wood

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PREFACE

JSP 390 Volume 2 sets out the laser safety management system need for compliance to the MOD policy in JSP 390 Volume 1. Following this management system will allow the user to comply with the requirements of JSP 390 volume 1 and the Control of Artificial Optical Radiation at Work Regulations (CAOR). This document is separated in to two parts. Part 1 contains the safety management system and Part 2 contains a series of leaflets providing technical information needed to assess the laser systems.

The latest edition (2011) of JSP 390 exists in 2 volumes: Volume 1 (Issue 3) contains policy and Volume 2 (Issue 1) contains the laser safety management system.



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UK MOD

Military Laser Safety

Volume 2 – Laser Safety Management System

Part 1 – Introduction to the Laser Safety
Management System

Issue 1

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TABLE OF CONTENTS

TABLE OF CONTENTS	5
1. INTRODUCTION.....	6
1.1 Aim	6
1.2 Overview	6
1.3 Document structure.....	6
1.4 Terminology	6
2. RISK MANAGEMENT	7
2.1 Introduction	7
2.2 The Role of the Laser Systems Safety Advisors (LSSAs).....	7
2.3 Hazard Identification – (Laser Classification and Hazard Distance Evaluation).....	8
2.4 Risk Estimation	9
2.5 Risk Evaluation	10
2.6 Risk Reduction (Laser Protective Measures and Safety Controls).....	11
2.7 Risk Acceptance (Producing the MLSSAC).....	11
2.8 Risk Communication (Issuing of the MLSSAC)	11
3. CERTIFICATION PROCESSES AND REQUIREMENTS	13
3.1 General Procedures and Requirements	13
3.2 DE&S Project Teams	13
3.3 Non-MOD Sponsored Trials on MOD-GOCO Property	14
4. WRITING A LASER SAFETY PAPER (LSP).....	16
4.1 Introduction	16
4.2 The Laser Safety Paper for a System (LSP (System))	17
4.3 The Laser Safety Paper for a Trial (LSP (Trial))	20
4.4 The Laser Safety Paper for Normal Operation (LSP(Normal Operation))	20
4.5 The Laser Safety Paper for Ranges (LSP (Range))	21
4.6 The Laser Safety Paper for Testing and Maintenance (LSP (Maintenance)).....	22
5. REFERENCES.....	23

1. INTRODUCTION

1.1 Aim

1.1.1 The purpose of Joint Service Publication 390 (JSP 390) - Volume 2 is to provide a Laser Safety Management System (LSMS) which complies with the policy laid out in JSP 390 Volume 1 - Policy.

1.2 Overview

1.2.1 JSP 390 – Volume 2 expands on JSP 390 Volume 1 framework and describes the processes that establish a laser safety management system. Compliance with the requirements of JSP 390 volume 2 will produce a suitable laser safety risk management system which will allow the safe use of lasers on ranges and on operations.

1.2.2 JSP 390 Volume 2 is split in two parts:

- a. **Part 1** contains the laser safety management system; following the processes outlined in this document will mean compliance with the policy stated in JSP 390 Volume 1 - Policy. The document contains how to carry out risk management for laser safety including; risk analysis, risk evaluation and Risk reduction.
- b. **Part 2** contains a collection of leaflets that provides supporting documentation required to carry out risk management including laser classification, hazard distance evaluation and writing laser safety papers.

1.2.3 The Military Laser Safety Review Panel (MLSRP) publishes JSP 390 volume 2 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 Military Laser Safety comprises of 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 (LSMS).** 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.

1.4 Terminology

1.4.1 The term safety is used throughout this document and refers to laser system safety and its impact on people.

1.4.2 To ensure consistent use of terms and phrases relating to safety within JSP 390, a glossary of terms is contained within JSP 390 Volume 2 - Part 2.

2. RISK MANAGEMENT

2.1 Introduction

2.1.1 Top-level guidance on risk management can be found at JSP 892 – Risk Management, while guidance on Ordnance, Munitions and Explosives (OME) safety can be found in JSP 520 – UK MOD’s Ordnance, Munitions and Explosives Safety and Environmental Management System. Further guidance specific to risk management for laser systems will be provided here.

2.1.2 The structure followed in Risk Management is shown in Figure 1. It shows the activities that make up a Risk Analysis and a Risk Assessment and shows the process of Risk Management from Hazard Identification through to Risk Communication. These terms are described in JSP 892. The risk management for military laser safety follows the same process with all stages being covered by the LSMS through the production of a Laser Safety Paper (LSP) to the issuing of the Military Laser System Safety Certificate (MLSSAC) MOD Form 2237.

