EWF Guideline
EUROPEAN LASER PROCESSING PERSONNEL

Minimum Requirements for the Education, Training, Examination and Qualification

EWF-651r2-21

MINIMUM REQUIREMENTS FOR THE EDUCATION, TRAINING, EXAMINATION AND QUALIFICATION

Guideline:

EUROPEAN LASER PROCESSING PERSONNEL

European Diploma in Laser Cutting at the Basic Level (ELC-B) European Diploma in Laser Cutting at the Comprehensive Level (ELC-C) European Diploma in Laser Welding at the Basic Level (ELW-B)

European Diploma in Laser Welding at the Comprehensive Level (ELW-C) European Diploma in Laser Surface Treatments at the Basic Level (ELST - B)

European Diploma in Laser Surface Treatments at the Comprehensive Level (ELST-C)

European Diploma in Laser Processing at the Basic Level (ELP-B)

European Diploma in Laser Processing at the Comprehensive Level (ELP-C)

This Guideline Supersedes the Guideline Special courses for training and qualification in “LASER WELDING” (Engineer, Technologist and Specialist levels), doc EWF-494-01.

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MINIMUM REQUIREMENTS FOR THE EDUCATION, TRAINING, EXAMINATION AND QUALIFICATION OF PERSONNEL

The use of this guideline is restricted to organizations approved by the EWF Authorized National Body (ANB).

1 INTRODUCTION

1.1 Guideline Structure

Chapter 2 provides an overview of the guideline content.

Chapter 3 of the guideline covers the minimum requirements for education and training. Students having successfully completed modules 1, 2, 6 and 7 of this course and passed the relevant examination (minimum in cutting, welding or other laser processes or all together) will be expected to be capable of applying the technology required in laser processing at the "Basic" level in cutting, welding and/or surface treatments as covered by this guideline. Students having successfully completed each module of this course of education and the appropriate examinations (minimum cutting, welding or other laser processes or all together) will be expected to be capable of applying the technology required in laser processing at the "Comprehensive" level in cutting, welding and/or surface treatments as covered by this guideline.

The contents are given in the following structure (overview):

TABLE 1 – OVERVIEW OF THE STRUCTURE OF THE TRAINING COURSES

	Teaching hours								
	Cutting (c)		Welding (w)		Surface Treatment (st)		Processing (p)		Safety Officer
	ELC-B	ELC-C	ELW-B	ELW-C	ELST-B	ELST-C	ELP-B	ELP-C	ELS-O
Module 1: BASICS OF LASER TECHNOLOGY	16	16	20	20	16	16	28	28	12
Module 2: LASER BEAM CUTTING SPECIALIZATION		20						20	
Module 3: LASER WELDING AND HYBRID-WELDING SPECIALIZATION				36				36	
Module 4: LASER SURFACE TREATMENTS SPECIALIZATION						16		16	
Module 5: QUALITY ASSURANCE AND SAFETY IN LASER PROCESSING	8	8	8	8	8	8	8	8	
Module 6C: PRACTICAL EDUCATION IN LASER CUTTING	28	8					28	8	
Module 6W: PRACTICAL EDUCATION IN LASER WELDING AND HYBRID WELDING			40	16			40	16	
Module 6ST: PRACTICAL EDUCATION IN SURFACE TREATMENTS					28	8	28	8	
Module 7 LASER SAFETY OFFICER									16
Total teaching hours	52	52	68	80	52	48	132	140	28

A “teaching hour” shall contain at least 50 minutes of direct teaching. It is not obligatory to follow exactly the order of the topics given in this guideline and choice in the arrangement of the syllabus is permitted. The depth to which each topic is dealt with is indicated by the number of hours allocated to it in the guideline.

It is to be noted that the overall structure of the syllabus for comprehensive and basic levels is similar, but some items are not considered appropriate in the education of the basic level candidate. This will be reflected in the scope and depth of the examination.

Chapter 4 of the guideline covers the rules for examination and qualification.

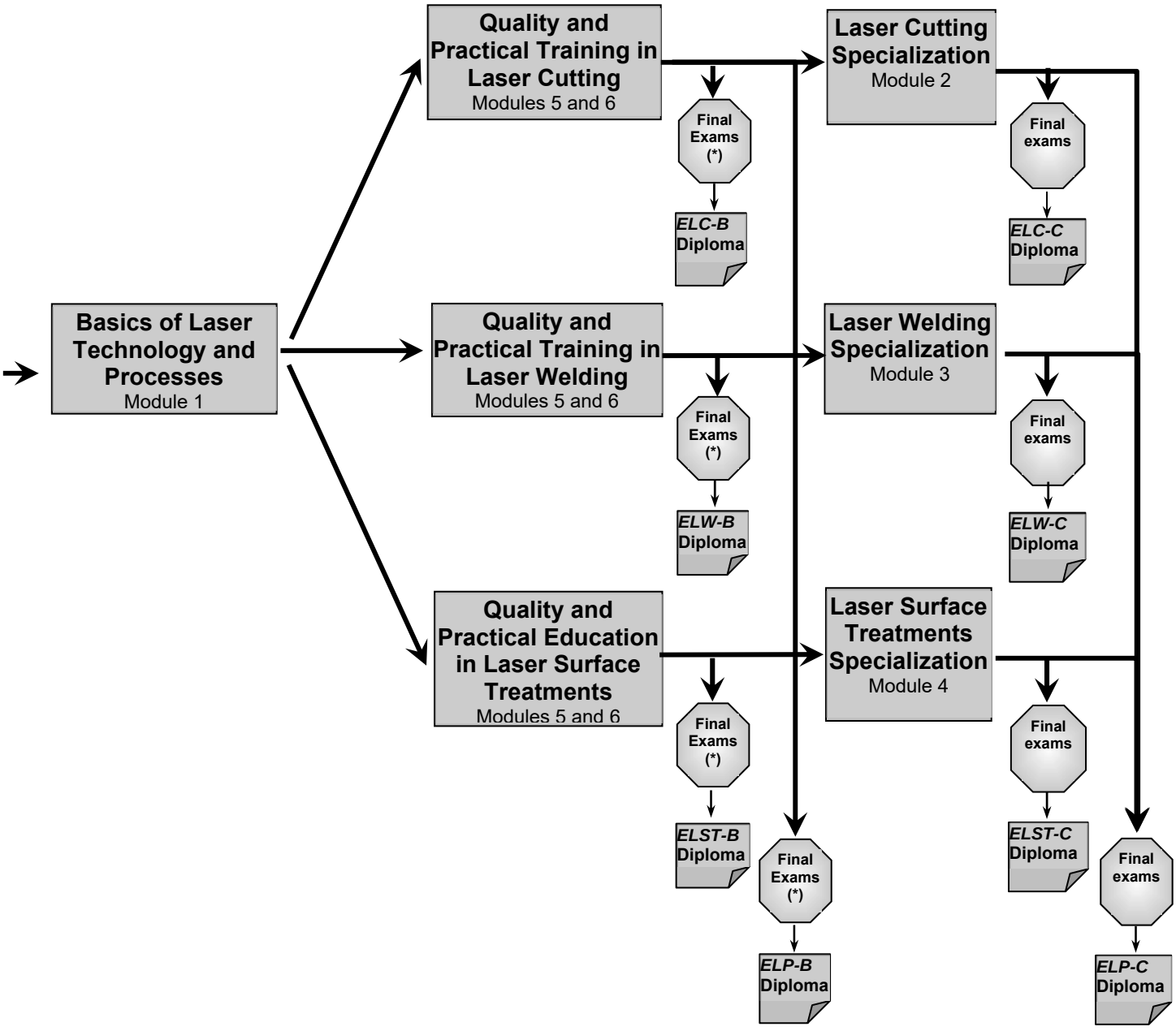
1.2 General Access Conditions

In a separate document (Directory of Access Conditions, Doc. IAB-020, latest revision) the national definitions are given in detail.

