LSO Training curricula

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1. Introduction

1-1-Purpose

This document represents contribution of PYLA for the phase 2 of the working group 1 “Laser Safety Training” within IT-ELLI project. The purpose of this phase is to define the curricula for each level of training. This document deals with the high level, LSO training, which has been used as a reference.

It is based on the CNSO (Comité National de Sécurité Optique) recommendation, on European directive (2006) and the standards dealing with laser risk.

1.2 Glossary and specific abbreviations

LSO laser safety officer
MPE maximum permissible exposure
NOHD nominal ocular hazard distance
AEL accessible emission limit
CNSO

1.3 Reference documents

1-3-1-Regulations reference

[1] – Directive 2006/25/EC - artificial optical radiation – April 2006

1-3-2-Standards reference

[2] – IEC/EN 60825-1: Safety of laser products - Part 1: Equipment classification and requirements – May 2014

[3] – IEC/EN 60825-4: Safety of laser products. Laser guards – July 2011

[4] – IEC 60825-14: Safety of laser products - Part 14: a user's guide – February 2004

[5] – IEC 60825-13: Safety of laser products - Part 13: Measurements for classification of laser products – October 2011

[6] – EN 12254: Screens for laser working places. Safety requirements and testing-April 2010

[7] – ISO/EN 11553-1: Safety of machinery. Laser processing machines. General safety requirements – December 2008

[8] – ISO/EN 12100**:** Safety of machinery. General principles for design. Risk assessment and risk reduction **-** December 2010

[9]- EN 207 - Personal eye-protection equipment. Filters and eye-protectors against laser radiation (laser eye-protectors) - June 2010

[10]-EN 208 - Personal eye-protection. Eye-protectors for adjustment work on lasers and laser systems (laser adjustment eye-protectors) - March 2010

[11]- ANSI Z136.1 – American National Standard for Safe Use of Lasers - 2014

1-3-3-Other references

[12]- IT-ELLI program O1 Laser safety training - phase 1 Synthesis

[13] – IT-ELLI program O1 Laser safety training - Report of the phone meeting of 1Curricula

As it has been decided during the phone meeting of the 1st of December [13], the proposed curricula is described with each parts, sub-parts, duration and pedagogical support for each part. It contents also the main pedagogical message for each sub-part.

2-1-Program and duration

Because the LSO is not a user but the responsible of the management of Laser Safety within an organization, the LSO training is the highest level of laser safety training (see Annex). The duration, according to IEC and CNSO recommendation has been fixed to 3 days.

The program must firstly lay the foundation before any practical application of laser safety can be applied. This must be made through the knowledge of laser operation, biological effects, standards and regulations. Then laser safety analysis, and means of prevention and protection can be chosen and applied.

The proposed program is given below. Time slots are approximate.

2-1-1-Program – 1st day

Introduction to laser safety

1 h 30	Introduction to laser safety
1 h 00	Laser technology and applications
1 h 45	Risks due to laser radiations

Risks and standardization

45‘	Protection standards, classification and MPE values
30‘	Standardization
50’	Regulation
1 h 00	Definitions, physical quantities and units in radiometry

2-1-2-Program – 2nd day

Protection and prevention

1 h 30	Non-laser beams hazards
1 h 30	Safety analysis: general approach
1 h 30	Safety analysis: examples
2 h 15	Means of prevention and protection

2-1-3-Program – 3rd day

Case studies, Practical exercises

1 h 10	Laser accidents analysis: film projection and database analysis
2 h 20	Personal and collective protective equipment: EN 207, EN 208, EN 12254, IEC 60825-4
1 h 30	MPE and DNDO calculations
1 h 30	MPE and DNDO calculations (software and practical tools demonstration)
1 h 00	MCQ, assessment form