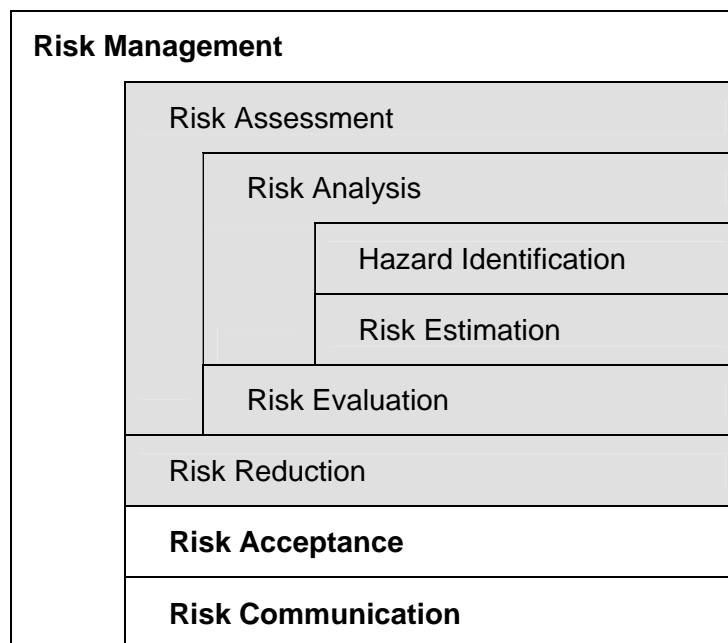


Figure 1 - Risk Management System



2.2 The Role of the Laser Systems Safety Advisors (LSSAs)

2.2.1 The LSSAs, residing in the Defence Ordnance Safety Group (DOSG), which is part of the Weapons Operating Centre of Defence Equipment & Support (DE&S), are members of both the Military Laser Safety Committee (MLSC) and the Military Laser Safety Review Panel (MLSRP). Their duty is to implement the policy of JSP 390 Volume 1 by assessing lasers systems and advising users and DE&S project teams on the safe use of laser systems to mitigate the risks described above, and are supported by the Subject Matter Experts (SMEs) from the Defence Science and Technology Laboratory (DSTL) and industry on the MLSRP.

2.2.2 The LSSAs are able to provide advice or guidance on any issue relating to the safe use, storage, testing or maintenance of laser devices and should be considered as a first point of contact for any such issues. The LSSAs can provide bespoke advice on procedural, engineering or protective controls that should be put in place for safe laser applications.

2.2.3 It is also the role of a LSSA to review the LSP as part of the overall risk management process and make sure it complies with LSMS for all laser devices used by the MOD. It is the role of the Project Team (PT) to produce the LSP for the laser equipment they are bringing in to service.

2.2.4 The LSP will capture all the aspects of the risk assessment and risk reduction. It should provide all the information about the laser system necessary to identify the hazards and estimate the risk; it should also contain the control measure and safety features which will be used to reduce the risk. For information on how to write a LSP see JSP 390 Volume 2 – Part 2.

2.2.5 The LSSA will review the LSP and then deem if the risk is acceptable in accordance with current guidance (IEC 60825-1), if it is they will produce a MLSSAC (MOD Form 2237) which will be issued to the PT purchasing the laser equipment.

2.2.6 If the risks are still unacceptable for training on Ranges or Dry Training Areas (DTA's) (i.e. the hazard distances are too large for the range or DTA) then the LSSA will need to assess the training location and issue a Military Laser Range Safety Clearance Certificate (MLRSCC) MOD Form 2238B.

Note: All trials are required to have a Military Laser Trial Safety Clearance Certificate (MLTSCC) issued by an LSSA. A trials plan will need to be submitted to the LSSA along with the LSP.

2.3 Hazard Identification – (Laser Classification and Hazard Distance Evaluation)

2.3.1 The first stage of risk management is to carry out a risk analysis by identifying the hazards and estimating the risk.

2.3.2 A hazard is any condition with the potential for causing harm. An unenclosed laser beam can be considered a hazard or so can exposed electrical cables. When dealing with laser systems the hazard can be broken down into two types, beam hazards and non-beam hazards.

a. **Beam Hazards** – these hazards directly associated with the energy emission of the laser beam and can cause skin damage or eye damage.

b. **Non-beam Hazards** – these hazards are associated with the equipment such as electrical hazard from the power supply and chemical hazards from the toxic materials used in lasers.

2.3.3 This document and the subsequent parts focus specifically on the beam hazards, although a list of non-beam hazard is provided in JSP 390 Volume 2 - Part 2. The non-beam hazards are generic hazards and are not specific to laser systems, but beam hazards are unique to lasers due to the nature of laser light, and the ability for the hazard to extend far from the equipment. Non beam hazards still need to be identified and assessed in accordance with the risk management process.