Applicants entering for comprehensive level shall fulfil at least the National Access Conditions at the IWT level but recommendation is IWE level.

Applicants not fulfilling the entry access conditions at comprehensive level may follow the course but are not allowed entry to the EWF examination at comprehensive level.

For basic level, no access conditions apply, but experience in welding or allied activities for at least one year is recommended.



(*) It Includes approval testing of operators according to EN ISO 14732 standard

Diagram 1 - Training modules and levels in education

See also routes and hours in appendix 1.

In appendix 2 is described qualification routes to European Laser Safety Officer education.

2 COURSE CONTENT OVERVIEW: THEORETICAL AND PRACTICAL EDUCATION

	Hours
THEORETICAL EDUCATION	
Module 1: BASICS OF LASER TECHNOLOGY (c 16, w 20, st 16, p 28)	
(Common for all levels and routes)	
M 1.1 Presentation of the program and introduction to laser techniques	2
M 1.2 Principles of laser emission and key laser parameters	3
M 1.3 Laser types, beam propagation and guiding between output and work piece	4
M 1.4 Laser systems and equipment	3
M 1.5 Basics of laser beam cutting	4
M 1.6 Basics of laser beam welding	4
M 1.7 Basics of laser beam hybrid-welding	4
M 1.8 Basics of laser beam surface treatments	4
For Comprehensive levels only	
Module 2: LASER BEAM CUTTING SPECIALIZATION	**20**
M 2.1 Laser beam as heat source for processing, beam and process parameters	1
M 2.2 Laser beam as heat source in cutting	1
M 2.3 Laser beam – material interaction	2
M 2.4 Laser beam cutting process - material interaction	2
M 2.5 Special characteristics of laser cutting	2
M 2.6 Product design and laser cutting	4
M 2.7 Economic considerations on laser processing	4
M 2.8 Case studies in laser cutting	4
Module 3: LASER WELDING AND HYBRID-WELDING SPECIALIZATION	**36**
M 3.1 Laser beam as heat source for processing, beam and process parameters	1
M 3.2 Laser beam as heat source in welding and hybrid welding	2
M 3.3 Laser beam – material interaction	2
M 3.4 Laser welding and hybrid welding process – material interaction	3
M 3.5 Special characteristics of laser welding and hybrid welding	4
M 3.6 Product design and laser welding and hybrid welding	4
M 3.7 Design considerations for static and dynamic loading in laser welding	5
M 3.8 Clamping device design	3
M 3.9 Economic considerations on laser processing	4
M 3.10 Case studies in laser welding and hybrid welding	8

Module 4: LASER SURFACE TREATMENTS SPECIALIZATION	12
M 4.1 Laser beam as heat source for processing, beam and process parameters	1
M 4.2 Laser beam as heat source in surface heat treatments	1
M 4.3 Surface heat treatments – material interaction	1
M 4.4 Special characteristics of surface heat treatment	1
M 4.5 Product design and laser surface treatments	4
M 4.6 Economic considerations on laser processing	4
M 4.7 Case studies in laser surface treatments	4

Module 5: QUALITY ASSURANCE AND SAFETY IN LASER PROCESSING	8
M 5.1 Quality assurance, beam diagnostics and parameter storage	2
M 5.2 Quality standards, CEN, ISO, SFS ISO EN	2
M 5.3 Qualification of laser processing personnel	2
M 5.4 Safety with industrial lasers	1
M 5.5 Health hazards and personal safety	1

PRACTICAL EDUCATION

Module 6C: PRACTICAL EDUCATION IN LASER CUTTING	
MC 6.1 Process and beam parameters in laser processing and their effect on quality	2
MC 6.2 Process monitoring and control	2
MC 6.3 Laser cutting in practice for basic level	24
MC 6.3 Laser cutting in practice for comprehensive level	4

Module 6W: PRACTICAL EDUCATION IN LASER WELDING AND HYBRID WELDING	
MW 6.1 Process and beam parameters in laser processing and their effect on quality	2
MW 6.2 Process monitoring and control	2
MW 6.3 Laser welding and hybrid welding in practice for basic level	36
MW 6.3 Laser welding and hybrid welding in practice for comprehensive level	12

Module 6ST: PRACTICAL EDUCATION IN SURFACE TREATMENTS	
MST 6.1 Process and beam parameters in laser processing and their effect on quality	2
MST 6.2 Process monitoring and control	2
MST 6.3 Laser surface treatments in practice for basic level	24
MST 6.3 Laser surface treatments in practice for comprehensive level	4

Voluntary part, not to be included in the examination

Module 7 LASER SAFETY OFFICER	16

3 THEORETICAL EDUCATION

3.1 Module 1: Basics of laser technology and processes 12

3.1.1 Presentation of the program and introduction to laser techniques 2

Objective:

The students will understand key terms and abbreviations and be acquainted with basic laser types and techniques.

Scope:

Definitions and terminology related to:

- content of the guideline
- basic types of laser
- development of industrial lasers and laser processing systems
- basic types of laser processes
- laser applications

Learning Outcomes

After this module student is able to:

Understand the terminology and definitions, which are used in this course.

Classify various laser types based on proper terminology.

Classify various types of laser processes based on proper terminology.

3.1.2 Principles of laser emission and key laser parameters 3

Objective:

The students will be acquainted with laser emission.

Scope:

- laser light
- wavelength
- resonators structure and operational principle
- laser parameter overview

Learning Outcomes:

After this module student is able to:

Explain the generation of laser light.

Explain the properties of laser beam.

Understand suitable wavelengths used in different laser processing applications and different materials.

Explain the optical components in laser system

3.1.3 Laser types and beam transfer between the output window and the work piece 4

Objective:

To understand how different kind of laser types work and how the beam guidance is done in those systems

Scope:

Laser types

- CO_2-laser
- Diode-laser
- Fiber-laser
- Disc-laser
- Beam Characteristics
- Propagation
- Focusability
- Power density distribution
- Polarisation
- Beam Transfer
- Mirrors and lenses
- Scanning optics
- Fiber optical systems
- Beam quality and beam control / observation

Learning Outcomes:

After this module student is able to:

Explain the working principles of the most common laser types.

Explain difference between laser types.

Explain the structure of laser types.

Understand the basic reasons for different types of laser beam delivery.
Explain the basics of beam properties, manipulations and guidance.

3.1.4 Laser material processing systems and equipment 3

Objective:

The student will be introduced to use and identify laser systems and internal & external equipment.

Scope:

- Laser work stations
- Gases in laser processes
- Optional accessories
- Most relevant laser beam parameters
- Beam guiding and focusing optics

- Welding fixtures

Learning Outcomes:

After this module student is able to:

Explain the basics of the most common laser workstations.

Understand the basics of the gases and fumes, which are used or formed in laser processes.

Understand the additional value of optional accessories.

Explain most common optional accessory in laser systems.

Explain most relevant laser beam parameters.

Explain proper selection of welding fixtures.

Explain the method for choosing most suitable focusing optics for different laser processes.

3.1.5 Basics of laser beam cutting 4

Objective:

The student will become acquainted with the most common laser cutting processes used in industry.