2-2-Description of each part

2-2-1-Introduction to Laser Safety

Title of the part	Sub part	Duration	Pedagogical supports	Pedagogical aim	Other, standards…
Introduction to laser safety 1h30	Laser emission	20’	Slides, photos	To understand what is a laser	
	Spatial emission	15’	Slides, whiteboard	To remember the amplification by the optical system of the eye for a collimated beam (Difference between laser and incoherent light)	
	Spectral emission	15’	Slides	To define some concepts: optical radiation, visible, biological spectral bands (UVC, ….)	
	Temporal emission	20’	Slides, whiteboard	To know the different temporal emissions	
	Examples	20’	Slides, photos, whiteboard	To stress on parasite emissions (reflection, transmission) due to polarisation, NL effects, gain ,…	
Laser Technology and applications 1h00	State of art of Laser applications	5’	Slides, photos	To show the laser revenues by applications	
	Laser interaction with materials in industrial applications	5’	Slides, photos	To draw a parallel with interaction biological media (different mechanisms and effects), some examples to show the benefits of the use of lasers	
	Research applications	40’	Slides, photos, plans of the installation	To show the general optical setup used in large laser facilities: plan of the installation Description of the different parts (Oscillator, CPA amplification, delay lines, compression…)	
	Military applications	5’	Slides, photos	To show the influence of propagation parameters and the outdoor use of lasers	
	Medical applications	5’	Slides, photos	The main medical applications: dermatology, ophthalmology and other applications (surgery, odontology…)	

2-2-3-Risks due to laser radiation

Title of the part	Sub part	Duration	Pedagogical supports	Pedagogical aim	Other, standards…
Risks due to laser radiation 1h45	Interaction mechanisms	10’	Slides, photos	To identify the mechanisms and the exposure parameters	
	Exposure parameters	10’	Slides, photos, whiteboard		
	Skin effects	25’	Slides, photos,	To associate exposure parameters and skin effects	
	Eye effects	60’	Slides, photos, whiteboard	To associate exposure parameters and ocular effects for each structure	

2-2-4-Exposure limits and laser classification

Title of the part	Sub part	Duration	Pedagogical supports	Pedagogical aim	Other, standards…
Exposure limits and classification 0h45	Reference standard	5’	Slides, photos	To identify the reference standards	[2]
	Exposure limits	15’	Slides, photos	To associate laser exposure parameters and MPE values for each biological spectral bands	[2]
	Laser classification	40’	Slides, photos	To know laser classification and AEL tables	[2]
	Methods of classification	10’	Slides, whiteboard	For manufacturer, to know how to classify a laser system	[5]

2-2-5-Regulations- Standardization – Radiometry recalls

Title of the part	Sub part	Duration	Pedagogical supports	Pedagogical aim	Other, standards…
Regulations – Standardization and Radiometry reminders 2h30	Standardization	40’	Slides	To know the main laser safety standards in relation with applications Comparison between European and US standards	[2, 3, 4, 5, 6, 7, 8, 9, 10,11]
	Relation between regulations and standardization	10’	Slides	To know according to European rules, the relation between regulation and standardization	[1,2…]
	Regulations General and specific	40’	Slides	To know the main features of the European and National regulation	[1]
	Radiometry reminders	60’	Slides, whiteboard	To have the basis to evaluate the irradiance or other radiometric quantities in order to compare them to safety values (MPE, AEL)	[…]

2-2-6-Non-laser beams hazards

Title of the part	Sub part	Duration	Pedagogical supports	Pedagogical aim	Other, standards…
Non-lasers beams hazards 1h30	Collateral radiations	35’	Slides, photos	To draw a parallel between exposure limits associated to laser radiations and those due to incoherent light, To disseminate some information about O4 IT-ELLI on Radiation safety	[…] Standards and regulations related to incoherent sources, ionizing and electromagnetic radiations
	Electrical, chemical, mechanical, thermal risks	25’	Slides, photos	To identify user oriented infrastructures other risks	Standards and regulations related to electrical risks
	Cryogenics and fire risks	15’	Slides, photos,	To identify user oriented infrastructures other risks	
	Toxicity of treated materials	15’	Slides, photos	To identify user oriented infrastructures other risks	Information from EU 643 Eureka program
	Ergonomics	15’	Slides, photos	To take into account ergonomics problems (lightning, noise, goggle wearing and signs, warnings identification)	