2.3.4 Not all laser systems are deemed hazardous and therefore there are a number of lasers which are exempt from the certification process. These systems will not require a MOD form 2237. A list is provided in JSP 390 Volume 2 – Part 2.

Classification

2.3.5 In order to ascertain if the laser beam is hazardous the laser system will need to be assessed and classified in accordance with IEC 60825-1. The level of classification can determine the level of risk and associated hazards which in turn dictate the amount work required to carry out a risk assessment. Certain laser classifications have no beam hazard and will require less work to complete the risk assessment. A complete list of laser classifications and how to calculate laser system classification is provided in JSP 390 Volume 2 - Part 2

2.3.6 The classification of a non exempt system is recorded on MOD Form 2237 the Military Laser System Safety Assessment Certificate (MLSSAC)

Hazard Distance Evaluation

2.3.7 Once the classification of a system has been established then a hazard distance for the system can be calculated in order to ascertain the level of risk of the laser system. Similar to ballistic and explosive safety there is a distance beyond which the risk of exposure is acceptable. In laser safety it is a distance from the laser output where the beam energy is equal to an agreed maximum exposure level (this can be for either the eye or skin).

2.3.8 As the beam travels away from the source it will expand, reducing the amount of energy per area and at a certain distance from the source it will have reached an acceptable level. This level is known as the Maximum Permissible Exposure (MPE). The acceptable value is calculated from a table in IEC 60825-1, this table and how to calculate MPE can be found in JSP 390 Volume 2 – Part 2.

2.3.9 From the MPE it is possible to calculate the hazard distances for different laser systems. These distances are known as either the Nominal Ocular Hazard Distance (NOHD) or the Nominal Skin Hazard Distance (NSHD). At these distances the likelihood of laser causing eye/skin damage is acceptable.

2.3.10 There are other factors to consider when calculating hazard distances such as the use of binoculars which can increase the hazard distance or effects of the atmosphere which can either reduce or increase the hazard distance. How to calculate the different hazard distances and the effects of the atmosphere can be found in JSP 390 Volume 2 – Part 2.

2.3.11 The hazard distances should be included in the LSP along with the laser parameters and method used to calculate them. The LSSA will review the information provided and recalculate the hazard distances to confirm that they meet the requirements of JSP 390. The agreed hazard distances will be included on MOD form 2237 (MLSSAC).

2.3.12 The above process used in calculating the hazard distances is a deterministic evaluation which is a pessimistic approach. For certain scenarios where the deterministic hazard distances are impractical it may be suitable to use a Probabilistic Risk Analysis (PRA). The MLSRP uses a mathematical model written specifically for this and will only accept results from this model. Probabilistic modelling will incur a cost which will be passed on to the PT wishing to bring the laser into service. For further information on PRA refer to JSP 390 Volume 2 – Part 2

Note: The properties of the laser beam play an essential part in calculating the classification and the hazard distances and need to be fully understood in order to provide an accurate representation of laser beam hazard. For information on beam properties refer to JSP 390 Volume 2 – Part 2

2.4 Risk Estimation

2.4.1 Now the hazards have been identified the level of risk will need to be estimated. Both beam and non-beam hazard will need to be considered and the likelihood of the event occurring and the severity will need to be assessed. Hazards involving the beam would include exposure to the laser beam with the

result being either skin or eye damage. How severe the injury will depend on the laser beam. Usually the higher the classification and the greater the hazard distances the greater the risk of causing eye and skin damage, but other the operation of the system will need to be considered. An example of the risk estimation matrix is below.

Likelihood	Severity			
	Minor	Significant	Severe	Catastrophic
Extremely Remote	Low	Low	Moderate	High
Remote	Low	Low	Moderate	Extreme
Reasonably Probable	Low	Moderate	High	Extreme
Frequent	Moderate	High	High	Extreme

Table 1 – Risk Estimation Matrix

2.4.2 When determining **likelihood** of harm, the following should be considered:

- number of persons exposed
- frequency and duration of exposure to the hazard
- existing precautions implemented and extent to which they are followed
- foreseeable abnormal situations
- foreseeable unsafe acts

2.4.3 When determining the potential **severity**, the following should be considered:

- part(s) of the body likely to be affected
- nature of the harm, ranging from minor injury to multiple deaths

2.4.4 Estimating the risk will require knowledge of the use of the laser system and environment it will be used in. The LSP should include this information. If the system is to be used in a trial then the trials plan should be included.

2.5 Risk Evaluation

2.5.1 When the risk has been estimated it is necessary to compare the estimated risk against risk criteria which the MOD has established. JSP 390 Volume 1 – Policy states that Service personnel and civilians will not be exposed to levels of laser radiation which may have an adverse effect to their health. Therefore the risk evaluation is used to make decisions about which risk meets this criterion and can be accepted and which risks need to be reduced.