Scope:

- Principle of laser beam cutting
- Characteristics of laser beam cutting
- Comparison of laser beam cutting with other cutting processes, e.g. flame, plasma or water jet cutting

Learning Outcomes:

After this module student is able to:

Explain basics of different kind of laser cutting.
processes. Understand proper use of processes.

Explain operational principles of processes.

3.1.6 Basics of laser beam welding 4

Objective:

The student will become acquainted with the most common laser welding processes used in industry.

Scope:

- Principle of laser beam welding
- Characteristics of laser beam welding
- Comparison of laser beam welding with other welding processes, e.g. electron beam welding, plasma arc welding, conventional arc welding

Learning Outcomes:

After this module student is able to:

Explain basics of different kind of laser welding processes.

Understand proper use of processes.
Explain operational principles of processes.

3.1.7 Basics of laser beam hybrid welding 4

Objective:

The student will become acquainted with the most common hybrid welding processes used in industry.

Scope:

- Principle of laser beam hybrid welding
- Process and energy source variations
- Different set ups

Learning Outcomes:

After this module student is able to:

Explain basics of different kind of hybrid welding processes.
Understand proper use of processes.
Explain operational principles of processes.

3.1.8 Basics of laser beam surface treatments 4

Objective:

The student will become acquainted with the most common laser surface treatment processes used in industry.

Scope:

- Laser surface hardening
- Laser cladding
- Laser surface melting
- Laser surface alloying
- Other processes (drilling, soldering, marking, ablation etc.)

Learning Outcomes:

After this module student is able to:

Explain basics of different kind of laser surface treatment and other processes.

Understand proper use of processes.

Explain operational principles of different processes.

3.2 ***Module 2: Laser beam cutting specialization*** **20**

3.2.1 Laser beam as heat source for processing, beam and cutting parameters

Objective:

The student will become acquainted with laser beam and its properties as heat source.

Scope:

- Laser beam power density
- Power density distribution
- Time of interaction
- Laser beam profiling and data storage

Learning outcomes for comprehensive level:

After this module student is able to:

Compute power need in different laser processes.

Explain the beam parameters.

Understand interaction time in laser processes.

3.2.2 Laser beam as heat source in cutting **1**

Objective:

The student will be introduced with special character of laser beam as heat source in cutting applications

Scope:

- Laser sublimation cutting
- Laser oxygen cutting
- Laser fusion cutting
- Laser remote cutting
- Beam absorption and reflection
- Laser beam parameters in cutting applications
- Laser beam parameters as error source
- Laser beam parameters impact on process

Learning Outcomes:

After this module student is able to:

Explain the differences between sublimation-, oxygen- and fusion cutting.
Explain factors of reflections in cutting applications.

Understand laser cutting phenomenon.

3.2.3 Laser beam – material interaction 2

Objective:

The student will understand the theoretical background of laser beam and material interaction.

Scope:

- Absorption and reflection
- Polarization, main parameters and impact on the process
- Polarization diagnostics
- Material properties
- Heat conduction
- Plasma generation

Learning Outcomes:

After this module student is able to:
Understand how materials affect to absorption and reflection of laser beam.
Explain importance of polarization when materials are processed.
Understand materials properties which affect workability of work piece.
Estimate heat conduction in work piece.
Explain the plasma cloud and methods to control it.

3.2.4 Laser beam cutting – material interaction 2

Objective:

The student will be introduced laser cutting in material interaction point of view.

Scope:

- Carbon steel
- Stainless steel
- Aluminium alloys
- Other alloyed metals
- Other materials (polymers, wood, paper, ceramics, etc.)

Learning Outcomes:

After this module student is able to:
Explain the reasons of cuttability of different kind of materials.
Review the metallurgical and structural changes in materials.
Explain required material preparation for laser cutting.
Illustrate proper cutting speed.
Understand material properties which correlate laser cutting.
Evaluate cutting quality based on material properties.

3.2.5 Special characteristics of laser beam cutting 2

Objective:

The student will be acquainted advanced laser cutting details.

Scope:

- Cutting methods and equipment
- Cutting beam parameters
- Cutting process parameters
- Gases and nozzles
- Special processes
- Standards

Learning Outcomes:

After this module student is able to:

Identify suitable cutting methods for different materials and products.
Understand cutting parameters and their mutual dependences.

Determine correct cutting parameters.

Select suitable cutting nozzle and assist gases.

Explain and identify special processes of laser cutting, like 3D-cutting and laser-water jet cutting.

Explain principles of most common laser cutting standards.

3.2.6 Design and laser cutting 4

Objective:

The students will be introduced to product design and laser cutting.

Scope:

- Laser cutting compared to conventional methods
- Freedom of shape and material
- Proper use of nesting
- 3D cutting
- Specification of cut (accuracy, roughness etc.)
- Cutting results versus laser beam parameters
- Indirect advantages
- Pre- and after machining

Learning Outcomes:

After this module student is able to:

Understand all the advantages of laser cutting from the design point of view.

Exploit complete manufacturing chain in designing process.

Understand the specification of cut.

Explain the restriction of laser cutting in design.
Be aware for 3D cutting possibilities and take advantage of it in designing process.

3.2.7 Economic considerations on laser processing 4

Objective:
The student will become familiar with economical aspect of laser processing

Scope:

- Investment cost of laser system
- Operating cost
- Unit cost

Learning Outcomes
After this module student is able to:
Explain the rationale of suitable laser system selection.
Estimate the investment and operational costs when purchasing laser system.
Estimate the unit cost for different products.
Choose the correct workstation and system.
Understand an economical difference between laser types.

3.2.8 Case studies in laser cutting 4

Objective:
The student will become familiar with application cases of laser cutting in their broader industrial context.

Scope:

- Advantages and disadvantages of laser cutting
- Cost calculation
- Comparison to competing cutting techniques
- Concepts of laser cutting systems

Learning Outcomes:
After this module student is able to:
For specified industrial application cases that are promising for laser cutting:
List the specific advantages and disadvantages of laser cutting.
Make a cost calculation.
Compare to competing cutting techniques.
Identify critical aspects of the laser cutting process to be considered.
Sketch a concept of a suitable laser cutting system.

3.3 Module 3: Laser welding and hybrid welding specialization 36
(for comprehensive levels only)

3.3.1 Laser beam as heat source in processing, beam and process parameters 1

Objective:

The students will become acquainted with laser beam and its properties as heat source.

Scope:

- Laser beam power density
- Power density distribution
- Time of interaction
- Dynamic and static beam forming in welding
- Laser beam profiling and data storage

Learning outcomes of comprehensive level:

After this module student is able to:

Estimate power need in different laser processes.

Explain and understand the beam parameters.

Understand interaction time in laser processes.

3.3.2 Laser beam as heat source in welding and hybrid welding 2

Objective:

The student will be introduced with special character of laser beam as heat source in welding and hybrid welding applications.

Scope:

- Conduction limited welding
- Keyhole welding
- Spot welding
- Hybrid welding
- Beam absorption and reflection
- Plasma/plume formation and control
- Laser beam parameters in welding applications
- Laser beam parameters as an error source
- Laser beam parameter impact on process

Learning Outcomes:

After this module student is able to:

Explain the beam properties between conduction-, keyhole- and hybrid welding.

Understand purpose of beam parameters in conduction-, keyhole- and hybrid welding applications.

Explain factors of reflections in welding applications.

Understand laser welding and hybrid welding phenomena.

3.3.3 MW Laser beam – material interaction 2

Objective:

The student will understand the theoretical background of laser beam and material interaction.