2-2-7- Safety analysis

Title of the part	Sub part	Duration	Pedagogical supports	Pedagogical aim	Other Standards…
Safety analysis 2h00	General methodology	5’	Slides, photos	To know how to manage a safety analysis	[8]
	Estimation of risks: quantitative approach	15’	Slides, photos	To define which kind of approach is the more adapted.	[8]
	Estimation of risks: semi-quantitative and qualitative approach	40’	Slides, photos,	To be able to make NHOD and Dλ calculations for direct viewing, for eye-aided viewing, for diffused beams	[8]
	Reduction of risks	10’	Slides, photos	To know what are the different ways to reduce risks	[8]
	Examples		Slides, photos, plans of the installation	To treat some pedagogical and users’ examples	

2-2-8-Means of prevention and protection

Title of the part	Sub part	Duration	Pedagogical supports	Pedagogical aim	Other, standards…
Means of prevention and protection 2h15	Laser zone	30’	Slides, photos	To install a laser zone	[2, 4]
	Normal use	20’	Slides, photos	To define the environment of a laser experiment	[2, 4]
	Adjustment phases	40’	Slides, photos,	To adjust laser optical paths in a safe way To be aware	[2, 4]
	Specific means of prevention related to the laboratory	30’	Slides plans of the installation	To identify in the laboratory local rules, procedures, preventing access, laser controlled areas	
	Synthesis tables	15’	Slides, photos	To have check-lists of standard general recommendation	[2, 3, 4]

2-2-9-Accidents analysis

Title of the part	Sub part	Duration	Pedagogical supports	Pedagogical aim	Other, standards…
Laser accidents analysis : Film and database 1h10	Film	15’	Film		
	Origin of data, Data base	15’	Slides, graphs	To be aware of the difficulty to access reliable accident reports. The main accidental situations	
	Implicated lasers	10’	Slides, graphs	Why these lasers have been implicated in accidents	
	Other risks and gravity of accidents	10’	Slides, photos, plans of the installation	The injured field of view, the consequences of accidents	
	Experience of accident victims	10’	Slides, graphs	To be aware that accidents don’t occur only for person with little experience	
	Conclusion	10’	Slides	The lessons learned from this database	

2-2-10-PPE and CPE

Title of the part	Sub part	Duration	Pedagogical supports	Pedagogical aim	Other Standards…
Personal and collective protective equipment 2h10	PPE criterions	10’	Slides, photos,	To be aware of all the criteria to meet for an adapted goggle	[9,10]
	EN 207	1h	Slides, photos, whiteboard	To be able to calculate EN207 goggle	[9]
	EN 208	30’	Slides, photos, whiteboard	To be able to calculate EN208 goggle	[10]
	EN 12254 and IEC 60825-4	30’	Slides, photos whiteboard	To be able to calculate EN12254 and IEC 60825-4 protection	[3,6]

2-2-11-Laser safety calculations

Title of the part	Sub part	Duration	Pedagogical supports	Pedagogical aim	Other Standards…
Laser safety calculations 3h00	Definitions of the basic notions	20’	Slides, whiteboard	To know the basic concepts for laser safety calculations (Time base, Limiting apertures, Apparent angle …)	[1,2]
	Relationship between MPE values and AEL	20’	Slides, whiteboard	To understand Laser Safety Standard building	[1,2]
	Calculation for repetitive pulses 2007/2014	40’	Slides, whiteboard	To be able to calculate MPE and AEL values	[1,2]
	Calculation for broadband or multi lines emission	40’		To be able to calculate MPE and AEL values	[1,2]
	LASERSAFETY Software	1h00	Software	To know that some software may calculate all safety related parameters	

2-2-12-Multiple choice question

To conclude this training a multiple-choice quiz is proposed with about 40 questions according to the main themes of the training. An example of this quiz is given in annex 2.

2. Annex 1: Abstract from IEC 60825-14: Definition of Competent person and LSO

Competent person

Where the employer or laser user is not able, without assistance, to properly determine the necessary safety arrangements and protective measures for eliminating or minimising the risks to health arising from the use of laser equipment, then the advice of a Competent Person should be sought. The Competent Person should have sufficient skill in, and knowledge and experience of, matters relevant to laser safety, and should provide appropriate assistance to the employer (or to the employer's delegated representative, or laser user) in hazard determination, risk assessment, and protective control and procedure provision.