2.5.2 It is important that the LSP for the laser system identify which risks can be accepted and which need to be reduced. The LSSA will review this evaluation to make sure it complies with JSP 390 Volume 1 - Policy.

2.6 Risk Reduction (Laser Protective Measures and Safety Controls)

2.6.1 Once the risk has been estimated and evaluated it may be possible to reduce the level risk through the use of protective measures and safety controls. The types of measure and controls used will depend on the laser system and how it operates. These measures and controls will however fall into three main categories:

- a. **Engineering Control Measures** – These are features of the system which can physically control/contain the beam. Features such as safety interlocks, key controls and beam enclosures are all features which can reduce the likelihood of exposure. It is often not practical to engineer out the hazard entirely, but it may be possible to greatly reduce the risk of laser exposure through these controls. Any engineering controls used need to be included in the LSP.
- b. **Administrative Control Measures** – These are specific instructions or set of requirements that must be met in order for the laser to be operated. These can include user manuals or standard operating procedures which should be established by the Project Team or the User. Suitable training is also considered a key administrative control. This information may not be contained in the LSP for the system, but should be provided to the LSSA for use of the laser system in training, trials and on operations.
- c. **Personal Protection Equipment (PPE)** - This is considered the last resort and only used when the engineering and administrative controls are not enough to reduce the risk to an acceptable level. PPE can include laser eye protection or special clothing which is laser resistant. When using laser eye protection it must provide the correct level of protection for the laser system being used. This information should be provided to the LSSA for use of the laser system in training, trials and on operations. BS EN 207:1999 provides greater detail on the use of laser eye protection.

2.6.2 The LSSA will review the methods used to reduce the risk (as included in the LSP) and will consider if they are acceptable before issuing a MOD Form 2237 (MLSSAC)

2.7 Risk Acceptance (Producing the MLSSAC)

2.7.1 Some risks cannot be removed or the cost of removing the risk may be disproportionate to the potential benefit gained. As long as the risk has been reduced to an agreed acceptable level and the equipment can be operated safely then the level of risk can be accepted/ tolerated.

2.7.2 When the PT and the LSSA have agreed the acceptable level of risk and the LSSA is content with safety controls a MOD Form 2237 (MLSSAC) will be issued. The MOD Form 2237 (MLSSAC) will provide the classification and the hazard distances of the laser system as well as any other safety considerations.

2.7.3 MOD Form 2238A (MLTSCC) will be required as well as a MOD Form 2237 (MLSSAC) for any trials taking place using the laser systems. For use of the laser system on ranges as part of training a MOD Form 2238B (MLRSCC) may be required where the hazard distances cannot be contained on the range.

2.8 Risk Communication (Issuing of the MLSSAC)

2.8.1 Once the risk has been identified and reduced and/or accepted then it will need to be communicated to the necessary personnel. The LSSA will issue a MOD Form 2237 (MLSSAC) and if required MOD Form 2238 (Range or Trial Clearance), which contains the risk management process carried out by the LSSA. This certificate will be issued to the PT or the User to be either included in the user manual for the equipment, captured in the safety case for the system or as part of the range/Trial procedures. The LSSA will keep a record of all MOD Form 2237 and 2238 issued.

Note: All laser safety MOD Forms have an expiry dates which will be a maximum of three years after they are issued. For renewal contact an LSSA requesting which certificate is to be renewed and provide confirmation that the laser system/ Trial has not changed. If any of the information is incorrect or has changed then a new certificate will need to be issued.

3. CERTIFICATION PROCESSES AND REQUIREMENTS

3.1 General Procedures and Requirements

3.1.1 Figure 3 shows the standard Laser Safety Management System process for laser systems. By following this LSMS process you will comply with each part of the risk management process (Section 2). This process can only be deviated from with agreement from the LSSA as it may be inappropriate in certain cases.

3.1.2 The MLSSAC states the agreed hazard distances and classification of the laser. It is issued after the LSP has been reviewed and the MLSRP have agreed the calculation method and results. The hazard distances and the product classification that are written in the MLSSAC must be cascaded down to subsequently issued documents, and other numbers/classifications must not be used. Should the specifications of the device change the MLSSAC will be reissued and the newly agreed results must again be cascaded.

3.1.3 Before beginning the LSMS process check that the device is not exempt. The list of types and requirements for exempt systems can be found in JSP 390 Volume 2 – Part 2. If there is any doubt about a device advice should be sought from an LSSA.

3.1.4 In the LSMS process the LSP has been broken down into five subsections, not all are required in order for the system to be certified.

- a. LSP (System) – LSP containing system specifications.
- b. LSP (Trial) – LSP covering trials of a laser system.
- c. LSP (Normal Operation) – LSP detailing standard operating procedures for the laser system.
- d. LSP (Range) – LSP detailing the use of a particular system on a range or training area.
- e. LSP (Maintenance) – LSP explaining maintenance or testing procedures for a system.