Scope:

- Absorption and reflection
- Polarization, main parameters and impact on the process
- Polarization diagnostics
- Material properties
- Heat conduction
- Plasma/plume generation

Learning Outcomes:

After this module student is able to:

Understand how materials affect absorption and reflection of laser beam.

Explain importance of polarization when materials are processed.

Understand material properties which affect weldability.

Estimate heat conduction in work piece.

Explain the plasma cloud and methods to control it.

3.3.4 Laser beam welding and hybrid welding – material interaction 3

Objective:

The student will be introduced laser welding and hybrid welding in material interaction point of view.

Scope:

- Weldability of materials
- Carbon steel
- Stainless steel
- Aluminium alloys
- Other alloyed metals
- Weld defects

Learning Outcomes:

After this module student is able to:

Explain the difference between the weldability of different kind of materials.

Review the metallurgical changes of different materials.

Explain required material preparation for laser- or hybrid welding.

Understand effect of filler materials.

Identify most common welding imperfections or defects in the weld.
Illustrate proper welding speed.

3.3.5 Special characteristics of laser beam welding and hybrid welding 4

Objective:

The student will become familiar with appropriate use of laser welding and hybrid welding and special properties of them.

Scope:

- Welding methods
- Welding equipment
- Welding process parameters
- Weld pool shielding
- Joint fit-up requirements
- Properties of welded joints
- Standards
- NDT of laser welds

Learning outcomes for comprehensive level:

After this module student is able to:
Gain extended knowledge on welding and hybrid welding.
Understand all advantages, which are linked to laser- or hybrid welding.
Explain the weld pool shielding requirements and methods.
Illustrate joint preparation and fit-up requirements when using laser-based welding.
Understand mechanical and structural properties of the joint.

3.3.6 Design and laser beam and hybrid welding 4

Objective:

The students will be introduced to the effect of use of laser- and hybrid welding on product design.

Scope:

- Joint design
- Tolerances
- Multi beam and multi spot applications
- Welding positions
- Distortions
- Mechanical properties of weld

Learning Outcomes:

After this module student is able to:
Understand the possibilities to utilize all the materials and structures that laser welding

can offer.

Explain different joint design and their potentials.

Choose the right joint design for different applications.

Understand the tolerances and other limitations.

Illustrate the possible influence of manufacturing tolerances on the final design of structure.

3.3.7 Design considerations for static and dynamic loading of laser welded structures 5

Objective:

The student will become familiar with different kind of stress and loads and how these can be noticed in weld designing.

Scope:

- Active forces
- Standards and rules
- Applications and joints

Learning Outcomes:

After this module student is able to:

Explain possible sources of exceptional and normal loads on the structure being considered.

Understand all the related stress and loads that affect the welded joint.

Understand standards and rules for beam welding structures.

Utilize different joint types for different applications.

3.3.8 Clamping device design 3

Objective:

The student will become acquainted with most common clamping principles and methods in laser welding.

Scope:

- Clamping devices
- Weld requirements for clamping device

Learning Outcomes:

After this module student is able to:

Understand the meaning of clamping in efficiency point of view.

Understand the joint design and clamping device relation.

3.3.9 Economic considerations on laser processing 4

Objective:

The student will become familiar with economical aspect of laser processing

Scope:

- Investment cost of laser system
- Operating cost
- Unit cost

Learning Outcomes

After this module student is able to:

Explain the rationale of selection of a suitable laser system.

Estimate the investment and operational costs when purchasing laser system.

Estimation of the unit cost for different products.

Selection of the correct workstation and system.

Understanding an economic difference between different laser types.

3.3.10 Case studies in laser welding and hybrid welding 8

Objective:

The student will become familiar with application cases of laser (and hybrid) welding in their broader industrial context.

Scope:

- Advantages and disadvantages of laser (and hybrid) welding, including design aspects
- Cost calculation
- Comparison to competing welding techniques
- Concepts of laser welding systems

Learning Outcomes:

After this module student is able to:

For specified industrial application cases that are promising for laser welding:

List the specific advantages and disadvantages of laser welding.

Make a cost calculation.

Compare to competing welding techniques.

Identifying the critical aspects of the laser welding process to be considered.

Suggestion and discussion of suitable joint design.

Sketch a concept of a suitable laser welding system.

3.4 Module 4: Laser surface treatments specialization 12
(for comprehensive levels only)

3.4.1 Laser beam as heat source in processing, beam and process parameters 1

Objective:
The students will become acquainted with laser beam and its properties as a heat source.

Scope:
- Laser beam power density
- Power density distribution
- Time of interaction
- Laser beam profiling and data storage

Learning outcomes for comprehensive level:
After this module student is able to:
Compute power need in different laser surface treatment processes.
Explain the beam parameters.
Understand interaction time in laser processes.

3.4.2 Laser beam as heat source in surface heat treatments 1

Objective:
The student will be introduced with special character of laser beam as heat source in surface heat treatment applications.

Scope:
- Hardening
- Remelting
- Cladding
- Alloying
- Beam guiding, manipulation and focusing
- Beam parameters

Learning Outcomes:
After this module student is able to:
Understand the beam properties and parameters in applications.
Explain the beam guidance methods in surface treatment applications.
Understand the most common phenomena in laser surface treatment´s.

3.4.3 Laser beam – material interaction 1

Objective:

The student will understand the theoretical background of laser beam and material interaction.

Scope:

- Absorption and reflection
- Polarization, main parameters and their impact on the process
- Polarization diagnostics
- Material properties
- Heat conduction
- Plasma generation

Learning Outcomes:

After this module student is able to:

Understand how materials affect absorption and reflection of laser beam.

Explain the importance of polarization when materials are processed.

Understand materials properties, which affect workability of work piece.

Estimate heat conduction in work piece.

Explain the plasma cloud/plume and methods to control it.

3.4.4 Surface heat treatments – material interaction 1

Objective:

The student will be introduced the surface heat treatment in material interaction point of view.

Scope:

- Hardening
- Remelting
- Cladding
- Alloying
- Ablation

Learning Outcomes:

After this module student is able to:

Classify surface heat treatment methods used on different materials.

Review metallurgical and structural changes in the material.

Explain the changes in microstructure.

Understand proper use of surface heat treatments.

Explain properties of the surface after heat treatment.

Understand the interaction between beam and base- or filler material in different surface treatment applications.

3.4.4 Special characteristics of surface heat treatment 1

Objective:

The student will become familiar with laser surface heat treatment and most of its applications.

Scope:

- Hardening
  - Parameters
  - Limitations
- Cladding
  - Parameters
  - Cladding methods
  - Applications
- Surface melting and shock hardening treatment

Learning Outcomes:

After this module student is able to:

Illustrate proper surface treatment parameters for an application.

Explain the goals for selecting a suitable surface treatment process for an application. Understand meaning of parameters in different surface treatment processes

3.4.5 Design and laser surface treatments 4

Objective:

The students will be introduced how does laser surface treatment processes effect on the product design.

Scope:

- Surface design
- Freedom of shape
- Tolerances
- Hardening and cladding overlapping
- Distortions
- Control of strength and hardness of hardening and cladding

Learning Outcomes:

After this module student is able to:

Understand the possibilities to utilize all the materials and structures that laser surface treatment (cladding, hardening, etc.) can offer.

Explain different design aspects and their potentials. Choose the right design for different applications.

Understand the tolerances and other limitations.

Illustrate the possible influence of manufacturing tolerances on the final design of structure.