The Competent Person need not be an employee of the organisation concerned, but may instead be an external adviser. The advice and assistance of a Competent Person is often only necessary temporarily, for example when first establishing appropriate protective control measures or when evaluating the risk prior to significant changes to procedures or equipment.

Laser Safety Officer

A Laser Safety Officer should be appointed in organisations in which Class 38 or Class 4 laser products are in use. The appointment of a Laser Safety Officer is also recommended where Class 1 M and Class 2M laser products generating well-collimated beams are in use, and which could present a hazard if viewed through binoculars or telescopes at a considerable distance from the laser. (This can include the installation and servicing of embedded lasers where access may be gained to higher levels of laser radiation than is implied by the laser product's class (see 4.1.3), or where the use of lasers of a lower class than 38 or 4 may nevertheless still introduce a significant risk, perhaps through the involvement of untrained people or because of the existence of associated laser hazards - see Clause 6.)

The Laser Safety Officer should take responsibility, on behalf of the employer, for the administration of day-to-day matters of laser safety. It is the employer's responsibility to ensure that the person appointed as Laser Safety Officer has sufficient competence and capability to perform this role satisfactorily. Suitable training should be provided if necessary.

The duties of the Laser Safety Officer should be agreed with the employer (or with the employer's delegated representative) and documented. These duties should be those necessary to ensure the continuing safe use of lasers within the organisation concerned, but are likely to include as a minimum:

a) being aware of and, if appropriate, maintaining records of, ail potentially-hazardous laser products (including the identification, specification, class and purpose of the laser product; the location of the laser product; and any special requirements or restrictions relating to its use);

b) responsibility for monitoring compliance with the organisation's procedures for ensuring safe laser use, for maintaining appropriate written records, and for taking immediate and appropriate action in respect of any non-compliance or apparent inadequacy in such procedures.

Whether the Laser Safety Officer can authorise, or merely recommend to a person having such authority, the termination of unsafe practices and the implementation of corrective actions should be agreed and specified in the documented duties.
The role of Laser Safety Officer rarely needs to be a full-time appointment. Where a Competent Person (see 3.2) has been appointed and that person is an employee of the organisation concerned (often desirable in organisations having extensive and varied laser use), then the Competent Person may also be the Laser Safety Officer.

In large organisations where there is extensive laser use, suitable employees may be appointed to act as local-area or departmental laser safety representatives in order to assist the Laser Safety Officer and to ensure, on behalf of the employer, safe laser use throughout the organisation. (The titles Laser Safety Officers and Senior Laser Safety Officer may be used, respectively, instead.) In such circumstances, regular liaison should be maintained between these people to ensure the consistent and effective overall management of the laser safety programme.

3.4 Information and training

All employees should, where relevant, be made aware of any hazards (including associated hazards; see Clause 6) to which they may be exposed during the use of laser equipment, and of the procedures necessary to ensure protection. Adequate warnings should be displayed. These warnings should include the laser hazard symbol shown in Figure 1 with appropriate wording. Sufficient instruction or training should be given in order that employees have the necessary understanding to avoid placing themselves and others at unacceptable risk. Safety training is especially important for those who work with Class 3B or Class 4 laser products.

Such instruction and training should be commensurate with the type of hazard and appropriate for the employees concerned. It should include, but need not be limited to:

a) the organisation's policy for safe laser use;

b) the risks of harm that could arise from the use and reasonably foreseeable misuse of the laser equipment;

c) the meaning of displayed warning signs;

d) the correct use and operation of the laser equipment, and of associated equipment, including personal protective equipment (where applicable - see 8.4.5);

e) working procedures and local rules;

f) the procedures to be followed in the event of an actual or suspected accident or other safety-related incident.

Instruction and training should be completed prior to operating or working with laser products, and repeated as frequently as necessary in order to ensure continuing compliance with safety procedures. Records of training should be kept.

3. Annex 2: Multi choice quiz example

Will be proposed later.