3.1.5 A full detail on what information is contained in each LSP and how to write to LSP is captured in Chapter 4 of this document.

3.2 DE&S Project Teams

3.2.1 Project Teams (PTs) in Defence Equipment and Support (DE&S) responsible for acquisition of laser devices or systems containing lasers or those trialling or demonstrating laser technologies are the main customer of the LSSAs. These PTs must adhere to every process provided herein, including those procuring devices for Urgent Operational Requirements (UORs).

3.2.2 DE&S PTs should begin by contacting an LSSA at the earliest stage in order to inform them of their intent to procure a laser (or any system containing a laser device). Timelines can then be discussed and advice will be given. The PT should be familiar with the process shown in the flowchart at Figure 3.

3.2.3 The first requirement will always be for the PT to supply a LSP describing the system as described in Section 3.2 (LSP (System)). It is also advised that a draft of the LSP for normal operation

(LSP (Normal Operation)) as described in Section 3.4 be submitted at the same time; giving the LSSA this document will give them clear understanding how the system is used so that they can better advise on the content of future submissions.

3.2.4 Once equipment has been assigned a NATO Stock Number (NSN) this should be reported to the LSSA so that he can more easily communicate with the user.

3.2.5 The necessity for certification as shown in Figure 3 should be included in the Through Life Management Plan (TLMP) for the system, particularly the need to renew the MOD Form 2237 and the 2238B as required.