3.4.6 Economic considerations on laser processing 4

Objective:

The student will become familiar with economical aspect of laser processing

Scope:

- Investment cost of laser system
- Operating cost
- Unit cost

Learning Outcomes

After this module student is able to:

Explain the rationale of suitable laser system selecting.

Estimate the investment and operational costs when purchasing laser system.

Estimate the unit cost for different products.

Choose the correct workstation and system.

Understand an economical difference between laser types.

3.4.7 Case studies in laser surface treatment 4

Objective:

The student will become familiar with application cases of laser surface treatment in their broader industrial context.

Scope:

- Advantages and disadvantages of laser surface treatments (cladding, hardening, melting, alloying) including design aspects
- Cost calculations
- Comparison to competing surfacing and hardening techniques
- Concepts of laser surface treatment systems

Learning Outcomes:

After this module student is able to:

For specified industrial application cases that are promising for laser surface treatments. List the specific advantages and disadvantages of laser surface treatments.

Make a cost calculation.

Compare to competing surfacing and hardening techniques.

Identify critical aspects of the laser surface treatment process to be considered.

Suggest and discuss more suitable joint design.

Sketch a concept of a suitable laser surface treatment system.

3.5 Module 5: Quality assurance and safety in laser processing 8
(common for all levels and routes)

3.5.1 Quality assurance and control in laser processing 2

Objective:

The student will become familiar with ~~laser~~ quality requirements, assurance and control of laser processing

Scope:

- Concept of quality assurance and quality control
- Common defects in laser processing
- Seam tracking
- Laser process monitoring and control Laser beam monitoring and control Process data base

Learning Outcomes:

After this module student is able to:

Understand the meaning of quality requirements, assurance and control of laser processing.

Understand the reason on formation of different defects in laser processing.

Choose appropriate process monitoring and inspection techniques.

3.5.2 Quality standards (CEN, EN ISO) 2

Objective:

The student will become familiar with all the standards related to laser processing

Scope:

- Standards on laser processing quality assurance
- Standards on laser welding procedure specification and qualification
- Standards on quality levels for laser welding

Learning Outcomes:

After this module student is able to:

Understand the requirements of standards for different processes.

Write correct welding procedure specifications.

Choose correct tests for welding procedure qualification.

3.5.3 Qualification of laser processing personnel 2

Objective:

The student will become familiar with requirements of laser processing personnel qualification (laser cutting, welding and surface treatment)

Scope:

- Standards on laser processing personnel qualification
- Operator qualification

Learning Outcomes:

After this module student is able to:

Understand the requirements of laser processing personnel qualification for different processes.

Can advise and choose the right procedures for training.

3.5.4 Safety with industrial lasers 2

Objective:

The student will become familiar the safety risks in laser processing

Scope:

- Basic risks (eye and skin) in laser processing
- Non-beam hazards (fire, electric, fumes) in laser processing

Learning Outcomes:

After this module student is able to:

Can avoid the risks in laser processing.

Understands the risks and hazards in laser processing.

3.5.5 Health hazards and personal safety 2

Objective:

The student gets familiar on personal risks in laser processing and laser safety standards

Scope:

- Standards on laser safety
- Eye and skin risks in laser processing Non-beam hazards in laser processing

Learning Outcomes:

After this module student is able to:

Choose of safety goggles.

Understanding meaning of the safety standard EN 60825 .

Avoid safety hazards in laser processing.

4 PRACTICAL EDUCATION

4.1 Module 6C: Practical education in laser cutting

4.1.1 Operating parameters in laser cutting and their effect on quality 2

Objective:

The student will become familiar with laser beam cutting and process parameters and their effects on process quality

Scope:

- Key operating parameters for laser beam cutting
- Common imperfections/defects in laser processing
- Unfocused and focused laser beam should be measured

Learning Outcomes:

The student will become familiar with choosing the acceptable laser parameters for laser cutting in practice.

4.1.2 MC Process monitoring and control 2

Objective:

The student will become familiar in practice with on-line process monitoring and control systems for laser beam cutting.

Scope:

- On-line process monitoring of laser cutting
- Spatial (camera) monitoring systems for welding or surface treatment
- Capacitive distance control systems for cutting
- Comparison to other basic quality control options (like robust process windows, operator skills, post-inspection and testing, etc.)

Learning outcomes for comprehensive and basic levels:

Experiencing how to integrate process monitoring into a laser system and process.
Experiencing how to integrate process control into a laser system and process.

Exploring practical potential and limits of monitoring systems.

Exploring practical potential and limits of control systems.

Comparison of process monitoring and control to other basic quality control options.

4.1.3 Laser cutting practical education

(for comprehensive **level)** **4**

Objective:

The student will become familiar with optimizing the laser cut quality through the laser system parameters in practice

Scope:

- Comparison of different materials
- Links between quality (roughness, dross, burning damage, etc.) and process parameters

Learning outcomes for comprehensive level:

Experience in cutting and comparing different materials.

Experience in interpreting and exploring the links between resulting cut quality and process parameters, leading to improvements.

Judgment of practical constraints and difficulties in laser cutting.

(for basic l**evel)** **24**

Objective:

The student will become familiar with carrying out laser cutting at a laser system in practice, including basic troubleshooting.

Scope:

- Oxygen and inert gas assisted laser cutting of mild steel
- Main process parameters
- Processing head (optics, nozzle)
- Cut quality assessment
- Transient sequences (drilling start, corner cutting, etc.)
- Troubleshooting

Learning outcomes for basic level:

After this module student is able to:

Understanding of the components and handling of a laser cutting system in practice. Choice adjustment and programming of the process parameters in practice.

Experience in oxygen and inert gas assisted laser cutting of mild steel

Assessment of the resulting cut quality.

Experience in transient laser cutting sequences (drilling start, corner).

Experience in troubleshooting.

4.2 Module 6W: Practical education in laser beam welding and/or hybrid welding

4.2.1 MW Operating parameters in laser beam welding and hybrid welding and their effect on quality 2

Objective:

The student will become familiar with all the laser beam and process parameters and their effects on process quality

Scope:

- Key operating parameters for laser beam processing including cutting, welding and surfacing
- Common imperfections/defects in laser processing
- Unfocused and focused laser beam should be measured

Learning outcomes for comprehensive and basic levels:

The student can choose acceptable parameters for laser beam welding and/or hybrid welding in practice

4.2.2 MW Process monitoring and control 2

Objective:

The student will become familiar in practice with on-line process monitoring and control systems for laser welding and hybrid welding.

Scope:

- On-line process monitoring of laser welding
- Spatial (camera) monitoring systems for welding
- Temporal (photodiode or pyrometer) monitoring systems for welding
- Seam tracking control systems for welding
- Comparison to other basic quality control options (like robust process windows, operator skills, post-inspection and testing, etc.)

Learning outcomes for comprehensive and basic levels:

Experiencing how to integrate process monitoring into a laser system and process.
Experiencing how to integrate process control into a laser system and process.

Exploring practical potential and limits of monitoring systems.

Exploring practical potential and limits of control systems.

Comparison of process monitoring and control to other basic quality control options.

4.2.3 MW Laser beam welding and/or hybrid welding practical education

(for comprehensive **level)** **12**

Objective:

The student will become familiar with optimizing the laser (and hybrid) weld quality through the parameters (laser system, fixture, edge preparation, etc.) in practice

Scope:

Links between visible quality (lack of penetration, underfill/spatter, etc.) and system parameters

- Comparison of different materials during laser welding
- Gap width variation during laser welding
- Plasma shielding during CO2-laser welding (Ar vs. He, 10 µm- vs. 1 µm-wavelength)
- Variation of the distance laser-arc during hybrid welding
- High wire feed rate for hybrid welding, including short-circuiting

Learning Outcomes for comprehensive level:

Experience in welding of typical (see scope) complex laser and hybrid welding situations.