3.3 Non-MOD Sponsored Trials on MOD-GOCO Property

3.3.1 The use of MOD property for all trials of laser devices is subject to the clearance procedure described herein.

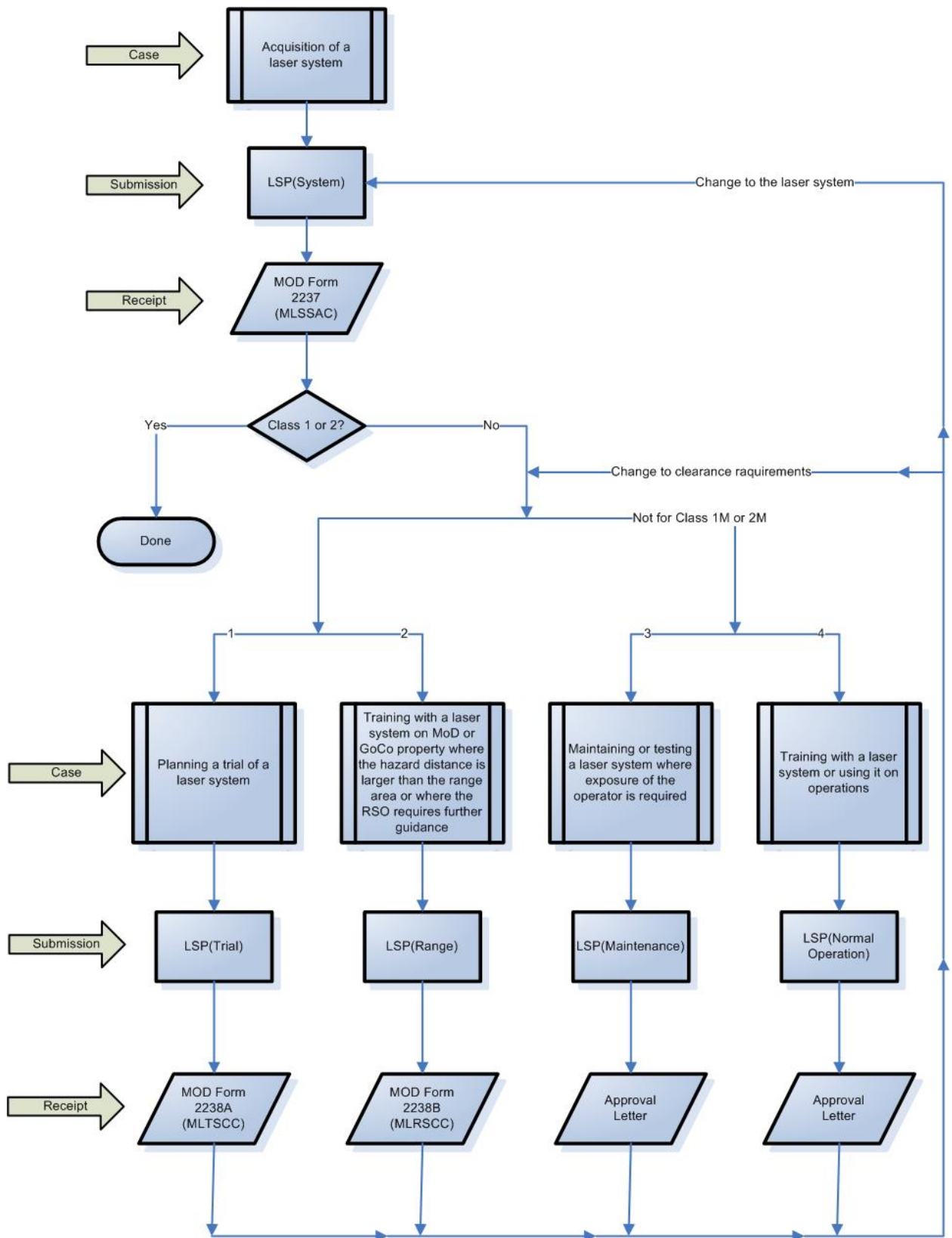


Figure 3 - Laser Safety Management System Process

4. WRITING A LASER SAFETY PAPER (LSP)

4.1 Introduction

4.1.1 A Laser Safety Paper (LSP) is a document that describes a laser system and how it is to be used safely.

4.1.2 A complete description of the requirements for submission of LSPs is provided in Chapter 3. This chapter guides the reader on how to produce a particular LSP.

4.1.3 There are five major types of LSP, each of which is written for a particular laser system or for a particular purpose. However, it is plausible that a scenario arises where any particular form of LSP is inappropriate and a cross between two or more will be a valid submission. In certain cases (see section 2.3) no LSP is required at all.

4.1.4 As mentioned there are five types of LSP are:

a. LSP (System) – LSP containing system specifications. An LSP (System) is required for all (non-exempt) laser devices. It will be approved by an LSSA by issuing a MLSSAC (MOD Form 2237) after extensive discussion with the author and when the hazard distances and laser classes have been agreed.

b. LSP (Trial) – LSP covering trials of a laser system. An LSP (Trial) is required for all trials of Class 1M, 2M, 3R, 3B and 4 laser devices. It will be approved by an LSSA by issuing a MLTSCC (MOD Form 2238A) after extensive discussion with the author and when risk management for the trial is nearing conclusion.

c. LSP (Normal Operation) – LSP detailing standard operating procedures for the laser system. An LSP (Normal Operation) is required for all Class 3R, 3B and 4 laser devices entering service. It will be approved by an LSSA in the form of a short letter highlighting the major risks.

d. LSP (Range) – LSP detailing the use of a particular system on a range or training area. An LSP (Range) is required for training with all devices with hazard distances that greatly exceed the dimension of the particular range or training area or where the Range Safety Officer (RSO) requests further advice be sought. It is always required for training with airborne designators and other high-powered airborne devices. It will be approved by an LSSA by issuing a Military Laser Ranges Safety Clearance Certificate (MLRSCC) (MOD Form 2238B) after a risk assessment has been conducted and hazard traces have been agreed.

e. LSP (Maintenance) – LSP explaining maintenance or testing procedure for a system. An LSP (Maintenance) is required for all Class 3R, 3B and 4 laser devices whose maintenance or testing procedures require personnel to work in the beam path or where reflected or scattered beams will be an issue. It will be approved by an LSSA in the form of a short letter highlighting the major risks and specifying particular requirements as necessary.

4.1.5 An LSP does not need to be a bespoke document; any document that contains all of the necessary information is a valid submission.

4.2 The Laser Safety Paper for a System (LSP (System))

4.2.1 The LSP (System) should give a complete description of the laser system without reference to its use in a particular scenario. It should provide a complete system specification as well as identifying hazards associated with the beam and describe the effect of potential faults. This chapter describes the minimum requirement for a suitable LSP (System) and is by no means complete; the LSP (System) must detail any and all factors that may influence a risk analysis for the device.

4.2.2 The LSP (System) should contain the following sections:

- a. Section 1: Executive Summary
- b. Section 2: Laser System Description
- c. Section 3: Laser Beam Description
- d. Section 4: Laser Classification and Hazard Distances

Each of which is described here.

4.2.3 Section 1 – Executive Summary: The LSP (System) should lead with an executive summary that clearly specifies:

- a. The name and version of the system
- b. The system manufacturer
- c. The type of system (e.g. handheld pointer, or airborne pod)
- d. The names of the lasers and their use (if there are more than one) and
 - (1) Whether they can be used simultaneously
 - (2) Whether the lasers can operate in several modes/settings (details not required here, just a yes or no)
 - (3) Whether this mode is switchable by the end user.
- e. The Project Team procuring the system
- f. The technology/system readiness level and/or stage in the CADMID cycle (Concept, Assessment, Demonstration, Manufacture, In-Service, Disposal).

Note: It should also briefly reference previous LSP (System) and MLSSACs (if they exist) if there have been changes.