Experience in interpreting and exploring the links between resulting weld quality and process parameters, leading to improvements.

Judgment of practical constraints and difficulties in laser welding.

(for basic **level)** **36**

Objective:

The student will become familiar with preparing and carrying out laser welding and hybrid welding at a laser system in practice, including basic troubleshooting

Scope:

- Fixture, optics, shielding gas flow
- Main process parameters
- Visual weld inspection
- Troubleshooting
- CO2- and 1 µm-wavelength laser welding
- Laser welding of mild steel and of stainless steel
- Laser welding of thin (< 2 mm) and thick (> 6 mm) sheets
- Welding of Zn-coated steel with trapped Zn position
- Laser welding of aluminium
- Hybrid welding (laser+GMAW) with leading vs. trailing arc

learning outcomes for basic level:

Understanding of the components and handling of a laser (and hybrid) welding system in practice.

Choice, adjustment and programming of the process parameters in practice.

Experience in typical (see scope) basic laser and hybrid welding situations Assessment of the resulting weld quality.

Experience in troubleshooting.

4.3 Module 6ST: Practical education in laser beam surface treatments

4.3.1 MST Operating parameters in laser beam surface treatments and their effect on quality 2

Objective:

The student will become familiar with laser beam surface treatments and process parameters and their effects on process quality

Scope:

- Key operating parameters for laser beam surfacing
- Common imperfections/defects in laser processing
- Unfocused and focused laser beam should be measured

Learning Outcomes for comprehensive and basic levels:

The student will become familiar with choosing the acceptable laser parameters for surface treatments in practice.

4.3.2 MST Process monitoring and control 2

Objective:

The student will become familiar in practice with on-line process monitoring and control systems for laser surface treatments.

Scope:

- On-line process monitoring of laser surface treatments
- Spatial (camera) monitoring systems for surface treatments
- Temporal (photodiode or pyrometer) monitoring systems for surface treatments
- Comparison to other basic quality control options (like robust process windows, operator skills, post-inspection and testing, etc.)

Learning Outcomes for comprehensive and basic levels:

Experiencing how to integrate process monitoring into a laser system and process Experiencing how to integrate process control into a laser system and process Exploring practical potential and limits of monitoring systems

Exploring practical potential and limits of control systems

Comparison of process monitoring and control to other basic quality control options

4.3.3 MST Laser beam surface treatments practical education

(for comprehensive **level)** **4**

Objective:

The student will become familiar with optimizing the quality of surfaces made by laser surface treatment through the parameters (laser system, surface preparation, etc.) in practice

Scope:

- Links between visible quality (cracks, pores, uneven surface, spatter, etc.) and system parameters
- Comparison of different materials (base and filler) during laser surface treatment

Learning Outcomes for comprehensive level:

Experience in surface treatments of typical (see scope) complex laser surface treatment situations.

Experience in interpreting and exploring the links between resulting quality and process parameters, leading to improvements.

Judgment of practical constraints and difficulties in laser surface treatment.

(for basic **level)** **24**

Objective:

The student will become familiar with preparing and carrying out laser surface treatment and at a laser system in practice, including basic troubleshooting

Scope:

- Fixtures, optics, shielding gas flow
- Main process parameters
- Visual surface inspection
- Troubleshooting
- CO2- and 1 µm-wavelength laser surface treatment
- Laser hardening of carbon steel
- Laser cladding of mild steel and of stainless steel with ordinary cladding materials

Learning Outcomes for basic level:

Understanding of the components and handling of a laser surface treatment system in practice.

Selection, adjustment and programming of the process parameter values in practice.

Experience in typical (see scope) basic laser surface treatment situations Assessment of the resulting surface quality.

Experience in troubleshooting.

4.4 Module 7: Laser safety officer

(voluntary part, not be included in examination course, 16 hrs)

Laser safety officer **16**

Objective:

The module (together with the module 1) is designed to provide the student with the knowledge required to perform the duties of Laser Safety Officer as described in standard EN 60825.

Scope:

By completion of the module the student will know

- effects of lasers have on the eye and skin
- the hazard analysis
- EN standard and other safety regulations associated with lasers
- the effects of non-beam hazards
- how to set up a laser safety program

Learning Outcomes

Understands the risks and hazards in laser processing.

Is able to prepare the hazard analysis.

Understands the safety standards.

5 EXAMINATION

5.1 Introduction

This guideline seeks to achieve harmonization of examination and qualification of personnel involved in the operation of laser processing of metallic materials in the European territory. The national welding organizations, being members of EWF, mutually acknowledge the Diplomas awarded in any member Country to laser processing personnel following examination conducted in accordance with this guideline.

Education must have followed this EWF guideline and the examination must have been conducted by the Authorized National Body.

5.2 Examination procedures and administration

Procedures and administration are covered by Document EWF416 (see latest edition).

5.3 Approval of the training course

Any training course leading to the EWF examination shall be approved by the Authorized National Body. The number of teachers required to give the course shall be sufficient to ensure that the essential specialist knowledge and industrial experience to cover the syllabus is adequately represented in the team of teachers and visiting lecturers.

5.4 Examination Board

An examination Board, acting on behalf of the ANB supervises the examination therefore independence, integrity and fairness of the examination system are maintained.

5.5 Admission to the examination

Admission to the examination leading to the award of the laser processing personnel diplomas will be restricted to those:

a) who comply with the minimum requirements specified in the directory of the access conditions, and
b) who have attended at least 90% of the course, approved by the ANB, according to this guideline.

Exceptions are at the ANB discretion.

5.6 Examination procedures at comprehensive level

The examination procedures described below are designed to test t of different situations in laser processing activities in industry. There he candidate's knowledge and understanding will be written examinations which have a series of multiple-choice questions and essay questions in each of the following modules:

Module 1: Basics of laser beam technology and processes
Module 2: Laser cutting specialization
Module 3: Laser welding and hybrid welding specialization
Module 4: Laser surface treatments specialization
Module 5: Quality assurance and safety in laser processing

The time devoted to the written examination shall be a minimum of 0,75 hours per module and field of activity (Cutting, welding and surface treatment). There has to be questions from each module, but number of examinations could be two: exam 1 modules 1, 2 and 3, exam 2 modules 4, 5 and 6. The questions are to reflect the course topics. However, the total examination time for all six modules shall be a minimum of 5 hours.

Module 7 (Practical exercises) will not be covered by the examination for the laser processing personnel at the comprehensive level.

5.7 Examination procedures at basic level

The theoretical examination procedures described below are designed to test the candidate's knowledge and understanding of different situations in laser processing active in industry. There will be a series of multiple-choice questions covering the whole field of each following modules:

Module 1: Basics of laser beam
technology and processes
Module 5: Quality assurance and safety in laser

processing Module 6: Practical exercises

The questions are to reflect the course topics. The time devoted to the written examination shall be a minimum of 0,5 hours per module, i.e. minimum 2 hours total.

The practical examination shall fulfil the EN ISO 14732 requirements.

5.8 Evaluation of performance

In order to pass the examination, the candidates shall achieve at least 60 % of the maximum possible mark examination.

The examination for all applicable modules shall be completed within a period of 3 years from the date of the first examination.