4.2.4 Section 2 – Laser System Description: The following should be contained in this section:

- a. A description of the system and definition of key sub-systems as well as parent systems, preferably diagrammatically.
- b. A list of platforms the system will be integrated into and a description of safety related integration issues, such as critical electronic connections.
- c. If a modular laser sub-system is used, the name of the manufacturer/supplier of the unit should be provided, along with model number and part-number and NATO Stock Number (NSN), if available.
- d. If the system contains multiple lasers each needs to be separately identifiable, and whether lasers can be used simultaneously needs to be captured.
- e. If a laser has a switchable wavelength it needs to be made clear that this is the case. The method of wavelength switching needs to be described and the options should be described as different modes of operation of the same laser medium.
- f. For systems where the beam is steered electronically, either manually or autonomously, the pointing accuracy must be given. Similarly, the probability of slewing off target and the existence of any hard stops or software determined angular limits must be given.
- g. There should be a discussion of possible system faults, with probabilities and consequences.
- h. The existence of any platform integration issues or platform specific interlock mechanisms should be discussed here.

4.2.5 Section 3 – Laser Beam Description – The following is a list of information required to carry out the classification and hazard distances calculations. For further details on the beam properties see JSP 390 Volume 2 Part 2

- a. The LSP (System) must make it clear how many lasers exist in the system and in which combinations they can operate. For each laser the following specifications must be included in the LSP (System), where applicable:
 - (1) Wavelength. It is possible the system will have multiple wavelengths, whether by design or as a by-product of the laser process. All wavelengths need to be considered in the LSP.
 - (2) Output type, such as Continuous Wave (CW), Single Pulse, Regularly/Repetitively Pulsed, Irregularly Pulsed (multiple pulses in separated pulse trains)
 - (3) For CW output, power.
 - (4) For single pulse output, the pulse energy and the pulse duration.
 - (5) For regularly pulsed output, as for single pulse plus the Pulse Repetition Frequency (PRF).

- (6) For irregularly pulsed output, as for single pulse plus the PRF within each train, the number of pulses in the train, the Pulse Train Repetition Frequency (PTRF).
- (7) The maximum length of time the beam can be switched on (not required for single-pulsed devices).
- (8) The minimum amount of time between firings.
- (9) The maximum possible amount of energy output in 0.25 s, 10 s and 100 s.
- (10) Divergence – measured to the 1/e value in both the horizontal and vertical axis.
- (11) The 1/e beam diameter, in both the horizontal and vertical axis, at the laser aperture and at 2 m from the aperture along the beam's axis.
- (12) The beam shape and profile (e.g. elliptical Gaussian) and the M^2 quality factor.

b. For each specification the value given should be the most hazardous (highest power, lowest divergence) value under normal operating conditions taking no account of what will happen in a fault. There should be a separate discussion of what can happen to these specifications under fault conditions and what the likelihood of such a fault is.

c. For every specification the source of the information must be given, for example the value may have been measured (in which case it should be stated by whom) or it may have been read from a manual.

d. For each mode in which the laser can operate, the LSP (System) must clearly explain the differences between the modes.

e. For scanning beams a complete description must be given, including motion relevant to a central axis (boresight) such as with angular velocities or with timings between angular extents. There should be enough detail for the reader to completely reconstruct the motion. This is usually easier with diagrams.

f. The existence of any stray laser energy (SLE) should be given and quantified, including the exit angle relative to the main beam.

4.2.6 Section 4 – Laser Classification and Hazard Distances

a. System classification and calculation of hazard distances should be carried out in accordance with the Control of Artificial Optical Radiation (CAOR) 2010 and the most up-to-date parts of the IEC 60825 series (specifically Parts 1 and 14). This volume provides the necessary information to complete these calculations.

b. It is generally unnecessary to reproduce every stage of the hazard distance calculations in the LSP (System) but it is important in more complex cases to include key results found on the route to determining the hazard distance or class.

- c. This section should end with a summary (table) of the Nominal Ocular Hazard Distance (NOHD), the Nominal Skin Hazard Distance (NSHD), the Extended Nominal Ocular Hazard Distance (ENOHD), the Ocular Hazard Distance (OHD), the Skin Hazard Distance (SHD) and the Extended Ocular Hazard Distance (EOHD) (each of which is defined in Chapter 8) and classification for each mode of each laser. The product class will be the highest classification listed here.

4.3 The Laser Safety Paper for a Trial (LSP (Trial))

4.3.1 The LSP (Trial) provides a complete description of a trial at a specific location (multiple firing points, multiple targets permitted) including a thorough risk assessment. The LSP (Trial) should make reference to the LSP (System), or multiple LSP (System) if several laser systems are to be used, but should not repeat the contents of the LSP (System) in any way except for the laser class and hazard distances stated in the MLSSAC.