5.9 Re-examination and appeals procedure

Failure in any individual module of the examination shall require re-examination only in the module failed. Examinations shall be retaken within 2 weeks to 15 months of the initial examination and, in the case of a second failure, one further attempt is permitted within 1 to 15 months from the date of the second examination. Failure of this third attempt will result in the candidate being treated as an initial candidate and a retake of the whole course will be required.

Candidates who feel they have been unfairly treated during the examination procedure have the right to appeal to the Authorized National Body.

5.10 European laser processing diplomas

After successful examination the applicable diploma is awarded to the candidate by the Authorized National Body.

Table 2 reports the full list of acronyms which shall be used in the diplomas and, as further reference, the relevant education modules.

Diplomas Layout are given on the doc EWF-416 (latest Revision), ANBs shall sue the templates to fill up the diplomas blanks, that are available in the EWF Qual&Cert System Sharepoint .

Table 2: Acronyms for the EWF qualifications for European Laser Processing Personnel

ACRONYM	QUALIFICATION	MODULES
ELC–B	**European Diploma in Laser Cutting at the Basic Level**	MODULE 1: basics of laser technology and cutting process MODULE 5: quality assurance and safety in laser processing MODULE 6c: practical training in laser cutting
ELW–B	**European Diploma in Laser Welding at the Basic Level**	MODULE 1: basics of laser technology and welding and hybrid welding processes MODULE 5: quality assurance and safety in laser processing MODULE 6w: practical training in laser welding and hybrid welding
ELST – B	**European Diploma in Laser Surface Treatments at the Basic Level**	MODULE 1: basics of laser technology and surface treatments processes MODULE 5: quality assurance and safety in laser processing MODULE 6st: practical training in surface treatments
ELP–B:	**European Diploma in Laser Processing at the Basic Level**	MODULE 1: basics of laser technology, basics of laser beam cutting, welding and hybrid welding and surface treatments processes MODULE 5: quality assurance and safety in laser processing MODULE 6c: practical education in laser cutting MODULE 6w: practical education in laser welding and hybrid wel. MODULE 6st: practical training in surface treatments
ELC–C:	**European Diploma in Laser Cutting at the Comprehensive Level**	MODULE 1: basics of laser technology and cutting process MODULE 2: laser beam cutting specialization MODULE 5: quality assurance and safety in laser processing MODULE 6c: practical training in laser cutting
ELW–C	**European Diploma in Laser Welding at the Comprehensive Level**	MODULE 1: basics of laser technology and welding process MODULE 3: laser beam welding specialization MODULE 5: quality assurance and safety in laser processing MODULE 6w: practical training in laser welding
ELST–C	**European Diploma in Laser Surface Treatments at the Comprehensive Level**	MODULE 1: basics of laser technology and surface treatments processes MODULE 4: laser beam surface treatments specialization MODULE 5: quality assurance and safety in laser processing MODULE 6st: practical training in surface treatments
ELP-C	**European Diploma in Laser Processing at the Comprehensive Level**	MODULE 1: basics of laser technology and processes MODULE 2: laser beam cutting specialization MODULE 3: laser beam welding specialization MODULE 4: laser beam surface treatments specialization MODULE 5: quality assurance and safety in laser processing MODULE 6c: practical training in laser cutting MODULE 6w: practical training in laser welding and hybrid weld. MODULE 6st: practical training in surface treatments

5.11 Transitional arrangements

Transitional arrangements can be offered by the ANB period of up to 3,5 years from the date of approval of this guideline by the EWF technical committee to those already awarded of the EWF record of achievement for the Special Course in Laser Welding (Engineer, Technologist and Specialist levels) - doc. EWF-494-01 for a according to the following criteria:

- Engineer and Technologist level: ELW-C;
- Specialist Level: ELW – B.

In addition, each ANB can offer transitional arrangements for a period of up to 3,5 years from the date of addition of this guideline to the scope of the ANB through approval by the EWF Technical Committee for national qualifications warded through courses and examinations covering the specific (cutting, welding and surface treatment) or the whole technology at the appropriate level (basic, standard), provided that:

- the access conditions to the relevant level are satisfied and
- the arrangements are approved by the EWF technical Committee.

APPENDIX 1

Training modules and hours according to qualification levels

		Laser Cutting		Laser Welding		Surface Treatment		Processing		Laser Safety Officer
		ELC-B	ELC-C	ELW-B	ELW-C	ELST-B	ELST-C	ELP-S	ELP-C	ELS-O
		52	52	68	80	52	48	132	140	28
Module 1: BASICS OF LASER TECHNOLOGY	**Hrs**	**16**	**16**	**20**	**20**	**16**	**16**	**28**	**28**	**12**
M 1.1 Presentation of the program and introduction to laser techniques	2	2	2	2	2	2	2	2	2	2
M 1.2 Principles of laser emission and key laser parameters	3	3	3	3	3	3	3	3	3	3
M 1.3 Laser types, beam propagation and guiding between output and work piece	4	4	4	4	4	4	4	4	4	4
M 1.4 Laser systems and equipment	3	3	3	3	3	3	3	3	3	3
M 1.5 Basics of laser beam cutting	4	4	4					4	4	
M 1.6 Basics of laser beam welding	4			4	4			4	4	
M 1.7 Basics of laser beam hybrid-welding	4			4	4			4	4	
M 1.8 Basics of laser beam surface treatments	4					4	4	4	4	
Module 2: LASER BEAM CUTTING SPECIALIZATION	**Hrs**		**20**						**20**	
M 2.1 Laser beam as heat source for processing, beam and process parameters	1		1						1	
M 2.2 Laser beam as heat source in cutting	1		1						1	
M 2.3 Laser beam – material interaction	2		2						2	
M 2.4 Laser beam cutting process - material interaction	2		2						2	
M 2.5 Special characteristics of laser cutting	2		2						2	
M 2.6 Product design and laser cutting	4		4						4	
M 2.7 Economic considerations on laser processing	4		4						4	
M 2.8 Case studies in laser cutting	4		4						4	
Module 3: LASER WELDING AND HYBRID-WELDING SPECIALIZATION	**Hrs**				**36**				**36**	
M 3.1 Laser beam as heat source for processing, beam and process parameters	1				1				1	
M 3.2 Laser beam as heat source in welding and hybrid welding	2				2				2	
M 3.3 Laser beam – material interaction	2				2				2	
M 3.4 Laser welding and hybrid welding process – material interaction	3				3				3	
M 3.5 Special characteristics of laser welding and hybrid welding	4				4				4	
M 3.6 Product design and laser welding and hybrid welding	4				4				4	
M 3.7 Design considerations for static and dynamic loading in laser welding	5				5				5	
M 3.8 Clamping device design	3				3				3	
M 3.9 Economic considerations on laser processing	4				4				4	
M 3.10 Case studies in laser welding and hybrid welding	8				8				8	