4.3.2 The trials plans must contain:

- a. Coordinates of Firing Points (FPs) (WGS84 or National Grid).
- b. Coordinates of Target Points (TPs). (WGS84 or National Grid).
- c. List of serials connecting device/mode to FP/TP, with distances between each FP and TP stated.
- d. Maps showing FP/TP with clearly marked range boundaries and the overlaid hazard trace for each serial taking into account terrain as best as possible.
- e. Target type, material and motion, if any
- f. Buffer angle available; i.e. how far the beam can be off target in any direction and still be contained within the range.
- g. System mounting and stability and details of how the device will be aimed before laser firing.
- h. Chain of command, LSO, list of personnel and their location during each serial.
- i. Firing time for each serial (how long the laser is on).
- j. Details of possible wet target or other reflection hazards.
- k. Use of Personal Protective Equipment (PPE).

4.3.3 The risk assessment must consider every reasonable eventuality and propose mitigations for each risk. These mitigations shall be followed at the trial.

4.4 The Laser Safety Paper for Normal Operation (LSP (Normal Operation))

4.4.1 The LSP (Normal Operation) will usually be provided when the system is ready to enter service. It provides details of the intended use of the system as well as a risk assessment for each scenario.

4.4.2 The LSP (Normal Operation) is only necessary for Class 3R, 3B and 4 lasers. However, the Standard Operating Procedures (SOPs) for Class 1M and 2M devices must inform the user of the EOHD of the device and instruct the user not to point the device at or near personnel using binoculars.

4.4.3 The LSP (Normal Operation) should describe how the system will be used in operations and in training, with a focus on safety procedures.

4.5 The Laser Safety Paper for Ranges (LSP (Range))

4.5.1 The LSP (Range) is a request for an LSSA to assess and endorse the use of an especially hazardous laser on a particular range. Especially hazardous means that the EOHD of the laser is greater than the dimension of the range and either there is no suitable backstop or there is a significant likelihood that the beam will stray off the range. An LSP (Range) is always required for airborne designators and other powerful airborne systems and is often required for powerful ground-based systems too. An LSP (Range) should also be produced when the Range Safety Officer (RSO) requires further guidance or stricter procedures for the training activity.

4.5.2 The LSP (Range) must contain:

- a. The name (if applicable) and location of the FPs (WGS84 or BNG).
- b. The name (if applicable) and location of the TPs (WGS84 or BNG).
- c. A list detailing which FPs and TPs can be used together with their separation in metres.
- d. Maps showing the range boundary and neighbouring populated areas with all FPs and TPs marked on.
- e. System mounting and stability, and details of how the beam will be aligned prior to use.
- f. A description of a typical engagement.
- g. For air-to-ground engagements, a description of the attack profile, including coordinates of First Laser Firing Point (FLFP) and Last Laser Firing Point (LLFP).

4.5.3 Reference must be made to JSP 403 Handbook of Defence Land Ranges Safety, Volume 1 Range Management.

4.5.4 In the case of airborne designators, if the scenario is cleared by the Air Command Air Weapon and Electronic Warfare Range Orders (ACAWEWRO), then an LSP (Range) is not required. If the scenario is very similar to one that is included in the ACAWEWRO then a simple read-across may be possible and, again, an LSP (Range) may not be required.

4.5.5 For high-powered airborne devices Probabilistic Risk Analysis (PRA) will generally be required and the reader should refer to Chapter 11. In this scenario, "high-powered" means the EOHD of device is greater than the slant range from platform to target and far greater than the height Above Ground Level (AGL).

4.5.6 If the terrain is used to terminate the beam then diagrams should be included that show the angle the beam would have to stray off target to no longer be terminated by the terrain.

4.6 The Laser Safety Paper for Testing and Maintenance (LSP (Maintenance))

4.6.1 The LSP (Maintenance) is a request for the MLSC to assess and endorse procedures for the testing or maintenance of laser systems where it is required that personnel be within the OHD.

4.6.2 An LSP (Maintenance) is only required for Class 3R, 3B and 4 devices.

4.6.3 The LSP (Maintenance) should include a schematic diagram of the location where the testing or maintenance is to take place, including locations of personnel and protective screens. Hazard traces for the beam should be marked on in the form of concentric circles of radius OHD, SHD and EOHD centred on the system and clearly labelled.

4.6.4 Necessary Personal Protective Equipment (PPE) that is to be used shall be described. For maintenance PPE refer to BS EN 208.

4.6.5 Safety features of the device may be overridden for maintenance activities and the LSP (Maintenance) must describe such changes.

4.6.6 Maintenance should only be carried out by suitably qualified personnel and the level of qualification required must be stated in the LSP (Maintenance).

5. REFERENCES

5.1.1 References 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.