		Laser Cutting		Laser Welding		Surface Treatment		Processing		Laser Safety Officer
		ELC-B	ELC-C	ELW-B	ELW-C	ELST-B	ELST-C	ELP-S	ELP-C	ELS-O
		52	52	68	80	52	48	132	140	28
Module 4: LASER SURFACE TREATMENTS SPECIALIZATION	**Hrs**						**16**		**16**	
M 4.1 Laser beam as heat source for processing, beam and process parameters	1						1		1	
M 4.2 Laser beam as heat source in surface heat treatments	1						1		1	
M 4.3 Surface heat treatments – material interaction	1						1		1	
M 4.4 Special characteristics of surface heat treatment	1						1		1	
M 4.5 Product design and laser surface treatments	4						4		4	
M 4.6 Economic considerations on laser processing	4						4		4	
M 4.7 Case studies in laser surface treatments	4						4		4	
Module 5: QUALITY ASSURANCE AND SAFETY IN LASER PROCESSING	**Hrs**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	
M 5.1 Quality assurance, beam diagnostics and parameter storage	2	2	2	2	2	2	2	2	2	
M 5.2 Quality standards, CEN, ISO, SFS ISO EN	2	2	2	2	2	2	2	2	2	
M 5.3 Qualification of laser processing personnel	2	2	2	2	2	2	2	2	2	
M 5.4 Safety with industrial lasers	1	1	1	1	1	1	1	1	1	
M 5.5 Health hazards and personal safety	1	1	1	1	1	1	1	1	1	
Module 6C: PRACTICAL EDUCATION IN LASER CUTTING	**Hrs**	**28**	**8**					**28**	**8**	
M 6C.1 Process and beam parameters in laser processing and their effect on quality	2	2	2					2	2	
M 6C.2 Process monitoring and control	2	2	2					2	2	
M 6C.3 Laser cutting in practice		24	4					24	4	
Module 6W: PRACTICAL EDUCATION IN LASER WELDING AND HYBRID WELDING	**Hrs**			**40**	**16**			**40**	**16**	
M 6W.1 Process and beam parameters in laser processing and their effect on quality	2			2	2			2	2	
M 6W.2 Process monitoring and control	2			2	2			2	2	
M 6W.3 Laser welding and hybrid welding in practice	12			36	12			36	12	
Module 6ST: PRACTICAL EDUCATION IN SURFACE TREATMENTS	**Hrs**					**28**	**8**	**28**	**8**	
M 6ST.1 Process and beam parameters in laser processing and their effect on quality	2					2	2	2	2	
M 6ST.2 Process monitoring and control	2					2	2	2	2	
M 6ST.3 Laser surface treatments in practice	4					24	4	24	4	
Voluntary part, not to be included in the examination	**Hrs**									
Module 7 LASER SAFETY OFFICER	16									16

APPENDIX 2

Standard and alternative routes to European Laser Safety Officer education

The Laser Safety Officer (LSO) is an individual designated by the employer with the authority and responsibility to effect the knowledgeable evaluation and control of laser hazards, and to monitor and enforce the control of such hazards. Training of Modules 1 and 7 gives the minimum education for acting as an ELSO.

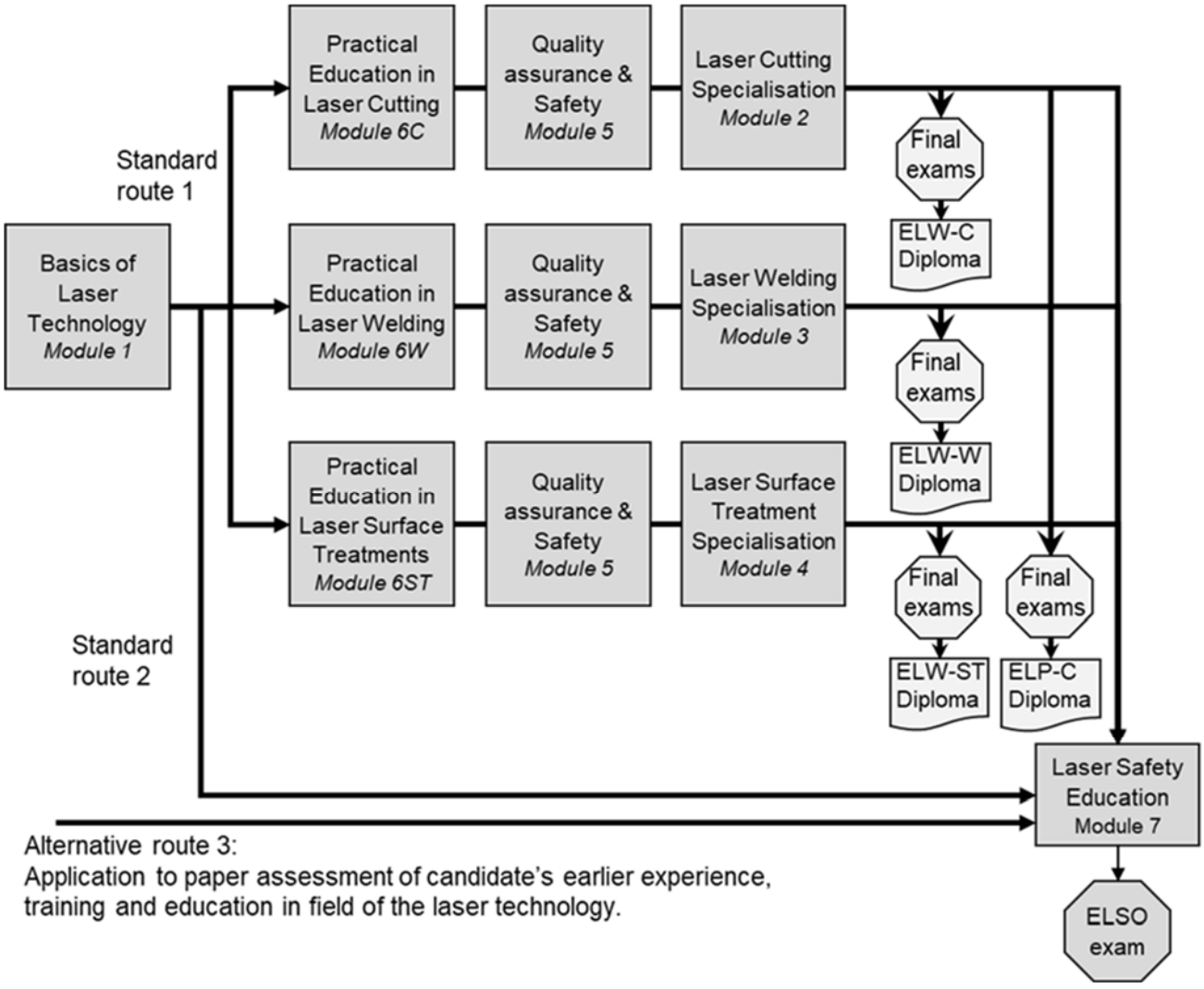


Diagram 10. Routes to European Laser Safety Officer qualification

APPENDIX 3:

Requirements of equipment in practical training

1. General comment:

The ANB which is interested in laser processing personnel training is recommended to apply full authorization of education laser processing personnel training and qualification; this can also refer only to a single field of qualification (cutting, welding or surface treatment).

Each ATB which will train laser processing personnel will apply the authorization to route(s) and level(s) which is suitable for their market and local/national industry.

2. General requirements

It is allowed to carry on the laboratory work in close cooperation with local/national industry (e.g.: training at the customer's facilities).

All the equipment shall be in good working order and fit for its purpose.

3.1 Requirements of equipment in practical education:

Equipment in practical education should fulfil requirements of selected route(s) and purposes of the qualification; this will include the following:

- Laser power sources
- Welding or cutting or surface treatment ancillaries (based on the applicable fields of training and qualification);
- Mechanical testing, metallurgical examination and NDT equipment shall be available for both demonstration and laboratory work purposes.
- well documented specimens, polished and etched, reflecting the field of education and qualification.

In case of laser welding at both comprehensive and basic level it is required:

- a Multi-kilowatt laser power source
- possibly both a CO_2-laser and a 1 µm-wavelength laser (in case one of these are not available, videos must be used)
- hybrid welding equipment (in case this is not available, videos must be used)